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S1 Putting Our Forensic House in Order: The Best Path Forward?

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The forensic science community has had an eventful year. In New Mexico, Governor Bill Richardson cited forensic science as a factor in his decision to endorse the repeal of the death penalty in his state, both for proving the occurrence of wrongful convictions and as a causal factor in wrongful convictions:

> "The system is inherently defective. DNA testing has proven that. Innocent people have been put on death row all across the country. Even with the advances in DNA and other forensic evidence technologies, we can't be 100-percent certain that only the truly guilty are convicted of capital crimes. Evidence, including DNA evidence, can be manipulated."
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> *Press Release of Governor Bill Richardson, March 18, 2009*

This duality in the reputation of forensic science, as a method of proving the truth to achieve justice and as a means of fostering incompetence to subvert justice, resonated throughout the country in the wake of the release of the NAS Report, "Strengthening Forensic Science in the United States: A Path Forward." Forensic scientists and professional organizations immediately issued press releases, white papers, and calls for action to address the Report's indictment of the forensic science system as fragmented, inconsistent, and weakly governed. The contents and conclusions of the Report were not surprising or unexpected for the scientists as many within their ranks had been struggling for years to bring enforceable standards to their scientific disciplines.

For others, attorneys and legislators – even those familiar with the justice system – the Report was an alarm. The shocking truth was that the people within the justice system had little knowledge or appreciation of the reality of forensic science practice. As one of the authors of the Report stated to Congress:

> "I had never heard an appeal in which a criminal defendant challenged the admission of forensic evidence at trial . . . I simply assumed, as I suspect many of my judicial colleagues do, that forensic science disciplines typically are grounded in scientific methodology and that crime laboratories and forensic science practitioners generally are bound by solid practices that ensure forensic science evidence offered in court is valid and reliable. I was surprisingly mistaken in what I assumed."
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> *Statement of The Honorable Harry T. Edwards, Senior Circuit Judge and Chief Judge Emeritus United States Court of Appeals for the DC Circuit, before the United States Senate Committee on the Judiciary, March 18, 2009.*

The Report provided attorneys and other activists with the means to garner the attention of the media and legislators to advance efforts to reform the forensic science system. Some of the reform efforts have focused on setting standards and providing resources for research, training, and certification of forensic scientists. Other efforts; however, have focused on adopting legislation to regulate the presentation of forensic science testimony and evidence in court.

These reform efforts raise the question whether attorneys and legislators, through laws and court rules, should be telling forensic scientists how to do their jobs. Relevant to the debate is the need for regulation and the effectiveness of court rule and legislative controls.

Guided by the proposals submitted by professional organizations, governmental entities, and private groups, the potential effectiveness and utility of reform efforts in the federal and state court systems will be analyzed in this session. Invited organizations include the Innocence Project, Consortium of Forensic Science Organizations, National Association of Criminal Defense Lawyers, the AAFS President's Panel on Scientific Integrity, and representatives from federal executive agencies.

The goals are to provoke debate and to achieve workable solutions to the problems highlighted by the NAS Report.

Interdisciplinary Symposium, NAS Report, Reform

S2 The Future of Forensic Science: Where We Are and Where We Are Going

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Throughout the past twelve years the Young Forensic Scientists Forum has provided a program for a group of attendees ranging from students to professionals new to their career in forensic science. The program has grown and continues to change each year since its inception to provide students and scientists with five years experience or less, with the most quality information possible. The continuing goal is to provide topics relevant to their education and training. The Forum also seeks to provide a comfortable environment for students and professionals new to their respective fields to establish contacts and communicate with their peers and with more experienced members and fellows of AAFS. This year proves to be exciting with a focus on the future of forensics with the theme, "The Future of Forensics: Where We Are and Where We Are Going." Speakers will share their experience, casework, and research in order to give participants an idea as to some of the new advances in forensic techniques, equipment, and even "what not to wear."

Following the daily session, the program will continue with an evening session titled, "Young Forensic Scientists Forum Poster Session." The poster session will feature posters by undergraduate and graduate students as well as forensic science professionals. The poster session will also present new, emerging forensic research, and technologies to attendees.

The annual YFSF Bring Your Own Slides Session, with presentations from students and emerging forensic scientists, is scheduled for Wednesday evening. The program will continue Thursday morning with the annual YFSF Breakfast Meeting, a CV/resume review, and various job related presentations. The presenters will focus on a variety of topics relating to the importance of professionalism when entering into the forensic science field and will share knowledge with participants through an open question and answer period.

It is the goal of the YFSF to foster relationships between the participants of the session with peers as well as established members of AAFS and to provide for a smooth transition from student, to emerging scientist, to established member. With the Forum group setting and the variety of programs offered throughout the week, the YFSF will not only provide academic and relevant technical information to attendees, but will also cultivate relationships that will last throughout a career.

YFSF, Special, Session

ES1 American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB) Symposium – The National Academy of Sciences Report: Impacts of Selected Recommendations on The Operation of Forensic Science Laboratories

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The Committee on Identifying the Needs of the Forensic Science Community: Committee on Applied and Theoretical Statistics National Research Council issued the report *Strengthening Forensic Science in the United States: A Path Forward*. This report contains thirteen "recommendations" all of which are important and will be impacted, perhaps indirectly, but impacted none-the-less, by legislative action in Washington, DC. The requirements to which forensic science laboratories will be expected to conform in the United States will change over the next few years.

There are three recommendations which will most probably impact forensic science laboratory accreditation and will have an immediate effect on the following: the way forensic scientists report analytical findings; the way in which a laboratory exists within a parent organization's structure; and, the requirement to conform to accreditation and certification standards. The specific elements of these three recommendations, in a paraphrased format, are:

Recommendation 2: In conformance with standards including but not limited to ISO 17025, standard terminology will be used in reporting on and testifying about the results of forensic science investigations. Laboratory reports for different forensic science disciplines should specify threshold minimum information necessary for a proper interpretation of results included in the report documentation and testimony. As part of the accreditation and certification processes, laboratories and forensic scientists should be required to utilize model laboratory reports when summarizing the results of their analyses. The terminology used in reporting and testifying about the results of forensic science investigations must be standardized. A side-by-side analysis will be presented comparing the existing reporting standards and terminology definitions found in ISO 17025 with the ASCLD/LAB supplemental requirements. Discussions will center on the need for changes in the accreditation program regarding terminology and report writing.

Recommendation 4: To improve the scientific bases of forensic science examinations and to maximize independence from or autonomy within the law enforcement community, Congress should authorize and appropriate incentive funds for allocation to state and local jurisdictions for the purpose of removing all public forensic laboratories and facilities from the administrative control of law enforcement agencies or prosecutors' offices. Discussions will explore the sufficiency of the ISO 17025 standards for scientific integrity and autonomy of laboratories in light of the NRC report.

Recommendation 7: Laboratory accreditation and individual certification of forensic science professionals should be mandatory and all forensic science professionals should have access to a certification process. In determining appropriate standards for accreditation and certification, the [oversight body] should take into account established

and recognized international standards, such as those published by the International Organization for Standardization (ISO). No person (public or private) should be allowed to practice in a forensic science discipline or testify as a forensic science professional without certification.

Difficult challenges lie ahead for achieving realistic mandatory certification. Possibilities exist within accreditation programs to facilitate and provide opportunities for the functional equivalent of certification. Options for certifications within the accreditation framework will be debated.

The program will include presentations by all speakers, followed by questions from the moderator to the panel. The session will conclude with questions from the audience to the panel members.

ASCLD/LAB Accreditation, NAS Report, NAS Recommendations

ES2 White House Subcommittee on Forensic Science

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A critical first step has been taken in our nation's efforts to improve the scientific foundation of forensic science, as called for in the National Academies of Science (NAS) report *Strengthening Forensic Sciences in the United States: A Path Forward*, as well as other reports. The National Science and Technology Council (NSTC), under the oversight of the Office of Science and Technology Policy, established a Subcommittee on Forensic Science on July 7, 2009. The NSTC, a Cabinet-level Council chaired by the President of the United States, is the principal means within the executive branch to coordinate science and technology policy. The Subcommittee on Forensic Science has three co-chairs, one each from the National Institute for Standards and Technology, the Department of Justice, and the Office of Science and Technology Policy. The Subcommittee has five interagency working groups (IWGs) each of which focuses on specific recommendations of the NAS report:

- Research, Development, Testing, and Evaluation (RDT&E)
- Standards, Practices, and Protocols
- Education and Ethics
- Certification and Accreditation
- Outreach

The Subcommittee and IWGs are composed of individuals representing federal, state, and local public crime laboratories and other federal and state governmental bodies.

The Subcommittee is inviting AAFS members to meet with Subcommittee co-chairs and representatives of each IWG for an update on progress being made to develop recommendations to improve the forensic sciences. This session will also provide an opportunity for Academy members to provide input and commentary to the Subcommittee regarding the path forward.

White House, NAS Report, Forensic Science

BS1 The Child Sexual Abuse Accommodation Syndrome (CSAAS): AMyth That Should be Banished From the Courts – Lessons From the Country Walk Case

Mohan Nair, MD, PO Box 849, Seal Beach, CA 90740; Rob Friedman, JD*, 301 South Monroe Street, Suite 401, Talahasse, FL 32301*

After attending this presentation, attendees will learn about the concept of the Child Sexual Abuse Accommodation Syndrome (CSAAS), current scientific support (or lack thereof), and concerns about ongoing misuse of CSAAS in the courtroom.

This presentation will impact the forensic science community by providing details of mental health professionals, lawyers, judges, law enforcement, and child protection workers who deal with sexually abused children will be made aware of the ongoing concerns about the lack of validity of CSAAS and its harmful impact in legal proceedings involving child sexual victimization.

In the early 1980s, courts eagerly admitted expert testimony in child sexual abuse prosecutions because of increased public awareness of the problem of child sexual abuse. In 1983, Dr. Roland Summit published an article titled *The Child Sexual Abuse Accommodation Syndrome (CSAAS)* in order to dispel certain misconceptions regarding the behaviors of the sexually abused child. Summit classified the reactions of the sexually abused child into five categories: (1) secrecy; (2) helplessness; (3) entrapment and accommodation; (4) delayed, conflicted, and unconvincing disclosure; and (5) retraction. This scientifically unsubstantiated and flawed theory became the wellspring of "expert evidence" in showing that a child had been sexually abused in the face of data that may suggest otherwise.

About a decade later, due to the concerns about the misuse of CSAAS as a CSA diagnostic tool, Summit, in 1992, explained that his 1983 theory was a "clinical opinion and not a scientific instrument." How meaningful this "retraction" was remains unclear in view of Dr. Summit's insistence (at least as of 1994) that the children of McMartin were indeed abused and the tunnels under the preschool are real.

Much of the premise for Summit's Child Sexual Abuse Accommodation Syndrome has been found to be not true. More recent studies of disclosure do not suggest any association between the relationship to the perpetrator and the delay. Higher disclosure rates were associated with incidents of sexual abuse that involved threats of physical injury rather than the other way around as he claimed. Only a minority of children who made claims of CSA recant.

Though no longer in the textbooks, with no new research that supports it in 20 years and overwhelming research that undermines its premise, CSAAS continues to be rolled out into courts by "experts " to "rehabilitate" alleged victims whose accounts and circumstances lack credibility. A recent high profile case where CSAAS was used by the prosecution involved the allegations against singer Michael Jackson in 2006. CSAAS is a dangerous theory that fails to meet the threshold for Daubert, has done immense damage and no good, and needs to be banished from the courtroom.

A notable misuse of the CSAAS is the 1984 Country Walk (Florida) child molestation case which resulted in a 35-year-old Cuban immigrant being sentenced to 165 years in prison and shares the same bizarre characteristics as other infamous CSA cases of that era: the McMartin Preschool case in Manhattan Beach California, the Kelly Michaels (Wee Care) case in New Jersey, and the Little Rascals case in North Carolina, all of which have been reversed.

Case presentations will discuss how untrained and unqualified "experts," Joe and Laurie Braga, used highly leading, suggestive interviewing strategies, and the use of anatomically detailed dolls detailed in the videotapes they maintained; and detail the multiple children interviewed by the same people who produced horrific and bizarre stories of sexual assault, being satanically ritually abused by masked men, snakes, drills, and other objects.

The only child who apparently showed physical evidence of abuse was Francisco Fuster's son, Noel, who tested positive for gonorrhea of the throat; however, the evidence was destroyed three days later, before the defense had any opportunity to retest. The validity of the test results were questioned and Noel, now an adult has repeatedly claimed that he was coerced to make false allegations against his father. Ileana Fuster, Francisco's wife and codefendant claims that she was, kept naked in solitary confinement and subjected to hypnotic brainwashing and coerced into testifying against her husband for a reduced sentence.

The Country Walk case is important in that the prosecution (and their experts) have insisted that it was an investigation and trial where everything was done "right." It remains a high profile case, handled closely by then Florida Attorney General Janet Reno, a case with multiple appeals, one where academics continue to fight over at the present time. A tragic difference between Country Walk and the other cases is that in the other cases, the courts reversed the findings. Francisco Fuster remains convicted and in prison.

False Memories, Ritual Abuse, Accommodation Syndrome

BS2 Fatal Forensic Moments — When Murphy's Law Enters the Court of Law

Susan E. Morton, BA, 821 Kains Avenue, San Bruno, CA 94066*

This presentation will take a light-hearted look at some unexpected disasters experts have faced in court and lived to tell about. The experienced expert may relive some or his or her own moments; the novice may be heartened to learn that human moments can be survived.

This presentation will impact the forensic science community by providing perspective on courtroom misadventures and benefit from the wisdom of those who have survived them.

We all prepare for things that can go wrong, but what about those things that were never thought of? That couldn't possibly happen? Just how does an expert make an accidental head-first summersault into the jury box look like part of a well prepared presentation? How did that bug get into my underwear and where is it going next? Why am I sitting on the floor surrounded by splintered wood instead of on the witness chair? All of these events were not related to the evidence being presented or anything else that anyone might have imagined happening. No one blundered; fate simply intervened.

Many of these events have befallen the presenter; other yarns have been gathered over a long career comparing notes with colleagues, usually while consuming adult beverages. Everyone has a story—and I am grateful that some have shared theirs with me. I will pass them along and hope that you enjoy these tales as much as I have, and indeed, as much as the participants do, now at a safely remote time.

The attendee may gain some insight in how to survive disasters or at least the wisdom to know that they can be survived. Humiliation is not the end of life as we know it. Egos survive, careers survive, and the courts carry on.

Testimony, Disaster, Wisdom

BS3 Cold Cases: An Evaluation Model for Investigators

James M. Adcock, PhD, 1812 Rambling Rose Lane, Hattiesburg, MS 39402; and Sarah L. Stein, MFS*, 1812 Rambling Rose Lane, Hattiesburg, MS 39402*

After attending this presentation, the attendees will be briefed on some of the reasons why the United States has so many cold cases (unresolved homicides). They will then learn how to conduct an organized approach of analyzing and evaluating old investigations with a view towards an accurate resolution with a successful prosecution.

This presentation will impact the forensic community by providing law enforcement agencies with a finite, scientific approach to the evaluation process for unresolved homicides. If the model is diligently followed it should significantly contribute to the solvability of these crimes.

In the United States, there are literally thousands of unresolved homicides and considering the past and present clearance rates that hover around 62%, this number of cold cases will increase over time. The causes of the phenomena are many and while not detailed in this lecture some of the significant reasons will be mentioned as a backdrop to the proposed model.

This Cold Case Evaluation Model was specifically designed to assist investigators and others through a regimented step by step process of reviewing and analyzing unresolved homicides. It is also suggested that anyone adopting this model should seriously consider the utilization of members from the private sector such as doctors, professors, nurses, business people and/or graduate students, etc., to conduct the evaluation under the direct supervision of at least one senior police detective. This will bring another dimension to the process as these evaluators will have fresh eyes and perspectives that are not jaded or biased by prior law enforcement experience.

The model is based on the premise that each investigation has three major aspects consisting of physical evidence, informational evidence (e.g., interviews, canvassing results, records checks, etc.), and the behavioral actions of both the victim and suspect(s). It contains numerous team meetings during each of the four phases where the information is fleshed out and the question? "How Do We Know That?" is answered with confidence and proper documentation.

There are four phases to the model that should be followed without exception. Phase I is the process of determining solvability factors and organization of the case file into categories followed by alphabetical and chronological listing of information under each category. Phase II lists all the physical evidence, correlates it to the information in the file, and suggests further testing. It also contains a comprehensive witness list. Furthermore, Phase II, provides the victimology and designs timelines as dictated by the information in the case file. In Phase III, relationship charts are designed, logic trees for evidence and other concerns are developed, suspectology for all suspects is identified along with suggested interview strategies for the investigative plan. Finally, in Phase IV the group discusses and identifies pre-, peri-, and post-offense behaviors relating to all suspects, lists all pros and cons for each suspect, prepares a thorough investigative plan, and writes the evaluation report.

The application of this cold case evaluation model will reduce time and resources in identifying what is solvable and will provide the investigators with a detailed plan of how to successfully resolve the investigation with a view towards prosecution.

Cold Cases/Homicides, Evaluation Model, Investigators

BS4 Patriotism, Perseverance, and Adaptability – The Amazing Story of Battlefield Forensics

David Wikoff, BA, United States Army Intelligence Center, USAIC, Fort Huachuca, AZ; and Michael J. Salyards, PhD, 4930 North 31st Street, Forest Park, GA 30297*

After attending this presentation, attendees will: (1) understand the role of forensic science in the expeditionary environment; and (2) learn the history of battlefield forensics.

This presentation will impact the forensic science community by discussing a transformational application of forensic science and highlights the dedication and ingenuity of several key players.

This presentation recalls the story of three men who transformed the way forensic science is used on the battlefield. During 2004 – 2005, David Wikoff, Greg Pitsenberger, and John "Crit" Bartley accepted an experimental mission in Iraq to identify combatants hiding within the local populace by recovering latent fingerprints. Their efforts led the movement to permanently implement forensics in the expeditionary environment. Interviews of these heroes with pictures and statistics will be used to tell this impressive story and show the effectiveness of forensic science in the tactical arena.

In 2004, Improvised Explosive Devices (IEDs) were the lead killer of troops in the war in Iraq. The National Ground Intelligence Center was tasked to fight the network of insurgents responsible for IEDs. As a part of that effort, they proposed a 30 day experimental forensic technician program to determine the usefulness of obtaining fingerprints in this tactical environment. Based on his broad experience as a former Marine and detective, Dave Wikoff was chosen to be the first person into Iraq to recover latent prints from IEDs. But after he arrived, he was initially prohibited from taking fingerprints. So, after reading recommended electronics books, he began producing technical intelligence reports that mapped the circuitry of IED devices. This collective effort led to an amazing journey across the combat zone which involved being shot at by sniper fire, rocket attacks, dragging insurgent's dead bodies behind points of cover to obtain their postmortem fingerprints, and processing body parts for forensic value. These efforts eventually led to the recovery of latent fingerprints, toxicology samples, explosive residue samples, and DNA samples from of numerous post blast IED attack sites and deliberate operations. Soon after, he would meet soldiers with material they had saved for him to fingerprint.

On one occasion, he received rocket launcher tubes used in a recent attack. Inside of the tape used to hold the weapon together, he discovered latent prints. However, Mr. Wikoff's original forensic equipment did not provide the capability to obtain prints from the inside of tape. Using an old detective trick, he mixed fingerprint powder, hand soap and water, and applied the mixture to the tape. Holding the camera with one hand and an alternate light source with the other, Wikoff crouched under an old tarp to take pictures. Soon Mr. Wikoff was processing rocket launchers and other more relevant material. Mr. Wikoff was awarded the Superior Civilian Service Medal for "Courage Under Fire, Perseverance, and Persistence." Despite being recognized for his success, Mr. Wikoff privately agonized he had not truly made a difference to the war fighter. He served as a short time as a Biometric Intelligence Analyst. One day he received a request to research a latent print match and assumed that it was an FBI generated match, but as he dug into the case he opened the image of the latent print and recognized the fluorescent ridges. It was a match to the rocket launcher tape he photographed on his knees with the tarp thrown over his back.

Battlefield Forensics, Latent Finger Prints, Improvised Explosive Devices

BS5 A Tale of Two Fetishes – A Case of Sexually Motivated Murder

Robert J. Morton, MS, Federal Bureau of Investigation, CIRG/NCAVC, FBI Academy, Quantico, VA 22135*

After attending this presentation, attendees will be exposed to the bizarre nature of fantasy involved in sexually motivated murder.

This presentation will impact the forensic science community by highlighting different fetishes that are seen in cases of sexually motivated murder and presenting the depth of these types of proclivities.

This presentation is designed to highlight a unique sexually motivated murder and the unusual fetishes displayed by the offender. This presentation will impact the forensic community by highlighting the bizarre behavior that manifests itself in sexually motivated murder cases, including the interactions with the victim and the scope of fantasy fetish material that offenders maintain.

The FBI's National Center for the Analysis of Violent Crime (NCAVC) is routinely consulted by federal, state, and local authorities in a variety of cases of bizarre and repetitive violent crimes, especially homicides. NCAVC assistance was requested by local authorities in regards to a case involving the murder of a local woman who was found dumped in the rural area of the county. The victim had been strangled and sexually assaulted.

The victim worked as a waitress and was last seen leaving work after her shift. The investigation quickly focused on a possible suspect, a local dentist who frequented the restaurant where the victim worked and had what was described as an unusual interest in the victim. After being questioned by the police, the suspect attempted to commit suicide.

After forensic evidence showed that the victim had been in the suspect's vehicle, the suspect was arrested. During questioning, the suspect stated that he and the victim had engaged in consensual sex, and the victim "accidently" died. The suspect panicked and removed the victim from his residence and disposed of her body.

The suspect also confessed to have several fetishes including necrophilia and a foot fetish. He claimed he had begun this obsession with feet and dead bodies as a result of his being exposed as a dental student to the morgue after the Oklahoma City Bombing case. He stated that since that time he was very interested in both areas and collected pictures and videos that utilized those themes. He even paid a company to make two movies involving both fetishes.

The suspect was also investigated for several other murders that had occurred in Oklahoma. He was indicted, eventually pleaded guilty to murder, and was sentenced to life in prison.

This case highlights the need to understand paraphilias and other bizarre sexual practices that manifest at crime scenes of sexuallymotivated murder.

Forensic Science, Sexually Motivated Murder, Fetish

BS6 Management of a Mass Disaster

Sawait Kanluen, MD, Chulalongkorn University, Department of Forensic Sciences, 254 Phayathai Road, Bangkok, 10330, THAILAND*

After attending this presentation, attendees will learn a systemic approach to managing a mass disaster utilizing major aviation disasters as examples.

This presentation will impact the forensic science community by allowing attendees to learn how to integrate scientific, operational, and scene management at a mass disaster site.

Casualties from mass disasters such as earthquakes, fires, hurricanes, and aviation disasters are becoming more frequent as the world's population continues to increase and development extends into previously rural areas. This presentation will focus on the management of aviation disasters utilizing the crash of Northwest Airlines Flight 255, Northwest Airlines Flight 1482, and ComAir Flight 3272 as examples.

Without proper planning, preparation, and practice, a mass disaster can be the "second disaster" for the medical examiner's office. The initial step in any mass disaster is to enlist local law enforcement to secure the scene to ensure safety for employees, limit tampering with the scene, and prevent theft of personal effects of victims. All scene personnel should wear photo identification badges without exception. Initial evaluation involves formulating a plan using the magnitude of the casualties, victim conditions, location, and likely identification method.

Body recovery is a vital step and usually occurs after the scene has been secured. The body recovery team includes a medical examiner office investigator, law enforcement, photographer, and scribe. A grid system should be used to mark the location of bodies discovered. Photographic documentation of the victim, personal effects, and location should occur prior to body transport. A refrigerated truck should be used for transport to the temporary morgue to prevent further decomposition of bodies. In an aviation disaster, a hanger and warehouse close to the crash scene can be used as a temporary morgue facility. A Disaster Portable Morgue Unit is available from the Federal Disaster Mortuary Operational Response Team and contains forensic equipment, computers, scientific supplies, as well as digital, dental, and photographic equipment for a temporary morgue. The morgue facility should have multiple areas to be able to accommodate receipt of the body, to conduct victim property inventory, body assessment and autopsy, dental identification, fingerprinting, photographic documentation of process, and body storage. A family assistance center, usually facilitated by the airline, should obtain antemortem records such as dental, medical, and x-rays from families and provide rooms for death notification and grief counseling.

To effectively manage a mass disaster, the medical examiner's office should have a written mass disaster plan and participate in regular mock drills.

Mass Disaster, Aviation Disaster, Airplane

BS7 School Bus Crash and Olga Franco: The Rest of the Story

Donn N. Peterson, MSME, Peterson Engineering, Inc, PO Box 664, Brainerd, MN 56401-0664*

After attending this presentation, participants will learn how biases and prejudices of multiple parties can adversely affect the outcome in a high profile highway accident case. Examples will be given to show bias and prejudice on the parts of first responders, investigating officers, news media, state police accident reconstructionist, prosecutor, and jury. They will also gain affirmation that simplified analyses can lead to significant errors in an accident reconstruction.

This presentation will impact the forensic science community by demonstrating how biased and incomplete analyses can lead to significant errors in an accident reconstruction and to a wrongful conviction of a person who is not guilty of the charges. Preconceived notions of physical phenomena may be wrong and difficult to view objectively.

On February 19, 2008, a cold winter afternoon in southwestern Minnesota, an eastbound minivan "blew" through a stop sign and crashed into the right side of a southwest bound school bus in an open country intersection. The school bus went out of control, continued moving southwest while rotating clockwise such that its rear end occupied most of the oncoming lane. A northeast bound pickup crashed into the rear left side of the school bus. The school bus came to rest on its left side in the northeast bound lane southwest from the intersection

facing southwest. Its rear axle was separated, and it came to rest near the rear end of the school bus. The pickup came to rest upright on the northeast bound shoulder facing northwest with its front end beneath the school bus left side. The minivan came to rest upright in the southwest bound lane facing northeast about 1½ car lengths southwest from the intersection. Four student passengers in the school bus were fatally injured and eleven others suffered personal injuries. Olga Franco, an illegal immigrant from Guatemala, was found on the driver's seat of the minivan owned by her boyfriend with her right foot trapped near the foot pedals, and no one else was found in the minivan.

Olga Franco, who speaks little or no English, consistently states through interpreters that her boyfriend was the driver and that she was the front seat passenger. They were on their way to work and would have made a 580 left turn at the intersection. Her boyfriend was never found. She was treated in a hospital, incarcerated, charged with gross negligence in being the driver causing the fatal crash, tried, convicted, and sentenced.

Many persons bought into the preconceived notion of physical phenomena that it would be impossible for Olga Franco to be found on the driver's seat with her right foot trapped near the foot pedals unless she had been the driver. They went on to conclude simply that Olga Franco must be lying when she says her boyfriend was the driver.

The frequent news media reports contained only selected elements from the events for their story. Most of the public following these reports were not even aware that the pickup had been involved. They also were not aware that tests of blood on the minivan's deployed airbags showed the DNA did not match Olga Franco but were from an unidentified male. Very few news media sources reported that Olga Franco had said her boyfriend was the driver with little or no follow up.

Engineering analyses show how, in a crash like this, a minivan front seat passenger would be moved toward the driver's seat and a driver would, in a crash like this, be moved toward the opened driver's door. This concept is contrary to the previously referenced preconceived notion of physical phenomena and was totally disregarded by the prosecution and the jury.

Engineering analyses also showed that the second crash with the pickup was several times more severe than the first crash with the minivan. Thus, the second crash with the pickup most probably caused the severe injuries and fatalities to the students on the school bus. Post collision spinning in yaw by the minivan accounted for about 2.5 times as much kinetic energy as that due to linear translation. Thus, any analyses that do not account for the spinning effects are subject to significant errors in the post collision dynamics.

Accident Reconstruction, Bias, Prejudice

BS8 Thomas Krauss Memorial Bite Mark Breakfast: Forensic Pathology and the Media

Jan C. Garavaglia, MD, District 9 Medical Examiner, 1401 Lucerne Terrace, Orlando, FL 32806*

After attending the presentation, the attendees will: (1) appreciate the complex interactions between the media and the forensic pathologist; and, (2) be better prepared to deal with media requests and pressures.

This presentation will impact the forensic community by providing a unique perspective on media relations.

The forensic pathologist has long been taught to keep a low profile and to speak to the media as little as possible, and then only when the investigation is complete. This presentation will offer the personal experiences of the author who has followed a somewhat different model – one that has included a long running syndicated TV show about forensic pathology as well as a book, and how these efforts have affected the function of the office and her abilities as a medical examiner. Perhaps surprisingly, the presenter has found that these forays into the world of "educational entertainment" have actually enhanced her office's reputation and helped her become a better and more compassionate medical examiner.

The presentation will also cover the growing separation between the media's expectations and the reality of the job of medical examiner and will review the conflicts which inevitably arise from this dichotomy. A variety of suggested do's and don'ts for media interactions will be offered, including hard learned advice on pitfalls to avoid.

Media Relations, Medical Examiner and the Press, Popular Culture and Pathology

L1 "Smart" Criminals Brought Down by Cutting Edge Forensic Science

Ann Rule, BA, PO Box 98846, Seattle, WA 98198*

After attending this presentation, attendees will learn how the tiniest scintilla of physical evidence has helped to convict killers.

This presentation will impact the forensic science community by bringing to light case studies of killers in the U.S. and how minute amounts of evidence helped solve the crime.

Killers are almost always quite intelligent and feel impervious to challenges by crime scene investigators, forensic pathologists, and forensic labs. However, time and again, their smug self-confidence trips them up. Using several of the cases researched in-depth, this presentation will highlight how the tiniest scintilla of physical evidence helped to convict them.

Several cases will be presented, specifically a segment on Ted Bundy and the things he didn't know about forensic science that trapped him—long before DNA appeared. Also presented is a case on Diane Downs, a murderous mother who recently had her first chance at parole turned down, had an I.Q. of over 140, but she didn't know much about ballistics or blood patterns on bandages.

Speaking of DNA, this presentation will discuss cases that were cold for more than 30 years and would surely have remained so—were it not for DNA matches.

Diane Downs, Investigation, Bundy

L2 Forensic Jeopardy!

Carl Wigren, MD, 449 Wells Avenue, North, Renton, WA 98057-5404*

The goal of this presentation is to present an interactive and fun parody of the *Jeopardy* game giving a forensic twist to the television hit.

This presentation will impact the forensic science community by providing a fun, thrilling and knowledge gaining presentation of forensic facts.

Categories include Mind Your Manners, Manners of Death, Annie Get Your Gun, For the Gun Nuts, Rotten Stuff, Decompositional Changes, Tinker Toys, Anatomy With Forensic Significance; and Others. See if you can answer basic forensic knowledge questions to extremely difficult questions. This fun session is sure to elicit cheers as well as collective "boos" from the crowd.

Forensic, Jeopardy, Forensic Facts

W1 Assessment and Interpretation of Toxicology in Neonatal, Pediatric, and Geriatric Deaths

Barry K. Logan, PhD, and Laura M. Labay, PhD*, NMS Labs, NMS Labs, 3701 Welsh Road, Willow Grove, PA 19090; Suzanne White, MD*, Wayne State University, Department of Emergency Medicine, 4201 St. Antoine, Detroit, MI 48201; Dennis J. Wickham, MD*, Office of Medical Examiner, PO Box 5000, Vancouver, WA 98666-5000; Ruth E. Winecker, PhD*, Office Chief Medical Examiner, Campus Box 7580, Chapel Hill, NC 27599-7580; and Walter I. Hofman, MD*, Montgomery County Coroner's Office, HSC, Ground Floor, 1430 DeKalb Pike, Norristown, PA 19401*

After attending this workshop, attendees will be able to: (1) define the terms "neonatal," "pediatric," and "geriatric," and describe the uniqueness of these populations as they apply to the practice of toxicology; (2) describe the most commonly encountered substances in these populations; (3) explain how the pharmacokinetic profiles of drugs may be affected in these populations; and, (4) identify the factors that should be taken into account when evaluating toxicological findings in these types of cases.

This workshop will impact the forensic science community and mankind as a whole by improving the quality of the investigation of death in these two challenging populations.

This workshop will examine the special considerations that need to be taken into account in pediatric and geriatric populations when ordering tests and interpreting test results. Presentation topics will include pharmacokinetic and pharmacological idiosyncrasies of these populations, investigation of SIDS deaths, and appropriate scope of toxicological analysis.

Pediatric, Geriatric, Toxicology

W2 Tools for Controlling Cognitive Biases in Casework

Chesterene L. Cwiklik, BS, Pacific Coast Forensic Science Institute, 2400 6th Avenue South, Suite 256, Seattle, WA 98134; and Kerstin M. Gleim, BA, BS*, Pacific Coast Forensic Science Institute, 2400 6th Avenue South, Suite 256, Seattle, WA 98134*

Upon completion of this workshop, the participants will be introduced to a logical framework for making casework decisions that control for cognitive biases and assist with making clear, useful, defensible, scientifically sound, and legally reliable decisions about the focus, priority and sequence of examinations, and what the results mean. This provides a means for laboratory work to meet the needs of the users and the needs of the courts and criminal justice system as a whole. These tools can be used by scientists in both the civil and criminal arenas to make decisions about casework, by laboratory management to make casework policy and allocate resources, by quality assurance officers to monitor controls for bias, and by attorneys and judges evaluating scientific work and making decisions about its use.

The role of the scientist in society is to provide information for other people to use in making decisions. The responsibility of the forensic laboratory is to provide the criminal justice system with good science applied to evidence in criminal or civil investigations: work that the users, the courts, and individuals accused of crimes or civil issues can be confident is useful, complete, and fair. The role of the forensic practitioner is to provide accurate, useful, and reliable scientific work on individual cases – work that can answer questions, withstand scrutiny, and address concerns raised by the NAS report. This presentation will impact the forensic science community by providing conceptual tools (i.e., reasoning tools) for the forensic practitioner and manager to use in making the everyday decisions upon which sound and defensible scientific information rests. A corollary focus is to provide attorneys and judges with reference points for evaluating the reliability of the information.

This half-day workshop is an introduction that addresses the steps between the receipt of a request for laboratory services and the beginning of testing. It also addresses the final steps when the forensic scientist must decide when the work is complete. Decisions made at the initial stage can control for cognitive bias and have a large impact on the final evaluation of evidence and the reliability of the final results. Hypothesis generation and testing flow from decisions about which items to examine, in what sequence to examine them, and which samples to collect for testing, and in turn affect decisions about when the work is complete. These decisions rely upon human interpretation (i.e., judgment).

This workshop will provide tools that the forensic practitioner can use in managing cognitive biases in the judgment part of casework. The approach emphasizes distilling information from the users of laboratory services (e.g., submitting agencies and attorneys) into scientifically testable questions that allow formation of multiple hypotheses at the outset and the formation of an analytical plan. Participants will apply these tools to case examples, making impact-based decisions early in the case; then as the case progresses, applying scientific reasoning to the case issues; and concluding work by evaluating the impact of results on the case hypotheses and determining whether the criterion of falsifiability (of interest to the courts) has been met. The principles are drawn from scientific practice and forensic literature and addresses concerns raised in the National Academy of Sciences report on the forensic sciences. The principles, based upon the scientific method, are presented as conceptual (reasoning) tools that are applied in a step-wise fashion to casework examples from criminalistics cases. Workshop participants will practice applying the tools in making casework judgments that are logical, minimize bias, can be documented, and rely upon scientific reasoning:

1. Multiple hypotheses at the outset to control for bias and lay the groundwork for final evaluation of results.
2. A framework for deciding which items to examine and when.
3. A framework for interpreting testing results based upon the weighing of hypotheses.
4. Reference points for knowing when you are done.
5. Having defensible work, records, conclusions, and testimony.

The presentation will consist of interwoven lectures, casework examples, and discussion exercises, applying conceptual tools to the casework examples.

Bias, Hypothesis Formation, Inference

W3 The Recognition, Detection, and Significance of Gunshot Residues

Vincent J. Desiderio, MS, New Jersey State Police, Central Laboratory, 1200 Negron Road, Hamilton, NJ 08691; Peter J. Diaczuk, BS*, 555 West 57th Street, New York, NY 10019; Michelle D. Miranda, MS, 365 5th Avenue, New York, NY 10016 and Michael A. Trimpe, BS*, Hamilton County Coroner's Office, 3159 Eden Avenue, Cincinnati, OH 45219*

After attending this presentation, attendees will have a better understanding of the construction and function of firearms and ammunition, the mechanisms of gunshot residue formation and deposition, and the forensic methods employed for the detection and interpretation of gunshot residues.

This workshop will impact the forensic community by providing training on the methods used for the detection of gunshot residues and the significance of any findings.

This full day workshop will discuss the various factors involved in detecting and interpreting gunshot residues. Special attention will be paid to the construction and function of firearms and ammunition and the forensic methods employed for this purpose.

GSR, Firearms, Distance Determinations

W4 Determining the Manner of Death in Equivocal Death Investigations: Homicide, Suicide, Accident, or Natural?

Vernon J. Geberth, MS, MPS, PHI Investigative Consultants, Inc., PO Box 197, Garnerville, NY 10923; Barbara C. Wolf, MD*, Chief Medical Examiner, District 5 Medical Examiner's Office, 809 Pine Street, Leesburg, FL 34748; and Mary I. Jumbelic, MD*, Chief Medical Examiner's Office, Onondaga County, Medical Examiners Office, 100 Elizabeth Blackwell Street, Syracuse, NY 13210-2303*

After attending this presentation, attendees will better understand the importance of crime scene integrity, the management of the homicide investigations, and the processing of the homicide crime scene as well as the application of the medicolegal investigation specifically as it relates to cause and manner of death and the evaluation of the lethality of injuries and wounds.

This presentation will impact the forensic science community by familiarizing forensic scientists and investigators in the art and science involved in death investigation.

Upon completion of this workshop, the participants will have an understanding of the unique dynamics of equivocal death investigations and the application of professional homicide investigation and medicolegal analysis to these events.

Equivocal Death, Manner of Death, Victimology

W5 The Forensic Tools Utilized to Reconstruct Death Scenes

Mary Fran Ernst, BLS, Saint Louis University Medical School, Division Forensic Pathology & Education, 6039 Helen Avenue, Saint Louis, MO 63134; Julie A. Howe, MBA, Saint Louis University, Division of Forensic Pathology, 1402 South Grand Boulevard, R512, Saint Louis, MO 63104-1028; Mary E.S. Case, MD*, Saint Louis University, 6039 Helen Avenue, Saint Louis, MO 63134; Neal H. Haskell, PhD*, 425 Kannal Avenue, Rensselaer, IN 47978; Paul E. Kish, MS*, Forensic Consultant & Associates, PO Box 814, Corning, NY 14830; and Timothy M. Palmbach, JD*, University of New Haven, Department of Forensic Science, 300 Boston Post Road, West Haven, CT 06516*

After attending this presentation, attendees will become familiar with methods and techniques involved in investigating and reconstructing multidisciplinary death scenes.

This presentation will impact the forensic science community by enhancing tools and techniques used in a multidisciplinary approach to reconstructing a death scene.

The reconstruction of a death scene is a complex problem which requires a multidisciplinary approach involving investigators as well as forensic scientists. A successful reconstruction requires cooperation between forensic disciplines with each knowing their respective roles in the reconstruction process. Reconstruction done properly is an applied science that can be conducted in a manner consistent with the scientific method. The body provides a wealth of pertinent information essential to determining much about the decedent and the events surrounding death. Those who possess the insight and skill to reconstruct life's last moments may ascertain an enormous amount of information from the decedent. A thorough, systematic inspection of the scene as well as the decedent assists all involved in the investigation and its outcome. The scene investigation is a primary source of information for medical examiners and coroners to determine cause and manner of death. Two of the more commonly encountered forms of forensic evidence associated with death scenes are bloodstains and the by-products of a discharged firearm(s). The critical examination of these two types of evidence can assist an investigator in determining the events surrounding a violent death. This workshop will demonstrate the forensic tools used to reconstruct death scenes, the thorough inspection of the decedent, methods of determining time of death and the difficulties therein, collection of pertinent information for the forensic pathologist to correctly determine cause and manner of death, as well as the reconstructing of death scenes with bloodstain pattern analysis and shooting incident reconstruction.

Reconstruct Scenes, Death Scenes, Forensic Tools

W6 Forensic Applications of Raman Spectroscopy

Patrick Buzzini, PhD, West Virginia University, Forensic & Investigative Sciences, West Virginia University, 304 Oglebay Hall - PO Box 6121, Morgantown, WV 26506-6121; Edward G. Bartick, PhD*, Suffolk University, Department of Chemistry/Biochemistry, Beacon Hill, 41 Temple Street, Boston, MA 02114-4280; John Lombardi, PhD*, City College of New York - CUNY, 138th Street & Convent Avenue, New York, NY 10031; and Edward M. Suzuki, PhD*, Washington State Patrol Crime Lab, 2203 Airport Way, South, Suite 250, Seattle, WA 98134-2045*

Upon completion of this workshop, participants will have a better understanding of raman spectroscopy and a greater appreciation of the potential capabilities of this technique for the analysis of a variety of evidentiary materials.

Recent technological progress in developments of commercially available instruments, deeper research and applications in casework has

rendered this method more attractive for forensic laboratories. The experience, knowledge, and related information presented in this workshop will impact the forensic science community by helping in the implementation of this technique in the laboratory setting.

This workshop covers the different applications of raman spectroscopy for the examination of different types of substances frequently submitted for analysis to a forensic laboratory.

Raman, Spectroscopy, Criminalistics

W7 Signature Examination: Translating Basic Science to Practice

Linton Mohammed, MFS, San Diego County Sheriff Crime Lab, 5255 Mount Etna Road, San Diego, CA 92117; Michael Caligiuri, PhD*, University of California, San Diego, 3350 La Jolla Village Drive, San Diego, CA 92161; Peter V. Tytell, BA, Forensic Research, 116 Fulton Street, Suite 2W, New York, NY 10038-2712; and Karen S. Runyon, BA, 400 South 4th Street, Suite 505, Minneapolis, MN 55415*

The goal of this workshop is to provide attendees with an understanding of the neuroscience and motor control processes involved in the production of normal handwriting. Research in the effects of simulation, disguise, medication, disease, and aging on handwriting movement and signatures will be presented, and the attendees will have the opportunity to work on hands-on examples which may improve their ability to distinguish between various types of signature behavior.

This workshop will impact the forensic science community, specifically those in questioned documents, by providing attendees with information about the various process involved in handwriting and data that may enable more objective and quantitative decision-making and guide future research in forensic document examination.

This workshop comprises theoretical and practical components. It gives an overview of motor control systems in handwriting and explores recent kinematic studies in signatures. The workshop will provide information on the effects of medication, illness, and aging on handwriting.

Document Examination, Signatures, Motor Control

W8 Forensic Multimedia Analysis

Zeno J. Geradts, PhD, Netherlands Forensic Institute, Ministry of Justice, Laan van Ypenburg 6, Den Haag, 2497 GB, NETHERLANDS; Richard Vorder Bruegge, PhD*, and Nicole A. Spaun, PhD*, Federal Bureau of Investigation, FBI-FAVIAU, Building 27958A, Pod E, Quantico, VA 22135; William R. Oliver, MD*, Georgia Bureau of Investigation, Northwest Regional Crime Lab, 533 Underwood Drive, Trion, GA 30753; and Ivo Alberink, PhD*, Jurrien Bijhold, PhD*, and Bart Hoogeboom, MS*, NFI, Laan van Ypenburg 6, Den Haag, 2497 GB, NETHERLANDS*

After attending this workshop, attendees will understand the possibilities and limitations of forensic multimedia analysis.

This presentation will impact the forensic science community by providing an overview of tools in forensic multimedia analysis, including an overview of state-of-the art tools and techniques. It will reference the National Academy of Sciences report and how they can be implemented.

This workshop on forensic image and video analysis covers the broad field of investigations, from camera comparison, to image enhancement, length measurement, 3D-model, facial comparison, and imaging in pathology. For some parts of the workshop, it is advised to bring a laptop with you for the hands-on experience.

Image Analysis, Photogrammetry, Camera Comparison

W9 Advances in Forensic DNA Analysis

Steven B. Lee, PhD, San Jose State University, San Jose State University, 1 Washington Square, Macquarrie Hall 521, San Jose, CA 95192; Jaiprakash G. Shewale, PhD*, Life Technologies, 850 Lincoln Centre Drive, Mail Stop 402, Foster City, CA 94404; Bruce Budowle, PhD*, Forensic & Investigative Genetics, University of North Texas Health Science Center, 3500 Camp Bowie Boulevard, EAD 310, Fort Worth, TX 76107; Michael D. Coble, PhD*, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, 2nd Floor, Rockville, MD 20850; Arthur J. Eisenberg, PhD*, University of North Texas - Health Science Center, 3500 Camp Bowie Boulevard, Fort Worth, TX 76107; Cecelia A. Crouse, PhD*, Palm Beach Sheriff's Crime Lab, 3228 Gun Club Road, West Palm Beach, FL 33406; Peter Michael Vallone, PhD*, National Institute of Standards & Technology, 100 Bureau Drive, Gaithersburg, MD 20899-8311; Ranajit Chakraborty, PhD*, Department of Environmental Health, University of Cincinnati College of Medicine, Cincinnati, OH 45267; Nader Pourmand, PhD*, University of California, Santa Cruz, 1156 High Street, Department of Biomolecular Engineering, Santa Cruz, CA 95064; and Charles H. Brenner, PhD*, DNAView, 6801 Thornhill Drive, Oakland, CA 94611-1336*

After attending this presentation, attendees will learn principles and applications of new and emerging forensic DNA technologies and applications in forensic casework.

This presentation will impact the forensic science community by providing a forum for review and in depth discussion of several new and emerging technologies like DNA repair, ancient DNA typing, SNP typing, and statistical challenges of combining multiple genetic markers for the analysis of challenging samples in trace DNA analysis. The attendees will also learn more about new and emerging forensic technologies including biometrics. New powerful and reliable forensic DNA methods being discussed may revolutionize the application of DNA to forensic science.

The use and application of molecular tools in forensic science is now well established. Recent research has led to new applications that are currently being evaluated and tested for their utility in helping to resolve cases in the justice system. New and emerging forensic DNA technologies and applications will be reviewed and discussed in this workshop. The workshop will cover topics such as: (1) Trace DNA - Low Copy templates and DNA repair; (2) new developments in DNA profiling of challenged samples; (3) novel methods for DNA storage/preservation; (4) utility of SNPs in missing persons and complex paternity cases; (5) advances and new technologies in forensic DNA; (6) DNA as a potential biometric tool; (7) statistical challenges in combining the results from autosomal STRs, Y-STRs, SNPs, and mtDNA typing; and (8) new directions in forensic mathematics – understanding the evidential strength of rare haplotype evidence.

References:

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4 Budowle B, van Daal A. Extracting evidence from forensic DNA analyses: future molecular biology directions Biotechniques. 2009 Apr;46(5):339-40, 342-50.

Forensic DNA, Trace DNA, LCN

W10 Taphonomy of Bone Destruction: Information Lost, Information Gained

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After attending this workshop, attendees will learn about the full spectrum of natural and artificial alterations common to bone in forensic settings, the signatures of taphonomic processes, and the higher-order taphonomic syndromes to which they can be attributed. The workshop includes hands-on presentations of taphonomic examples.

This presentation will impact the forensic science community by providing common language and basic understanding of taphonomic processes (the study of an organism's changes from its death onwards) and the imprints that they leave upon bones is necessary to forensic anthropological investigations. These processes are structured into three major categories of:

1. Differentiation between deliberate human interaction including perimortem traumas, natural postmortem alterations.
2. Contextualization of remains, indicating what environments and agencies influenced the remains.
3. Estimation of postmortem interval.

While information is lost through these alterations, knowledge is gained through accurate analysis and interpretation of imprinting upon osseous remains concerning the causal agencies involved.

This workshop provides lectures on and practical demonstrations in forensic osteological taphonomy. The topics covered include histological analysis of microscopic bone destruction; characteristic signatures of natural processes including burial, surface deposition, and water transport; the effects of animal gnawing and dispersal of bone; artificial alterations including ritual, anatomical, and curational; indicators of postmortem interval including weathering; and indicators of perimortem vs. postmortem timing, including thermal alteration, fracture, and other types of bone trauma.

Taphonomy, Bone Destruction, Postmortem

W11 Investigation of Deaths in Custody – Evolution of Police Practices and Medical Examiner Methods

Wendy M. Gunther, MD, Office of the Chief Medical Examiner, Tidewater District, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510-1046; William R. Oliver, MD*, Georgia Bureau of Investigation, Northwest Regional Crime Lab, 533 Underwood Drive, Trion, GA 30753; Jeffery J. Gofton, MD*, 830 Southampton, Suite 100, Norfolk, VA 23510; and Donald R. Norrell, BA*, Office of the Chief Medical Examiner, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510-1046*

The goal of this workshop is to review the medicolegal investigation of deaths in custody, including those occurring during pursuit, subdual, and incarceration of offenders. Using a decade of cases to illustrate changes that have occurred as police practices have required alteration following media outcry and family lawsuits, this workshop will illustrate how medicolegal investigation may be updated to follow suit. Additional goals include review of the current state of knowledge of the role of less lethal weapons, including conducted energy weapons, and excited delirium, in deaths during subdual; and discussion of medicolegal death investigator responsibilities and relationships with police during police-involved deaths.

This presentation will impact the forensic community by analyzing the nature of deaths in custody using a case-study format, discussing the principles behind investigation of each major category of death in order to answer the five questions the family will ask and the six questions the medical examiner/investigator must ask, while reviewing past and recent case histories to learn from the lessons of the past. Attendees will gain insight into ways in which updated death investigation techniques, for both medical examiners and medicolegal death investigators, can keep pace with changes in police practices.

After a brief introduction which includes a pre-test to assess the attendee's current state of knowledge, the workshop begins with a discussion of the five questions the family will ask about a death in police custody, and the six questions the medical examiner and medicolegal death investigator must ask. These questions are then put to use in case studies covering deaths during pursuit, subdual, and incarceration. Cases covered in the section on deaths during police pursuit include motor vehicle crashes and other accidental deaths while fleeing from police, suicide by perpetrator while fleeing, "suicide by cop", and a police shooting in a SWAT team situations. Discussion of investigation of these deaths involves analysis of the relationship between medicolegal death investigators, who are often ex-officers, with police. Judicial outcomes and changes in police policy are discussed. Cases covered in the workshop include discussion on deaths during subdual including restraint asphyxia with a scene re-enactment, deaths involving ingestion of drugs by the perpetrator, deaths following less lethal weapons such as pepper spray or conducted energy weapons (CEWs), deaths following CEW use and excited delirium, jailhouse hanging and unexpected natural deaths, and judicial outcomes and changes in custodial policy. The presentations are followed by a summary and a post-test.

Death in Custody, Medicolegal Death Investigation, Conducted Energy Weapons

W12 Attorneys and Scientists in the Courtroom: Bridging the Gap

Max M. Houck, MA, West Virginia University, 1600 University Avenue, 208 Oglebay Hall, Morgantown, WV 26506-6217; Ted W. Vosk, JD*, 8105 Northeast 140th Place, Bothell, WA 98011; and Ashley Emery, PhD*, University of Washington, Department of Mechanical Engineering, MEB 215, Seattle, WA 98195*

After attending this workshop, attendees will be presented a basis for improved communication between legal and scientific professionals, will better understand the substantive issues facing each in the context of the criminal justice system, and gain common knowledge based framework within which each can operate.

This workshop will impact the forensic science community by minimizing the negative impacts to the criminal justice system created by the cultural gap between legal and scientific professionals and to maximize the benefits to be gained from the utilization of forensic science by fostering understanding and communication.

This workshop will examine the distinct professional cultures of forensic scientists and attorneys, their practical and philosophical differences, how these differences negatively impact the criminal justice system and how both professions can bridge the gulf between them.

Culture, Science, Courtroom

W13 Forensic Comparison in a Digital World

David K. Ord, DDS, Clark County Office of the Coroner Medical Examiner, University of Nevada - Las Vegas, School of Dental Medicine, 1001 Shadow Lane, Mail Stop 7415, Las Vegas, NV 89106; Steve Scarborough, BS*, 3702 River Canyon, Las Vegas, NV 89129; Steven Dowell, BS*, Los Angeles County Department of Coroner, 1104 North Mission Road, Los Angeles, CA 90033; and Edward E. Herschaft, DDS*, University of Nevada - Las Vegas, School of Dental Medicine, 1001 Shadow Lane, Mail Stop 7412, Las Vegas, NV 89106-4124*

After attending this workshop, attendees will be aware of the nuances and workflow barriers that face forensic laboratory personnel while employing a variety of digital media at the center of their comparative operations. Most comparative analysis sections continue to use traditional comparison processes employing combinations of various media to arrive at probative comparison conclusions. This workshop will introduce attendees to a new technology that facilitates secure image work flow and addresses these problems. This advanced technology can now provide forensic scientists with the tools to make the transition to a Network Based Comparison Workflow.

This presentation will impact the forensic science community by serving as a reference for those forensic odontologists, fingerprint examiners, tool mark analysts, and other experts who may be requested to provide comparison testimony, demonstrating a workflow that is both scientific and documentable. Furthermore, it will allow the participant to familiarize themselves with the system by using pre-supplied odontologic, fingerprint, and tool mark data.

This program interweaves the fields of fingerprints, odontology, and tool marks in developing an electronic workflow using Mideo Systems' CASEWORKSeis software. Presentations will be made in each of the fields followed by a hands-on experience in using the software in case development.

Forensic Science, Workflow, Comparison

W15 Chemometrics for Forensic Scientists: The Good, the Bad, and the Misleading

J. Graham Rankin, PhD, Marshall University, Forensic Science Program, 1401 Forensic Science Drive, Huntington, WV 25701; John V. Goodpaster, PhD*, FIS Program, Indiana University Purdue University Indianapolis, 402 North Blackford Street, LD 326, Indianapolis, IN 46202; Stephen L. Morgan, PhD*, University of South Carolina, Department of Chemistry & Biochemistry, 631 Sumter Street, University of South Carolina, Columbia, SC 29208; and Peter de B. Harrington, PhD*, Ohio University, Chemistry & Biochemistry, Clippinger Laboratories, Athens, OH 45701-2979*

The goal of this workshop is to acquaint attendees with the application of Chemometrics (advanced statistical techniques applied to analytical data) in forensic applications especially those involving large data sets derived from GC/MS, GCxGC, LC/MS,ICP/MS and similar techniques of complex mixtures where pattern matching is used to identify or match two samples (fire debris, micro spectral analysis, etc). After completing this workshop, the attendees will know the basic theory of principal components analysis (PCA), cluster analysis, and other techniques; how and when to apply them to forensic data; and what commercial and non-commercial statistical packages are best for forensic applications.

With the recent NAS report and other court challenges to expert testimony about determination of “match” or “consistent” between two or more samples of physical evidence, a determination of statistical probability of a random match is now being required for such determinations. Advance statistical techniques used in Chemometrics combined with large datasets can aid in that determination. There are a number of different commercial packages available, each with a number of “features” that may not be appropriate for a particular application. In particular, some packages automatically perform “pre-treatments” to the data may be appropriate to spectral data, but not for chromatographic data. Further, different packages determine “statistical distance” (and by extension, statistical probability of a random match) by different algorithms which may lead to different results. A better understanding of how and when these techniques should be used will impact the forensic science community by enabling the criminalists to explain their results in court.

This workshop will give an overview of chemometric techniques and software available which is being increasingly used by forensic scientists for doing comparison of physical evidence. Proper selection of techniques and especially pre-treatments of data are key to correct interpretation of the results.

Chemometrics, Pattern Matching, Cpectral Analysis

W16 Introduction to Perception, Observer Effects, Bias, and Expectation in Forensic Science

Keith Inman, MCrim, California State East Bay, Department of Criminal Justice Administration, 4068 Meiklejohn Hall, 25800 Carlos Bee Boulevard, Hayward, CA 94542; John J. Lentini, BA*, Scientific Fire Analysis, LLC, 32836 Bimini Lane, Big Pine Key, FL 33043; Norah Rudin, PhD*, 650 Castro Street, Suite 120-404, Mountain View, CA 94041; and Michael Risinger, JD*, Seton Hall University, School of Law, One Newark Center, Newark, NJ 07102*

Upon completion of this workshop, participants will better understand how the brain processes information, and particularly the type of information used and generated in forensic science. Attendees will be able to define the terms that are key to understanding how and

when bias occurs; will understand the scientific philosophical foundation and practical applications of sequential unmasking; and will participate in a series of exercises that demonstrates the need for procedures that minimize the impact of domain irrelevant information when making decisions and inferences about physical evidence.

The presentations will impact the forensic science community by demonstrating the need for improved procedural safeguards against bias in the examination of physical evidence, which in turn will lead to more objective evaluations and properly limited inferences in reporting results to the criminal justice community.

This workshop will begin to address the need identified by the NAS Report by introducing participants to the concepts of cognitive psychology, how the brain works, the vocabulary of perception, bias and expectation, and the application of these concepts to forensic casework. In addition, workshop participants will engage in a variety of exercises that will further clarify bias and expectation, and how these may interfere with objective processing of data, including the processing of crime scene information and analytical results.

Bias, Observer Effects, Sequential Unmasking

W17 Fires and Explosions: A Multidisciplinary Overview of Investigative Methods, Mental States of Perpetrators, and Psychological Trauma to Victims

Alan R. Felthous, MD, Forensic Psychiatry Division, Saint Louis University School of Medicine, 1438 South Grand, Saint Louis, MO 63104-1027; Robert Weinstock, MD, 10966 Rochester Avenue, #4C, Los Angeles, CA 90024; Douglas J. Carpenter, MS, Combustion Science & Engineering, Inc., 8940 Old Annapolis Road, Suite L, Columbia, MD 21045; Daniel A. Martell, PhD*, Park Dietz & Associates, 2906 Lafayette, Newport Beach, CA 92663; Jimmie C. Oxley, PhD*, University of Rhode Island, 51 Lower College Road, Kingston, RI 02881; Thomas P. Shefchick, BSEE*, PO Box 62284, Sunnyvale, CA 94088; Douglas H. Ubelaker, PhD*, Department of Anthropology, NMNH - MRC 112, Smithsonian Institution, Washington, DC 20560; Allan J. Warnick, DDS*, Wayne & Oakland Counties, Medical Examiner's Office, 31632 Schoolcraft Road, Livonia, MI 48150; John J. Lentini, BA*, Scientific Fire Analysis, LLC, 32836 Bimini Lane, Big Pine Key, FL 33043; Suzanne Yang, MD*, Law & Psychiatry Program, University of Pittsburgh, 3811 O'Hara Street, Pittsburgh, PA 15213; and J.C. Upshaw Downs, MD*, Georgia Bureau of Investigation, 925 A Mohawk Drive, Savannah, GA 31419*

Upon completion of this workshop, attendees will obtain a broad, multidisciplinary understanding of various methods of investigating fires and explosions as well as of the psychology of perpetrators and victims.

This presentation will impact the forensic science community by better informing attendees about methods of various disciplines in investigating fire and explosions, motivation and mental states associated with setting fires and bombs, and patterns of psychopathology experienced by surviving victims.

A multidisciplinary, multisectional faculty brings a variety of methods to the investigation of fires and explosions and to the understanding of the psychology of perpetrators and of surviving victims. Myths, old, new, and high tech, in fire investigations will be put to bed. Changes in the seventh edition of NFPA 921 Guide for Fire and Explosion Investigation will be explained. The motivations, mental states and mental disorders of arsonists will be discussed. The application of fundamental knowledge and engineering tools to the investigation of fires, using the scientific method, will be explained. An electrical engineering approach will demonstrate with case examples how fires initially reported to have been caused by electrical malfunction turned out to have been arson. The pathological component will address the approach to the postmortem examinations of victims in a fire setting, to include the expected findings, common artifacts, determination of fire versus other trauma, and masqueraders (i.e., non-fire deaths with burned bodies). This pathological overview should prepare participants to recognize what they should look for in the examination of a burned body in order to determine whether the victim died as a direct result of the fire or was otherwise dispatched with attempted concealment.

Description of investigation of large bomb scenes will emphasize novel approaches learned by the British during the PIRA bombing campaign. Issues of packaging and contamination will be given to the history of explosive accidents and attacks and/or terrorist opportunities offered by common chemicals that can be made into explosives

After an introductory discussion of explosion investigation, the multiple way in which victims of arson suffer will be described. The dynamics of the arson victim's experience will be presented and attention directed to issues of loss, survivor guilt, depression, and post-traumatic stress. Treatment of arson survivors will be explained. The physical anthropology component will cover the fundamentals of recognizing and interpreting thermal effects on bones and teeth. In this context specific attention will be given to coloration, microscopic structure and form, fragmentation patterns, antemortem versus postmortem exposure, and the complex factors involved in interpretation. The odontology contribution will explain the importance of teeth in the investigation of fires and explosions and in the identification of otherwise unrecognizable deceased victims.

Fires, Explosions, Investigation

W18 Strengthening Forensic Science in the United States: A Path Forward – The Judges' Perspective

Stephanie Domitrovich, JD, PhD, Sixth Judicial District of PA, Erie County Court House, 140 West 6th Street, Room 223, Erie, PA 16501; Joseph P. Bono, MA*, Indiana University Purdue University Indianapolis, Forensic Sciences Program, Indiana University Purdue University Indianapolis, 402 North Blackford Street, Indianapolis, IN 46202; Kenneth E. Melson, JD*, Bureau of Alcohol, Tobacco, Firearms, & Explosives, 99 New York Avenue, Northeast, Suite 5S 100, Washington, DC 20226; Robert Epstein, JD*, Federal Community Defender Office, Suite 540 West Curtis Center, 601 Walnut Street, Philadelphia, PA 19106; Joseph J. Maltese, JD*, New York Supreme Court, 355 Front Street, Staten Island, NY 10304; Linda L. Chezem, JD*, 530 Denny Drive, Mooresville, IN 46158; Barbara P. Hervey, JD*, Texas Court of Criminal Appeals, Supreme Court Building, 201 West 14th Street, Room 106, Austin, TX 512-427-9057; W. Milton Nuzum, JD*, Director, Judicial College, The Supreme Court of Ohio, 65 South Front Street, Columbus, OH 614-387-9445; and Catherine Shaffer, JD*, King County Superior Court, 516 Third Avenue, C-203, Seattle, WA 98104*

The goal of this workshop is to present for discussion the opinions of judges, attorneys, and a forensic scientist on the impact of what is now referred to as the "NAS Report."

This presentation will impact the forensic science community by presenting how judges might be impacted by the verbiage in the NAS Report.

The goal of this workshop is to form a bridge between forensic scientists and those decision-makers in the judiciary (judges) in understanding what the courts may require in the way of expert witness testimony and report writing.

NAS Report, Expert Witness Testimony, Judges' Perspective

W19 Gunshot Wounds - Theory and Practice

Vincent J.M. Di Maio, MD, 10 Carriage Hills, San Antonio, TX 78257; and Kimberley Molina, MD*, Bexar County Medical Examiner's Office, 7337 Louis Pasteur Drive, San Antonio, TX 78229*

After attending the presentation, the attendee will appreciate the theory of mechanisms and features of gunshot wounds including handgun, rifle, and shotgun wounds. In addition, the attendee will become familiar with the principles of gunshot residue testing and the demographics of wound types and locations.

The presentation will impact the forensic community by imparting critical knowledge to medical examiners and death investigators regarding firearm wounds. This knowledge will be used in decision-making process of medical examiners/death investigators in deciding cause and manner of death and will augment the literature used to establish the standard of practice for the examination of firearm wounds. It will increase the competence of the medical examiner in examining firearm wound cases and thus, will improve performance on such cases.

This workshop will address the theory of wounding, including wound dynamics and the effects of the differing types of firearms and ammunition. The workshop will demonstrate entrance and exit wounds made from different types of firearms, from handguns, rifles, assault rifles, and shotguns, and will discuss and explain those differences. In addition, the workshop will address gunshot residue and its testing utility in the medical examiner setting as well as the demographics of firearm usage including range and location of wounds. Blowback and reactions times pertaining to gunshot wounds will also be discussed.

Gunshot Wounds, Firearms, Handguns

W20 The Forensic Investigation of Human Remains From Armed Conflicts and Catastrophes

Shuala M. Drawdy, MA, 124 Fisherman Road, Satsuma, FL 32189; Morris Tidball-Binz, MD*, International Committee of the Red Cross, 19 Avenue de la Paix, Geneva, 1202, SWITZERLAND; Duarte N.P. Vieira, PhD, MD*, Instituto Nacional, de Medicina Legal, Coimbra, CA 3000-213, PORTUGAL; John E. Byrd, PhD*, JPAC/CIL, 310 Worchester Avenue, Hickam AFB, HI 96853-5530; Luis Fondebrider*, Argentine Forensic Anthropology Team (EAAF), Rivadavia 2443, 2do piso, dpto.3 y 4, (1034) Capital Federal, Buenos Aires, ARGENTINA; Stephen Cordner, MB*, Victorian Institute of Forensic Medicine, 57-83 Kavanagh Street, Southbank, Victoria 3006, AUSTRALIA; William Goodwin, PhD*, School of Forensic Medicine and Investigative Sciences, University of Central Lancashire, Preston, PR1 2HE, UNITED KINGDOM; Ute Hofmeister, MA*, International Committee of the Red Cross, Avenue de la Paix 19, Geneva, 1202, SWITZERLAND; Paul S. Sledzik, MS*, NTSB, Office of Transportation Disaster Assistance, 490 L'Enfant Plaza, SW, Washington, DC 20594; Thomas Parsons, PhD*, Forensic Sciences International Commission on Mission Persons, 45A Alipasina, Sarajevo, 71000, BOSNIA-HERZEGOVINA; and Clyde C. Snow, PhD*, 2230 Blue Creek Parkway, Norman, OK 73071*

After attending this workshop, attendees will become familiar with the main normative and practical considerations for large-scale forensic investigations in the search for missing persons from armed conflicts and catastrophes.

This workshop will impact the forensic community by providing an updated review of current knowledge and practice in investigations into missing persons from armed conflicts and catastrophes.

A multidisciplinary panel of international experts will share their recommendations, experiences, and lessons learned regarding practical considerations for large-scale forensic investigations in the search for missing persons from armed conflicts and catastrophes. Topics for discussion will range from logistical issues and constraints involved in organizing international forensic missions and integrating various forensic methods in the identification of human remains, to working with families, and addressing expectations of the bereaved. In addition, the importance of maintaining quality assurance and ethical conduct while carrying out international forensic missions will be addressed.

Missing Persons, Armed Conflicts, Catastrophes

W21 Insects: Their Practical Applications in Death Investigations

Jeffrey D. Wells, PhD, West Virginia University Department of Biology, Life Sciences Building, Room 3135, 53 Campus Drive, PO Box 6057, Morgantown, WV 26506-6057; Ralph E. Williams, PhD*, Purdue University, Department of Entomology, 901 West State Street, West Lafayette, IN 47907; and Neal H. Haskell, PhD*, 425 Kannal Avenue, Rensselaer, IN 47978*

After attending this presentation, attendees will have an understanding on the practical application insects can have in death investigations. Attendees will learn how insects can be used in estimating the postmortem interval; how insects can be assessed in the geographical association between a victim, crime scene, and assailant; how insects can be utilized in toxicological tests of suspect residue from a corpse; and how DNA evaluation in insects can be utilized in human identification and insect species identification. Attendees will also learn proper insect collection and preservation methods.

This presentation will impact the forensic science community by providing practical guidelines on how insect evidence can be of significant importance in death investigations.

Insect evidence can be of pertinent value in death investigations. Insects can be useful in estimating the postmortem interval, geographical association of the crime scene, assessing toxicological residues, and aiding in human identification from DNA analysis. These facets of forensic entomology will be presented as well as how insect evidence should be properly collected and preserved for examination and analysis.

Forensic Entomology, Forensic Insects, Postmortem Interval

W22 Navigating the World of Forensic Journals & Forensic Information

Barry K. Logan, PhD, NMS Labs, 3701 Welsh Road, Willow Grove, PA 19090; A.W. Jones, PhD, DSc, National Lab Forensic Chemistry, 12 Artillerigatan, Linkoping, 0 58758, SWEDEN; Jeffrey B Teitelbaum, MLIS*, Forensic Laboratory Services Bureau, 2203 Airport Way South, Suite 250, Seattle, WA 98134; Jay A. Siegal, PhD, Indiana University/Purdue University Indianapolis, 402 North Blackford Street, Indianapolis, IN 46202; Bruce A. Goldberger, PhD*, Department of Pathology, University of Florida College of Medicine, 4800 SW 35th Drive, Gainesville, FL 32608; Michael A. Peat, PhD*, 6700 Woodlands Parkway, Suite 230-308, The Woodlands, TX 77381; and Mary A. Hotchkiss, JD*, University of Washington, Washington School of Law, William H. Gates Hall, Seattle, WA 98195-9333*

After attending this workshop, attendees will possess new techniques and guidelines that will assist them in searching for and assessing forensic information and making decisions about the proper use of copyrighted material, as well as gain insight into the world of forensic journal publishing.

This presentation will impact the forensic community by providing practical information that can be used by anyone working in any field of the forensic sciences. Finding the right information is central to the progress of any casework or discipline, and this workshop will present the full life cycle of forensic information - how the information is generated, distributed, retrieved, and utilized—by the leading practitioners in the field.

This workshop will consist of a 4-hour lecture/panel format. Three speakers will explore topics (impact factors, search techniques, copyright issues, etc.) relating to the use of forensic journals and forensic information, and a panel of forensic journal editors and publishers will discuss the issues facing major publishing companies (article costs, online access, open access, etc.).

Forensic Information, Forensic Journals, Searching Techniques

W23 Good Measurement Practices in the Proper Use and Calibration of Balances and Pipettes

Thomas A. Brettell, PhD, Cedar Crest College, Department of Chemical & Physical Science, 100 College Drive, Allentown, PA 10104; Donna Lodek*, and Joesph Moran, BS*, Henry Troemner, LLC, 201 Wolf Drive, PO Box 87, Thorofare, NJ 08086; and Janine Kishbaugh, MS, Cedar Crest College, Forensic Science Program, 100 College Drive, Allentown, PA 18104*

The objective of this workshop is to present a thorough and concise synopsis of the procedures required to properly use and calibrate laboratory balances and pipettes. The topics covered are targeted towards preparing forensic science laboratories for accreditation under ISO/IEC 17025 General Requirements for the competence of testing and calibration laboratories.

This workshop will have a significant impact on laboratory personnel and administrators of forensic science laboratories by educating forensic scientists on the proper use and calibration of balances, weights, and pipettes. By providing proper technical information to forensic science laboratory personnel, the analyses and tests performed will be assured to be reliable and hold up to legal challenges when confronted by the adversarial process of the court system.

As forensic science laboratories strive to upgrade and maintain their accreditation to meet ISO/IEC 17025 standards, personnel must understand the proper use of the balances, weights, and pipettes. This understanding includes the meaning of the measurement and the variables that exist in this measurement, such as uncertainty and certification. An important part of this workshop will involve detailed discussions of the procedures and issues involved in handling, measuring, and certification of balances, weights, and pipettes. The goal of the workshop is to present suggestions for developing viable, practical suggestions for making proper measurements with laboratory balances and pipettes for achieving accreditation under the ISO accreditation program for a forensic science laboratory.

Balances, Weights, Pipettes

A1 The Importance of Accreditation: Advancing Forensic Science and Laboratory Management

Dean M. Gialamas, MS, Orange County Sheriff-Coroner Department, Forensic Science Services, 320 North Flower Street, Santa Ana, CA 92703*

After attending this presentation, attendees will gain an understanding and knowledge on the general importance, current status, and future direction of laboratory accreditation.

The presentation will impact the forensic science community by serving as a historical review of the historical, current, and future importance of laboratory accreditation programs.

Laboratory accreditation programs have been in existence for well over twenty-five years. Originally implemented and still used today as a voluntary programs to demonstrate compliance with accepted standards of quality, the recent release of the National Academy of Sciences Report, entitled *Strengthening Forensic Science in the United States: A Path Forward*, has brought a renewed awareness to the importance of accreditation programs. Moreover, the movement towards internationally based standards, such as ISO/IEC 17025, has brought a new awareness to satisfy not only the technical quality standards, but also to meet the needs of stakeholders and further improve the overall management systems in forensic laboratories. Now more than ever, quality and managerial systems in forensic science are being put to the test. This presentation will briefly review the history of accreditation, its importance in the criminal justice system, the current status and future direction of laboratory accreditation, including its impact on policy makers and forensic service providers.

ASCLD, Accreditation / ISO, Laboratory Quality

A2 Certification in the Forensic Sciences

Victor W. Weedn, JD, Office of State Medical Examiner, PO Box 94, Trenton, NJ 08625-0094; and Vincent J. Desiderio, MS, New Jersey State Police, Central Laboratory, 1200 Negron Road, Hamilton, NJ 08691*

After attending this presentation, attendees should appreciate the varied certification programs in forensic sciences, understand the different approaches of the medical and criminalistic communities, recognize the important role that individual certification has in assuring stakeholders in the quality of forensic sciences, and grasp the impact certification has had in the courts.

This presentation will impact the forensic science community by revealing the lack of uniformity and impact that certification has had in the forensic sciences, despite its important role in the quality of forensic scientific services and the credibility of forensic sciences.

The *National Academies of Science Report, Strengthening Forensic Science in the United States: A Path Forward*, released precisely a year ago, recommended that certification and accreditation be mandated throughout the forensic sciences. They are indeed both important components of quality assurance.

Certification generally refers to people. Typically "certification" refers to education and/or training short of an educational degree and the issuance of a document. In the case of a professional career field, it can be much more and it is so in the case of most forensic disciplines.

Certifying bodies in forensic sciences include: the American Board of Criminalistics (ABC), the American Board of Pathology (ABP), the Association of Firearms and Toolmarks Examiners (AFTE), the American Board of Psychiatry and Neurology (ABPN), the American Board of Medicolegal Death Investigators (ABMDI), the American Board of Forensic Toxicology (ABFT), the American Board of Forensic Odontology (ABFO), the American Board of Forensic Anthropology (ABFA), the American Board of Forensic Entomology (ABFE), the American Nurses Credentialing Center (ANCC), the International Association of Forensic Nurses (IAFN), the Digital Forensics Certification Board (DFCB), the National Academy of Forensic Engineers (NAFE), the International Institute for Forensic Engineering Sciences (IIFES), the American Board of Forensic Document Examiners (ABFDE), the Board of Forensic Document Examiners (BFDE), and the International Association for Identification (IAI).

Board certification is generally required for practice of a medical discipline and is becoming true for forensic pathology. The National Association of Medical Examiners (NAME) requires forensic pathology (FP) board certification to call oneself a forensic pathologist. It is only conferred after successful completion of an American Council on Graduate Medical Education (ACGME)-accredited medical school, successful completion of a medical board examination, successful completion of an ACGME-accredited pathology residency program, successful completion of an ACGME-accredited forensic pathology fellowship, and passage of anatomic (AP) and forensic (FP) pathology board certification tests, promulgated by the American Board of Pathology (ABP). Despite the large investment of time and resources and even after months of disciplined study, more than one third of all those who take the forensic pathology boards fail and an even higher rate fail the anatomic boards. Applicants are given only three chances to pass. The American Board of Medical Specialties (ABMS), including the ABP, requires recertification through passage of a new board examination every ten years. Maintenance of Certification (MOC) is being implemented which requires continued education and experience in the interval period. Furthermore, state licensure requirements impose additional requirements, which among other things monitor criminal behavior, ethical lapses, and drug and alcohol impairments.

The American Board of Criminalistics (ABC) is the primary certification program for most criminalists, specifically comprehensive criminalistics, drug analysis, fire debris analysis, molecular biology, and trace analysis (hairs & fibers, paints & polymers). Certification requires passage of a rigorous test, in which a sizable percentage of applicants fail. The test includes some general forensics, quality assurance, evidence handling, safety, ethics, and legal questions in addition to knowledge, skills, and abilities (KSA) subspecialty questions. Eligibility for the certification as a Diplomat includes a baccalaureate degree in a natural science or equivalent, two years of full-time experience in the field, and the applicant must be actively working in criminalistics. However, to become a Fellow one additionally needs to maintain successful proficiency testing. Certification must be maintained on a five-year cycle through the accumulation of points based on continuing education and

contributions made to the field. Loss of certification can occur if a Diplomat or Fellow does not accrue the required points or is found to be acting in an unethical manner.

Thus, in both cases, the certification in forensic sciences involves both knowledge and practice. The medical community has emphasized professional practice and as a result most forensic pathologists are currently board-certified, but relatively few medical examiner offices are accredited. On the other hand, the criminalistics community has emphasized technical procedures and as a result most crime labs are accredited; however, relatively few criminalists are certified.

Many other programs in the forensic science involve knowledge but not skills or practice. In total there are about a eighteen recognized and credible certifying bodies in the forensic sciences. However, anyone can issue a certificate—there is no guarantee that a certificate is meaningful. The Forensic Specialties Accreditation Board (FSAB) accredits such programs as evidence of their credibility.

Judicial scrutiny of the forensic sciences has largely focused on the credentials of the expert. Thus, it is surprising that, to date, the issue of certification has generally been neglected or minimized in the legal foundation of forensic science experts. In fact, most attorneys seem to be unaware of the vagaries of certification in the forensic sciences. Case law emphasizes this lack of judicial focus.

The forensic science community must do a better job in recognizing and broadcasting the importance of individual certification as a foundation for scientific authority within society.

NAS, Forensic Certification, Certifying Bodies

A3 Traceable Standards to Ensure National Uniformity in Analysis Results

Susan M. Ballou, MS, National Institute of Standards and Technology, Law Enforcement Standards, 100 Bureau Drive, MS 8102, Gaithersburg, MD 20899-8102*

After attending this presentation, attendees will be able to evaluate their laboratory methodology or protocols relative to, implementation of material standards, identifying existing gaps in their use, and NIST standard reference material production.

This presentation will impact the forensic science community by demonstrating the application of the National Institute of Standards and Technology (NIST) standard reference materials (SRMs) to forensic examinations.

This presentation will provoke the forensic community to re-evaluate their respective analysis process and determine if a material standard should be in place. The first step requires understanding of standards, the difference between paper and material, and how these standards are perceived by the community. Standards Development Organizations (SDOs) will briefly be discussed to provide a framework of understanding between this type of activity and the development of material standards. NIST's foresight created several projects that identified critical material standards and their placement in the laboratory process. Details on these projects will be provided offering insight into two forensic disciplines' methodology, meddlesome human factors, and the respective changes that dramatically improved test results and national uniformity.

The National Academy of Sciences (NAS) Report, *Strengthening Forensic Science in the United States: A Path Forward* released on February 18, 2009, offers several recommendations to improve accuracy, reliability, and validity in the advancement of forensic science. As a result, NIST's involvement in these recommendations relative to standards, validation, and proficiency testing will increase providing an opportunity for information sharing at this presentation. It is recommended that the forensic science community be familiar with the NAS Report.

Standards, SDO, NIST

A4 Meeting the Challenge of the NRC Report: Producing Meaningful Mandatory Standards for Forensic Science

John J. Lentini, BA, Scientific Fire Analysis, LLC, 32836 Bimini Lane, Big Pine Key, FL 33043*

After attending this presentation, attendees will have an appreciation for the standards development infrastructure that already exists within forensic science, and will understand how to get involved in producing additional necessary standards.

This presentation will impact the forensic science community by making it clear that meeting the challenges for standardization proposed by the National Research Council (NCR) Report can be accomplished using already existing infrastructure.

The NRC Report, *Strengthening Forensic Science in the United States: A Path Forward*, recognizes the need for valid standardized test methods and reports, but was critical of the forensic science community for failing to mandate the use of meaningful standards, and critical of some of the standards, especially those developed by SWGs, for being too vague. These are perhaps valid criticisms when the state of forensic science standards is viewed in a vacuum, but it must be noted that as forensic scientists, we usually do just what we are asked.

We are servants of the criminal justice system, and ever since the *Daubert* case was decided in 1993, have been waiting for the judiciary to demand more of us, and for our legislative bodies to fund the efforts required for us to comply. Neither the request nor the funding appeared, though the request to do more seems to be here now that the NRC report has been published.

The forensic science community is quite capable of complying with the demand for meaningful mandatory test methods, followed by understandable and complete scientific laboratory reports. All that is required is the will to use the infrastructure that we have built up over the last twenty years.

There has always been some initial resistance to the idea of laboratory accreditation, but now more than eighty percent of our public sector laboratories are ASCLD-LAB accredited, without any mandates. Certification is available in most forensic science disciplines, and if the courts want to demand that only certified practitioners testify, all that is needed is to find a way to pay for it. Certification is already tied to ethical practice codes of the various certifying bodies (at least those bodies accredited by FSAB). Enforcement of ethics codes could easily be strengthened by making it possible to file a complaint without risking one's life savings.

As for standard test methods, the well-oiled machine, ASTM International has been providing forensic science with credible standards since before *Daubert*, and has been providing most other industries with credible voluntary consensus standards for more than a century.

Working with the SWGs, Committee E-30 on Forensic Sciences has produced over fifty forensic standards, and always has more in the

pipeline. These standards are maintained constantly, and must be reapproved or revised on a five year schedule. There is no reason that the SWGs that have not yet partnered with E30 could not do so now, and no reason that the use of a standardized methodology could not be mandated.

Recognizing that not every test can be anticipated, E30 is now working on a general method describing how to set up and validate new methodologies when the need arises.

It is hoped that the NRC report results in actual legislation that is shaped with the help of the forensic sciences, and actual funding so that its new demands can be compiled with, and respond to its criticisms. If that happens, there is no doubt that we are up to the challenge.

Forensic Science, Standardization, Infrastructure

A5 How Much Do You Really Know About the Quality Assurance Standards?

Heather J. Seubert, BS, Federal Bureau of Investigation Lab, DNA I Unit, 2501 Investigation Parkway, Room 3230, Quantico, VA 22135*

After attending this presentation, attendees will have an understanding of the history behind the development and implementation of the Quality Assurance Standards for use by forensic and DNA databasing laboratories.

This presentation will impact the forensic community by demonstrating how the Quality Assurance Standards have improved the field of Forensic DNA testing and evolved into a benchmark within the forensic science discipline.

The roles in which the DNA Identification Act of 1994, the DNA Advisory Board, the Federal Bureau of Investigation, the Scientific Working Group for DNA Analysis Methods (SWGDAM), and the forensic community as a whole played in the development of the Quality Assurance Standards will be highlighted. The attendees will also gain an understanding for the development of the FBI Quality Assurance Standards Audit Document and how it has been used to assess the quality practices and performances of DNA laboratories throughout the country.

DNA, History, Quality Assurance Standards

A6 Standard Methods of Analysis in Forensic Science: Panacea or Problematic

Jay A. Siegel, PhD, Indiana University - Purdue University Indianapolis, Chemistry, School of Science, 402 N Blackford, LD 326 D, Indianapolis, IN 46202; and Barry A.J. Fisher, MS, MBA, 19854 Vintage Street, Chatsworth, CA 91311*

After attending this presentation, attendees will understand the importance of developing standard methods of analysis in forensic science but also to not rely completely on such methods because it stifles the necessary creativity, imagination, and intuition that is so important to solving crimes and reaching conclusions about scientific evidence.

This presentation will impact the forensic science community by reminding forensic scientists that standard methods are important but that on occasion, it is necessary to go beyond them and use creativity, imagination, and intuition in doing their work.

One of the hallmarks of good scientific procedure is to develop standard methods and protocols for the analysis of practically anything and make sure that the methods are validated for their intended purposes. As a general principle, it is hard to argue with such an approach. In recent years as increasing demands are being put on forensic science to become more scientific, practitioners and academics have run headlong into a program of developing standards for analysis of every type of evidence and every situation. The recent report of the National Academy of Sciences on the needs of forensic science had a whole chapter devoted to the issue of standard methods. There are numerous TWGs and SWGs sponsored by no less than the NIJ and the FBI that are setting standards for analysis in particular areas. The forensic science committee of the ASTM has been busy for years developing consensus standards. Groups of practitioners in various disciplines also have committees that help set standards in those areas.

Primarily all of this activity can be beneficial to forensic science but there are also dangers lurking within. For one thing, the higher level of standardization, the fewer degrees of freedom in making choices about the best methods of analysis in a given case. This runs the risk of turning forensic scientists into forensic technicians; people who are permitted to do only what is in the "cookbook." Forensic cases aren't like that. They are unique. The evidence is intertwined within the context of the scene and the surrounding circumstances. Recognizing the need to have reliable, valid scientific methods available for the analysis of physical evidence, forensic scientists must be able to exercise, judgment and use imagination and yes, even intuition, in deciding how best to approach evidence analysis.

This presentation will discuss the concept of standardization of forensic analysis in the context of the real world crime scene and make the case that another hallmark of good science is to be able to use experience and lateral thinking in developing solutions to problems. Further, good forensic science also implies reasonable common sense. It is not possible to have standard procedures for everything encountered in criminal investigations. Forensic scientists, like all scientists should apply their expertise based on good science, prior experience and an understanding of the task at hand.

Standard Methods, Forensic Analysis, Interpreting Evidence

A7 Investigating the Role and Impact of Forensic Science Evidence on the Criminal Justice Process

Joseph L. Peterson, DCrim, Ira Sommers, DSW, Deborah Baskin, PhD, and Donald Johnson, MS, California State University, Los Angeles, School of Criminal Justice and Criminalistics, 5151 State University Drive, Los Angeles, CA 90032*

The goal of this presentation is to discuss the results of a national research study investigating the role and impact of forensic science evidence on the criminal justice process.

This presentation will impact the forensic science community by presenting empirical data collected in a research project that tracked the collection, analysis and use of forensic science information on randomly selected criminal cases in three jurisdictions nationwide. Data was gathered from criminal justice agencies that use the services of three forensic crime laboratories/systems: Los Angeles County Sheriff's Department Scientific Services Bureau, Indianapolis-Marion County Forensic Services Agency, and the Indiana State Police Laboratory System.

The study had four main objectives: (1) estimate the percentage of crime scenes from which one or more types of forensic evidence is collected; (2) describe and catalog the kinds of forensic evidence collected at crime scenes; (3) track the use and attrition of forensic

evidence from crime scenes through laboratory analysis, and then through subsequent criminal justice processes; and, (4) identify which forms of forensic evidence contribute most frequently (relative to their availability at a crime scene) to successful case outcomes.

The primary data collection method was a prospective analysis of official record data that followed cases from police incident report to final criminal disposition. A random selection of incidents reported to law enforcement agencies in 2003 were drawn from the serious crime categories of homicide, attempt murder/aggravated assault, rape, robbery, and burglary. For the smaller jurisdictions (South Bend, Fort Wayne, and Evansville) using the Indiana State Police Laboratory, additional years were sampled to obtain a sufficient number of homicides and rapes. A total of 1,723 incidents were sampled in Los Angeles, 1,229 incidents in Indianapolis, and 1,253 incidents from the smaller Indiana jurisdictions, for a total of 4,205 cases that were entered into the final data set. Information was collected primarily through review of three different types of case reports: police incident reports and investigator files, crime laboratory records, and prosecuting attorney files. Additional information and insight was gathered in each of the study jurisdictions through interviews with crime scene investigators, criminalists, detectives, prosecutors, and defense attorneys about their views of, and reliance upon, scientific evidence.

In addition, a poll was administered by telephone to more than 1,200 registered California voters, asking their attitudes about the reliability of various types of testimony and scientific evidence, the amount of time they spent watching television programs with a criminal justice theme, and several sociodemographic questions. The project team also developed seven robbery case scenarios in which the type and strength/specificity of the forensic evidence was varied, and that were administered to a convenience sample of about 950 persons in the greater Los Angeles area.

The findings of empirical data collected from the participating laboratory systems, and from the surveys of citizens about their views toward scientific evidence and testimony, will be presented. The frequency that various types of physical evidence were collected, submitted, and examined by crime laboratories was affected by crime type. Additional detailed information about cases was gathered, including: overall investigative techniques used in making arrests, relationship between assailant and victim, number of witnesses to the crime, time elapsed between crime, its report to police and suspect's arrest, and suspect statements to police. A multivariate statistical analysis was performed on cases, and results showing the impact of physical evidence on the arrest, prosecution and adjudication of affected cases will be presented.

Role, Impact, Forensic

A8 The Implications of the National Research Council's Report – Strengthening Forensic Science in the United States: A Path Forward for Graduate Forensic Science Degree Programs

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After attending this presentation, attendees will understand the National Research Council's (NCR) recommendations for forensic science education in the United States and the issues these recommendations raise for forensic science graduate degree programs.

This presentation will impact the forensic science community by making the forensic science community aware of the implications of the NRC report for graduate education in the forensic sciences and by suggesting ways in which the goals and objectives set forth in the NRC report might be met.

In February 2009, the National Research Council issued a report entitled, *Strengthening Forensic Science In The United States: A Path Forward*. This report included a number of recommendations for strengthening forensic science in the United States. It also reviewed the status of forensic science education programs in the United States and laid out a broad set of goals and objectives for these degree programs:

Forensic examiners must understand the principles, practices, and contexts of science, including the scientific method. Training should move away from reliance on the apprentice-like transmittal of practices to education at the college level and beyond that is based on scientifically valid principles. In addition to learning a particular methodology through a lengthy apprenticeship or workshop during which a trainee discerns and learns to copy the skills of an experienced examiner, the junior person should learn what to measure, the associated population statistics (if appropriate), biases and errors to avoid, other threats to the validity of the evidence, how to calculate the probability that a conclusion is valid, and how to document and report the analysis. Among many skills, forensic science education and training must provide the tools needed to understand the probabilities and the limits of decision making under conditions of uncertainty.

The report also laid out five goals or objectives for graduate forensic science degree programs. For graduate programs, the curriculum should, at a minimum, ensure that each student: (1) understand essential issues in the forensic science disciplines, including the reduction of error rates; (2) develop an understanding of the areas of knowledge that are essential to forensic science; (3) acquire skills and experience in the application of basic forensic science concepts and of specialty knowledge to problem solving; (4) be oriented in professional values, concepts and ethics; and (5) demonstrate integration of knowledge and skills through a capstone experience, such as a formal, objective tool (e.g., the American Board of Criminalistics Forensic Science Aptitude Test) or another comprehensive examination or a thesis and/or research project.

The report makes some concrete curriculum suggestions:

Graduate students also should take a hands-on crime scene investigation class that covers investigation techniques and evidence association, including its examination, collection, and preservation. In addition, in-service work with a collaborating institution can provide significant practical training. In addition, student research and exposure to research is a critical component of an appropriate forensic science education.

The specific curriculum components advocated by the authors of the NRC report are easily implemented: indeed most graduate forensic science degree programs already have courses in crime scene investigation and required research courses. However, the overall approach of the NRC report to forensic science education raises a number of interesting issues that this presentation will explore:

- What is the best balance between graduate education and hands-on "apprentice" or "'workshop" learning?
- Given the NRC report's focus on understanding of the scientific method, should admission to graduate forensic science degree programs be restricted to students having undergraduate degrees in natural science?

- For would-be forensic science graduate students who did not major in a natural science, how many undergraduate science courses (and in what subjects) should be required to insure an understanding of the scientific method?
- Should the scientific method and critical thinking be explicitly taught in graduate forensic science courses (in graduate seminar courses, perhaps)?
- Does the report's enumeration of minimum goals for graduate degree programs adequately address current problems in the forensic sciences? Or should graduate degree programs set even higher educational goals?
- Given the fact that the overwhelming majority of forensic scientists will not be involved in research during their careers, is the emphasis on research misguided? Or is research a proxy for other pedagogical goals that might be better met through other teaching approaches?

"If forensic science education programs had sufficient rigor in science, law, and forensics, crime laboratories would have to spend less time and money for training, thereby shortening as well the apprenticeship time needed. Forensic science methods should be taught in the framework of common scientific practice. Even if a student graduates with a science degree, he or she often lacks education in issues that are critical to the functioning of crime laboratories, including quality assurance and control, ethics, and expert testimony."

"Measures should be taken to improve feedback from the laboratories to the schools to insure that the curriculum is not only comprehensive from an academic standpoint but also meets the practical requirements of operating laboratories."

NRC Report, Forensic Science Education, Scientific Method

A9 Adverse Consequences Stemming From the Conceptualization of the Forensic Science Laboratory as a Mere Testing Facility

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The goal of this presentation is to contribute to an awareness of the need for more scientific input in criminal investigations.

This presentation will impact the forensic science community by encouraging a reexamination and a broadening of the role of the forensic science laboratory.

A forensic science laboratory system should be more than a testing facility. Succinctly stated, it should be a scientific problem solving resource with a physical evidence focus. Of course, there are predefined analytical problems faced by the laboratory that arise in routine, high-volume cases such as drug testing. The testing facility conceptualization suffices with these. However, when the forensic science laboratory is viewed exclusively as a mere testing facility, the true nature of the forensic science enterprise is obscured. The function of a forensic science laboratory system must be directed to the optimal extraction of information from the physical evidence record produced during the events comprising a crime (or accident) to be investigated.

In most jurisdictions around the world law enforcement agencies assume control of the crime scene, and most commonly nonscientist investigators circumscribe and define the scientific problem(s) to be subsequently addressed by laboratory scientists. Although this is the well-entrenched traditional approach, it needs to be rethought. While it may be natural for law enforcement agencies to take initial control of the crime scene, it does not follow logically that law enforcement personnel should carry out the physical evidence investigation. The physical evidence problems to be addressed should be defined by scientists. This should be done in the context of the scene, not later in the laboratory. Skilled definition of the scientific problem is critical to ensuring that the most appropriate testing is performed and that the most effective and efficient use is made of resources. These critical activities are properly in the domain of scientists. Overlooked possibilities for obtaining useful information from the physical evidence record may thwart case solutions, whereas meaningless testing is wasteful of resources. Beyond the scene, a further complication is that prosecutors can also become involved in decisions that effectively circumscribe laboratory activity, both early in the investigation and during the development of the prosecution case. While input from prosecutors may be valuable, it should not take the form of interference with scientific decisions.

Where the forensic science laboratory service is seen only as a testing facility, myriad adverse consequences flow from this misperception. Some of these are directly related to case resolutions and the quality of justice. Others affect such things as laboratory operation and funding.

In circumstances where both the definition of the scientific problem and the interpretation of laboratory results are left to investigators and attorneys, the laboratory assumes a reactive stance, and the scientists are cast into the role of technicians passively carrying out *tests on items* in response to naïve requests by nonscientists. It should not be a surprise to see poor, incomplete, inaccurate, misleading, and erroneous casework as a direct consequence. In these circumstances, the likelihood of successful case solutions and the concomitant physical evidence contribution to the conviction of the guilty would decline while the risk of wrongful conviction could rise. With more scientific input across the entire physical evidence continuum, from crime scene to courtroom, this situation would be reversed.

In addition to gaining more effective and equitable case solutions, a broader understanding, on the part of user agencies and the public, of the true role and capability of a forensic science laboratory system can be expected to offer other important positive benefits. It should result in improved funding and allocation of personnel resources and less uninformed interference by external agencies and critics. Laboratory manager's responses attempting to address some of this interference and criticism can be can be counterproductive and lead to unintended adverse consequences, such as over-reliance on "safe" but restrictive protocols that result in "cookie cutter-like" approaches to a succession of the highly varied case scenarios that are encountered "real world" practice.

Forensic Science Laboratory, Role of Laboratory, Criminal Investigation

A10 A Minimally-Destructive DNA Extraction Technique for Feather Barbs and Its Application to Wildlife Forensics

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After attending this presentation, attendees will be introduced to the importance of accurate species identification in regards to wildlife forensics, and describe a new minimally-destructive yet highly-sensitive technique for obtaining accurate DNA-based species identification from bird feather barbs. The attendees will also learn how this technique may be applied to a variety of bird-related wildlife forensic contexts, including wildlife law enforcement, the illegal trade of bird products, and hazardous environmental incidents.

This presentation will impact the forensic science community by providing an efficient and accurate DNA-based species identification technique for bird feathers recovered in forensic contexts. Additionally, due to its high-sensitivity, this technique will also benefit bird studies in other disciplines, including ecology, biology and archaeology, by allowing the recovery of DNA from small, damaged, or degraded bird feather samples.

The accuracy of bird species identifications is critical for wildlife law enforcement and other aspects of wildlife forensics, and may be challenging when only the feathers are available for analysis. Though accurate morphologically based identifications are possible when feathers are complete and intact, they may be unfeasible when feathers have been modified, dyed, or damaged; DNA-based species identification techniques can be far more accurate. Current DNA extraction techniques; however, require the destruction of the entire feather or are restricted to those samples that retain fresh tissue in the feather shaft. Existing techniques are not effective when dealing with damaged, modified, or antique feathers, and are extremely destructive when testing crafted items and artifacts such as headdresses and fans, including those that may be culturally valued or historically prized.

This presentation will present a new DNA extraction technique that is both minimally destructive and highly effective. This technique borrows methods and strategies from "ancient DNA" analysis to obtain accurate mitochondrial DNA-based species identification using only a few feather barbs, rather than the whole feather. The technique was tested on feathers from a variety of species, including American crow (*Corvus brachyrhynchos*), wild turkey (*Meleagris gallopavo*), a museum-curated specimen of Ruffled Grouse (*Bonasa umbellus*), and a 200-year-old archaeological magpie (*Pica pica*) feather.

DNA extraction of the feather barbs was conducted within a dedicated Forensic DNA Laboratory at Simon Fraser University. Two to seven feather barbs were removed from the feather shaft using a sterile scalpel and digested overnight in a lysis buffer. A modified silica-spin column method was followed for DNA extraction and subsequent PCR amplifications targeted mitochondrial DNA using bird-specific primers focused on either the control-region or cytochrome b gene. The obtained DNA sequences were compared to modern published reference sequences through multiple alignments and phylogenetic analyses. The successful recovery of species-specific DNA from "fresh" feathers, historic museum specimens, and archaeological samples demonstrates the sensitivity and versatility of this minimally destructive technique.

This new DNA extraction technique can be applied to a variety of national and international forensic contexts. The technique will benefit wildlife law enforcement responsible for identifying the illegal possession of feathers (and other bird products) from species protected under the U.S. Migratory Bird Treaty (MBTA), the U.S. Endangered Species Act (ESA), and the Convention on International Trade in Endangered Species (CITES). This minimally destructive technique will be valuable for identifying crafted trade products or artifacts incorporating the feathers of protected birds. Furthermore, this highly sensitive technique can be applied to small, damaged, or degraded feathers in other forensic contexts, including the identification of species involved in bird strikes (collision between birds and man-made vehicles, usually aircrafts) or hazardous environmental incidents (e.g., oil spills).

Wildlife Forensics, DNA Analysis, Bird Feathers

A11 Dual Extraction of DNA and mRNA From Human Body Fluids for Forensic Analysis

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After attending this presentation, attendees will be presented with results suggesting that a dual extraction protocol is realistic for isolation of DNA and RNA for downstream forensic analysis of evidentiary-type body fluid samples.

This presentation will impact the forensic science community by showing that how DNA and mRNA can be isolated and analyzed from a single evidentiary-type body fluid stain yielding sufficient quality and quantity of nucleic acids in order to obtain DNA short tandem repeat (STR) typing. It will also demonstrate how to perform mRNA profiling to identify person of origin and tissue of origin from a forensic sample, respectively.

DNA evidence allows for the identification of the person from whom a sample was derived by STR typing but does not provide information concerning the tissue origin. Identification of the tissue origin of a stain may aid in the investigation. Currently, reverse transcription polymerase chain reaction methods have been developed for definitive identification of body fluids including blood, saliva, semen, menstrual blood, and vaginal secretions. These methods utilize tissue-specific mRNA markers to identify fluid origin in a rapid manner with minimal amounts of sample. Many of the stains encountered at crime scenes involve heterogeneous mixtures and, in many cases, involve small amounts of body fluids. Separate samplings of mixed stains to isolate DNA and RNA are less desirable than performing one extraction on a single sample. Therefore, a pre-requisite to the use of mRNA expression profiling in forensic analysis is the ability to co-extract DNA and RNA from the same sample that yields sufficient sensitivity for downstream forensic applications.

The purpose of this study was to identify the best method to co-extract DNA and RNA from a single sample that yields sufficient quality and quantity for molecular typing. Various dual extraction kits for DNA and RNA were tested for their ability to extract DNA and RNA from multiple sized body fluid stains. A phenol-chloroform method for DNA extraction and a silica spin-column based kit for RNA extraction was used for each sample set to serve as a control to compare the dual extraction kits. These studies were performed on various amounts of blood, saliva,

and semen stains along with menstrual blood and vaginal secretion stains on cotton swabs. All of the dual extraction kits successfully yielded DNA and RNA based on quantification utilizing real-time quantitative polymerase chain reaction (qPCR) assays. The RNA yield obtained from the dual extraction kits was similar to that of the silica spin-column based RNA extraction kit. In contrast, the DNA yield obtained from these kits was significantly lower than the phenol-chloroform extraction for all of the body fluids tested. The DNA isolated from the body fluid stains were analyzed by STR typing, and the mRNA was converted to cDNA and analyzed by PCR utilizing tissue-specific primers for mRNA profiling. Despite lower DNA yields compared to phenol-chloroform extraction, all of the dual extraction kits analyzed produced DNA and mRNA of sufficient quantity and quality to generate full STR profiles from the DNA and to obtain positive results for mRNA profiling utilizing tissue-specific primers. In conclusion, dual extraction of DNA and RNA from forensic-type samples appears feasible for the use of STR typing and mRNA profiling.

DNA, mRNA Profiling, STR Analysis

A12 DNA Extraction From Putrefied and/or Skeletonized Human Remains

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After attending this presentation, attendees will be provided with guidelines for accurate, reproducible, and efficient DNA extraction from either putrefied or skeletonized human remains.

This presentation will impact the forensic science community by discussing how DNA extraction from either putrefied or skeletonized human remains recovered in open spaces or in cemetery areas where the period of inhumation, exhumation, and subsequent tumulation in stone niches is regulated by local laws.

Compact bone represents a suitable tissue for DNA extraction even if the applied methodology is complex and requires a correct procedure, including cleansing of the obtained fragments, pulverization, demineralization, phenol-chloroform extraction, and subsequent purification of the DNA on silica columns. The quality of the STR genetic profiles is acceptable and they can be used for forensic purposes without regard to both quality and quantity of the extracted DNA, which as can easily be foreseen, are often low.

The personal identification test and the following comparison between the profile obtained and that of close relatives is requested by the Judicial Authority in the case where the mortal remains found are compatible with a missing person record filed or in the case of a request of parent attribution regarding a deceased person. Though DNA extraction can be carried out in any body region, it is recommended to perform it from compact bone tissue when in the presence of postmortem degenerative phenomena.

In this study, the human remains made available from the Judicial Authority were found in a wade range of conditions, from the conservation point of view, due to the different kind and time of exposition to biotic and abiotic factors. They were recovered in open spaces or in cemetery areas where the period of inhumation, exhumation, and subsequent tumulation in stone niches is regulated by local laws. Some of them were also recovered in cemeteries where the dead are buried in zinc coffins. The operations which made their exposition possible were the following: extumulation from a zinc coffin; removal from cemetery niche following exhumation; exhumation after inhumation in a wooden coffin; and recovery in open spaces after death.

DNA extraction from bone fragments can be obtained with several methods, depending on the conditions of the human remains. In the case under examination, the extraction methodology was complex, due to the fact that DNA had to be extracted from corpses which were undergoing putrefaction and/or were reaching the stage of skeletonization. A fragment of femoral diaphysis of approximately 4.0 cm was fixed in alcohol and subsequently deprived of the muscles and the inner trabecular structure (where present) before being rinsed with water – alcohol – ether and later pulverized and demineralized.

Pulverization was carried out with steel balls. Demineralization of 0.5 g of bone powder was obtained by means of a 0.5 M EDTA solution with a pH of 8.0. Purification after phenol-chloroform extraction was achieved with silica gel columns.

The quality of the DNA extracted was assessed via 2% P/V agarose gel electrophoresis run, in the presence of ethidium bromide.

The quantity of the DNA contained in the extracts was determined with the REAL-TIME PCR technique.

The individual profiles were obtained with STRs multiplex amplification followed by separation using capillary electrophoresis.

Statistical processing of the results obtained has shown that, without regard to the state of degradation of the specimen, it is possible to extract an individual profile. The methodology proposed here is also useful for personal and criminological identification on human remains in a bad state of preservation.

DNA, Extraction, Human Remains

A13 Inference of Ethnic Origins of Forensic Unknown Y-STR Profiles in Singapore

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After attending this presentation, attendees will understand that the cumulative variations of the Y-STR markers among the different ethnic groups might be used to infer the ethnic origins of an unknown Y-STR profile obtained from a crime scene.

This presentation will impact the forensic science community by demonstrating how the predicted ethnic origin can be a potential investigation lead for law enforcement agencies.

Singapore is a multi-ethnic country consisting of mainly Chinese, Malay, and Indian. In addition, with an increase in the foreign workforce, the percentage of other minority populations such as Caucasian, Bangladeshi, and Thai are on the rise as well. With this diverse ethnic population in view, it could be beneficial to the law enforcement agency if the ethnic group of the perpetrator can be predicted in order to provide an investigative lead. Based on the laboratory's Y-STR population database, it was observed that there are some unique and distinct differences in the Y-STR markers between the different ethnic groups. By studying these dissimilarities, the laboratory has developed an excel program to predict the ethnic group of unknown forensic Y-STR profiles.

The program was formulated based on a few assumptions and criteria. Firstly, as Y-STR is inherited as a haplotype from one generation to another, therefore haplotype comparison will be a major component in this program. Secondly, certain alleles are more common in one ethnic group compared to others, thus allowing those alleles to serve as distinctive markers for that ethnic group. Lastly, there is an unequal

distribution of allele frequencies between the ethnic groups in a few loci if not all loci. Hence for calculation purposes, this program assumes each marker is an independent locus even though this defers from the haplotype inheritance pattern.

The Y-STR loci involved are DYS19, DYS389I, DYS389II, DYS390, DYS391, DYS392, DYS393, DYS385ab, DYS438, DYS439, DYS437, DYS448, DYS456, DYS458, DYS635, Y GATA H4. Profiles of 240 individuals from each of the Chinese, Malay, Indian, Thai, Bangladeshi, and Caucasian ethnic groups were used to write this excel program. The functions of the program are to compare Y-STR haplotypes between the unknown profiles with those in the existing database, to identify alleles that are distinctive to each of the ethnic groups, and to provide arbitrary frequencies of the unknown profiles. Finally, all these aspects will be computed to rank and predict the possible ethnic group of the unknown profile.

Preliminary results based on a total of 160 Y-STR profiles demonstrated that the percentage of having the correct ethnic group being inferred is close to 88%, 66%, 89%, and 75% for Chinese, Malay, Indian, and Caucasian respectively. The percentage decreases for the three major ethnic groups when Bangladeshi and Thai are considered. This can be explained by the similarities among the Asian populations which are genetically closer in nature. An outlier ethnic group (African-American) is included in the program to serve as a control and none of the Asian ethnic groups returned African-American as the predicted ethnic origin.

This in-house excel program demonstrates the possibility of using Y-STR data to infer the most likely ethnicity of the DNA profile and to furnish such information to law enforcement agencies to serve as a potential investigative lead in Singapore.

Y-STR, Ethnic Groups, Haplotype

A14 Study on SNPs Relating to Ethnicity and Hair/Eye Pigmentation in a Population of Texas

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After attending this presentation, attendees will be able to comprehend the workings of a SNP analysis of pigmentation characteristics. Attendees will also be knowledgeable about preliminary data and results from a population study to evaluate the power of prediction of SNPs related to ethnicity and hair/eye pigmentation in Huntsville, Texas, as well as, the correlations that have been found in the literature.

This presentation will impact the forensic science community at large in that it will gain insight into little practiced methodologies when it comes to SNP analysis of ethnicity and hair/eye color pigmentation. By being able to identify phenotypic characteristics based off of a biological specimen, investigators may be able to ascertain more concrete descriptive factors of the ever so common "Jon Doe" or provide characteristics to the public of a criminal that has left evidence behind at a crime scene. By being able to rely on genetically coded characteristics rather than counting on eyewitness accounts of characteristics, it is possible that unidentified victims can be claimed more quickly and this has the potential to apprehend criminals more efficiently.

This research proposes to test the power of prediction using SNPs linked to ethnicity and hair/eye pigmentation in a population within rural Huntsville, Texas. To do this, a significant number of samples will be gathered and analyzed using a multiplexing system and then compared to correlation studies that are currently available. This study will also focus on a few anti-contamination efforts and how they apply to SNP analysis as well as whether or not one approach is more efficient in reducing contamination than another.

SNP, Pigmentation, Population

A15 Application of Modified STR Amplification Protocols to Commingled Remains From the USS Oklahoma

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After attending this presentation, attendees will have learned about the use of aggressive amplification strategies to obtain nuclear data from degraded skeletal remains in the case of the USS Oklahoma.

This presentation will impact the forensic science community by demonstrating how additional genetic information can assist with the re-association and identification of commingled remains in missing persons cases.

Four hundred and twenty-nine crewmembers were lost when the USS *Oklahoma* capsized and sank during the attack on Pearl Harbor on December 7, 1941. Over the next two years, the *Oklahoma* was righted and eventually towed to dry dock. Unknown remains recovered throughout the salvage process were buried in individual or common graves at the Nu'uanu and Halawa cemeteries in Hawaii. In 1947, the unidentified remains from the USS *Oklahoma* were disinterred. After three years of controversy surrounding the segregation of the grossly commingled skeletons, the approximately four hundred unknowns were separated into sixty five caskets and reburied in the National Memorial Cemetery of the Pacific. In 2003, one of the *Oklahoma* caskets was exhumed by the Central Identification Laboratory (CIL). This casket was believed to contain the remains of five individuals; however, anthropological analyses determined that many more were represented. Subsequently, 177 skeletal elements from the casket were submitted to the Armed Forces DNA Identification Laboratory (AFDIL) for mitochondrial DNA (mtDNA) typing. The 95 distinct mtDNA sequences recovered confirmed the suspicions of the CIL anthropologists.

Although the identification of degraded skeletal remains at AFDIL is primarily achieved through mtDNA typing, the forensic utility of this data is often limited by the molecule's uniparental inheritance and lack of recombination. Additionally, mtDNA testing requires either direct or maternal references for evidentiary comparison, and in some cases these types of references are unavailable. In the case of the USS *Oklahoma*, reference material has been collected for only fifty three of the nearly four hundred missing individuals. Further, the sometimes low power of discrimination of mtDNA is evident in this case as sequences from several skeletal elements and references share matching control region haplotypes. In one particular instance, four *Oklahoma* samples possess a

common mtDNA haplotype shared by two families and the use of coding region data was unable to provide any resolution despite past successes.[1] When specific limitations of mtDNA testing such as these are encountered, data from alternative DNA markers in the nuclear genome can benefit the overall identification effort. Unfortunately, the poor quality and limited quantity of nuclear DNA present in degraded skeletal remains has historically restricted the use of short tandem repeat (STR) markers. However, aggressive STR typing protocols[2] have recently shown great promise on the degraded skeletal elements typically encountered at AFDIL[3], particularly when the modified amplification is coupled with an improved DNA extraction.[4]

To provide additional genetic information, STR amplification protocols were applied to the four *Oklahoma* samples that share a common mtDNA haplotype. As in most cases processed at AFDIL, the degraded skeletal elements from the Pearl Harbor battleship yielded too little DNA to produce usable data under standard amplification conditions. Therefore modifications were made to the suggested protocols of two commercially-available amplification kits, one targeting markers on the Y-chromosome and another containing autosomal STRs with reduced-size amplicons. In addition to the commercial kits, two multiplex panels developed at AFDIL were utilized to type 15 X-chromosomal STR loci. Since aggressive parameters were used to amplify the low DNA quantity samples, data authenticity was confirmed by performing triplicate amplifications with only duplicated alleles included in a finalized, consensus profile.[2] Nuclear data generated with all three marker systems enabled the sorting of the four *Oklahoma* samples. Additionally, kinship analyses were performed using genetic data derived from the various skeletal elements and family reference specimens in order to assess the confidence in the presumptive identifications based upon odontological, anthropological, and contextual findings. The successful re-association of the commingled remains and genetic support for identification in this example from the USS *Oklahoma* demonstrates the practical utility of modified STR typing strategies in missing persons cases.

The opinions and assertions contained herein are solely those of the authors and are not to be construed as official or as views of the United States Department of Defense or the United States Department of the Army.

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Degraded Skeletal Remains, Short Tandem Repeats, Missing Persons

A16 Successful Extraction of DNA From Paper Currency

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The goal of this presentation is to demonstrate to attendees the possibility of an additional source of analyzable nuclear DNA in a forensic context, namely paper currency. In addition, it will showcase the importance of small pilot studies in advancing forensic science research.

This presentation will impact the forensic science community as it introduces a previously unexplored source of analyzable nuclear DNA, in the form of U.S. paper currency. Low quality and quantity DNA is associated with crime scene evidence; it is important that all potential sources of analyzable DNA be investigated in a laboratory setting before valuable biological evidence is potentially destroyed in unfruitful attempts at producing a genetic profile.

Previous studies investigating the primary transfer of analyzable DNA from an individual to an inanimate item have neglected to consider paper currency as a potential source of DNA in a forensic context. Publications concerning paper currency and illegal actions focus mainly on drug contamination, specifically the extraction of narcotics such as cocaine. DNA recovered from crime scenes is subject to degradation from many different contaminants. As such, all possible sources of viable DNA must be investigated. The direct contact that is required for paper currency use, in addition to its high frequency in society, creates an obvious source for collection and association within a forensic investigation. The goal of this research project was to conduct a pilot study that explored the possibility of extracting and analyzing viable DNA from United States (U.S.) currency.

This pilot experiment was designed in two parts: (1) to explore the possibility of actually obtaining nuclear DNA from paper currency that is able to be successfully amplified via the polymerase chain reaction (PCR); and, (2) to compare DNA recovery in relation to variability among the bills by a comparison of DNA quantity and quality. Bill variability includes wear and creasing with samples being taken from a worn area, an unworn area, and the center crease of the bill. DNA quantity was evaluated by amplicon intensity on an agarose gel and DNA quality was assessed by PCR amplification success. The preliminary test on a single U.S. one dollar bill revealed successful PCR amplification targeting the HUMTHO1 locus. The HUMTHO1 locus was selected for this study because of its inclusion in the Combined DNA Index System (CODIS) and thus has a direct applicability to forensic investigations. The study was then expanded and eleven U.S. one dollar bills were taken directly out of circulation and swabbed for potential analyzable DNA in three areas (worn, unworn, and center crease). PCR amplification of the HUMTHO1 locus was successful for all the samples. Comparison of samples retrieved from an unworn bill and a worn bill suggest that worn bills may have higher concentrations of donor DNA as exemplified by differences in amplicon intensity on an agarose gel. Differences also appeared between the samples obtained from creased areas versus flat areas of eight different bills (four bills with center creases and four flat). Samples taken from flat areas produced brighter bands when viewed under ultraviolet lighting than those taken from along a centerfold. This study suggests that it is possible to extract viable DNA from U.S. paper

currency; however, the yield may vary depending on the condition of the bill and the area sampled.

DNA Extraction, Paper Currency, PCR Amplification

A17 DNA Laboratory Bailout: No-Cost Methods for Improving Productivity

Tiffany Adams, BS, Las Vegas Metropolitan Police Department Forensic Laboratory, 5605 West Badura Avenue, Suite 120B, Las Vegas, NV 89118*

After attending this presentation, attendees will have learned how simple macro-based automation using pre-existing spreadsheet software can improve productivity in a DNA laboratory, how to identify the most suitable targets for macro development, and what factors affect the overall impact of macro-based automation.

This presentation will impact the forensic science community by assisting DNA laboratories in identifying and developing no-cost, simple macro-based automation solutions to increase productivity and reduce case backlogs.

When laboratory budgets shrink, funds dissipate for staff expansion, and additional equipment acquisitions despite increasing demands for forensic DNA testing. Any clerical/calculation-based task that is repeated can be automated by developing macro-based solutions using spreadsheet software programs already in use by the laboratory. By substituting time-consuming, repetitive tasks in DNA casework with macro-based automation, productivity and consistency can be enhanced while utilizing existing staff and equipment, affording dwindling budgets more "bang for their buck," and ultimately decreasing total DNA case backlogs with minimal cost adjustments.

Four automation targets were identified based upon expected overall impact and ease of development. Using Microsoft® Office Excel 2007, workbooks were created to interface with commonly-used data collection and statistical analysis software in order to automatically tabulate and evaluate data into a concise, report-ready format. The amount of time required for the original manual procedures versus newly automated procedures was compared and the timesavings were projected to increase productivity by at least ten percent. To fully understand the true overall impact of implementing no-cost, macro-based automated methods into DNA casework, actual time consumption is measured for several batches of various types of cases performed by several analysts using both manual and newly automated procedures. Additionally, this study examines how increased productivity affects DNA case backlogs and what factors limit or increase the expected results.

DNA, Automation, Productivity

A18 Analysis of Mock Sexual Assault Samples Using a One-Step Cell Elution and Preferential Lysis Method

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After attending this presentation, attendees will have gained an understanding of the improvements that have been made to a one-step cell elution and preferential lysis method for the recovery of cellular material from cotton swabs.

This presentation will impact the forensic science community by describing a fast and simple method to recover sperm cells from low cell number samples, which could help increase sexual assault sample throughput.

Differential extraction is the most common method for the recovery and separation of male and female cellular material from sexual assault swabs, accomplished by utilizing proteinase K and an anionic detergent. However, differential extraction is laborious and time-consuming, often requiring an overnight incubation of the cotton swab. In addition, some sperm cells are lost due to digestion by proteinase K, which can greatly decrease the likelihood of obtaining a STR profile of the perpetrator[1].

Microfluidic devices can be used for forensic analysis, providing a rapid, cost-effective alternative to the most widely used DNA analysis methods. Furthermore, these devices allow for the potential to integrate multiple analysis processes on a single device.[2] A microfluidic device has been used in combination with an acoustic trapping method to separate sperm cells from female epithelial cell lysate;[3] however, results obtained with this method depend on the recovery of sperm cells from the cotton swab, as well as comprehensive lysis of epithelial cells. A faster, reliable method for the successful recovery of sperm cells and lysis of epithelial cells from a sample is necessary to further benefit from these novel examples of integrated microfluidic devices for DNA analysis of sexual assault evidence.

Previous work has demonstrated a two-step method consisting of a thirty-minute incubation to elute all cellular material, followed by the addition of proteinase K and a second thirty-minute incubation to selectively lyse female epithelial cells[4]. This two-step method provides a comprehensive lysis of female epithelial cells and nearly doubles the recovery of sperm cells over differential extraction techniques. However, more recent work has improved the two-step method by using an Orchid Cellmark proprietary reagent and a single step method to reduce incubation time to as little as thirty minutes, while providing comparable sperm cell recoveries to those obtained with the two-step method[4].

The current work and focus of this presentation is on the optimization of the one-step method to maximize the recovery of sperm cells from mock sexual assault samples and the application of this method to low cell number mock sexual assault samples. Low cell number samples are defined in this work as samples containing ≤3000 sperm cells. Several incubation times and temperatures were evaluated to maximize recovery of sperm cells and the comprehensive lysis of female epithelial cells. Additionally, several anionic detergents were evaluated to determine if sperm cell recovery could be increased. The sperm and epithelial cells eluted from mock sexual assault evidence swabs were counted using a hemacytometer and results indicate that sperm cell recovery can reach as high as 90% with a thirty-minute incubation using the one-step method. This method has the potential to be used as an alternative to conventional differential extraction methods, as well as being adapted to microfluidic devices for eventual integration into a micro-total analysis system for DNA processing and more rapid analysis of sexual assault samples.

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Cell Elution, Preferential Lysis, Low Cell Number

A19 Touch DNA Profiling by Means of Single Tube Extraction Method From Cyanoacrylate Fumigated Latent Prints Developed on Weapons, Cartridges, and Casings

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After attending this presentation, attendees will gain knowledge about the potential of a Single Tube DNA extraction method in STR profiling from cyanoacrylate treated prints.

This presentation will impact the forensic science community by showing the application of a combined approach developed to yield useful STR profiles from cyanoacrylate fumigated weapons and cartridges, in real casework investigations, through the set-up and the reporting of the preliminary results of a thorough experimentation, designed to assess the influence of critical factors in DNA profiling, such as the role of surface matter in PCR inhibition, the degree of enhancement reagent inhibition and how to overcome it, the effect of ALS exposure to DNA degradation, and the detrimental effect of the enhancement process in the epithelial cells/nucleic acids release.

Touch DNA normally refers to STR typing from handled objects for personal identification purposes. Routinely, forensic practitioners used to fumigate touched objects with cyanoacrylate in order to enhance latent prints. Superglue fuming is one of the most widely used techniques for the detection of marks. On the other hand, fingerprints are also a well-known source of biological material; indeed, epithelial cells can be transferred as residues from sloughing or through direct contact with an object. Sometimes fingerprint characterization cannot be performed after enhancement because of smudging and/or overlay. For this reason, many authors have attempted nuclear DNA typing from recovered fingerprints for use in criminal investigations. In general this trend has led to the demand for an assessment of technical reliability of DNA analysis performed on exhibits. So far, unambiguous approaches in this field have not been indicated yet, nor has the establishment of reliable and robust guidelines been considered an easy task. Different homicide cases, which included "touch DNA" analysis after cyanoacrilate fuming on handguns, rifles, and various ammunitions, are presented. Following collection by swabbing with bidistilled water, adjusted single tube extraction, traditional STR, and mini-STR analysis methods were performed. In the first case, a profile recovered from a partial print on a handgun trigger revealed that the gun was carried to the crime scene by the victim and used first to threaten the alleged murderer. In the second case, a partial profile was yielded from the bolt handle of a rifle, excluding the match with the suspect's profile. In the third case, partial DNA profiles were obtained from a 12-gauge and from a .32 auto caliber spent casings. An STR allelic pattern from the .32 auto casing was not assigned, but the DNA profile from the 12-gauge casing matched with a LP Unit technician's profile that accidentally contaminated the item. Even if QA requirements were strictly adhered to, the mishap strengthens the argument for evolution in laboratory procedures. In addition to the investigative potential, the above mentioned results points out the limits and drawbacks of such an approach. Following the results from real casework, the goal was to set up an experimental procedure to assess the influence of various factors affecting the yield of STR profiles. At first, the laboratory's proficiency was assessed by analyzing prints left by unrelated donors on microscope sterile slides. Then DNA analysis was set up on an array of prints left by the same donors on different items including plastic bags, metal boxes, a brand new Beretta handgun, and several brand new 9mm brass fmj cartridges, properly cleaned before print deposition. Each article was separately inspected with a forensic light. Cyanoacrylate fuming was then performed in a DNA free cabinet that was sterilized before and after each single process to avoid cross contamination. After enhancement, each article was inspected and photographed to collect marks. Finally the article was submitted to the DNA lab for analysis. DNA extractions were performed using the following parameters: (1) swab with 3x3 mm paper with bidistilled water; (2) single tube extraction in 30-50 µl final volume and DNA amplification following recommended protocol; and (3) blank control extracted with every sample. PCR was carried out using traditional STR and mini-STR kits and every sample was amplified in duplicate or in triplicate repetition to monitor stochastic fluctuation. Preliminary results indicate a good degree of reliability of the approach when applied on most of the tested items. Previous work showed inhibition caused by cyanoacrylate during the extraction and amplification processes, while more recent articles indicate the use of diverse strategies to overcome such analytical hurdles. As to the latter issue, it should be emphasized that the untreated fingerprints usually provided better STR DNA profiles than the treated fingerprints. In the single tube approach, adequate methodology prevents or minimizes the loss of DNA, whereas inhibition and "in-tube" nucleic acid degradation is still the major concern. As a matter of fact, the single tube approach revealed an enormous potential: a higher sensitivity in touched objects for STR profiling could be reached by properly adjusting the reaction conditions and by using length-reduced amplicon markers. Profiles were obtained both from good and poor quality fingerprints, revealing the independence between good fingerprint donors, and good DNA shedders.

Touch DNA, Latent Prints, Superglue

A20 Collection of DNA From Spent Shotgun Shells

Alexis Smith, BA, 341 Fisher Hall, 600 Forbes Avenue, Pittsburgh, PA 15282; Julia R. Patterson, BA, 1602 East Carson Street, Floor 3, Pittsburgh, PA 15203*

After attending this presentation, attendees will gain a better understanding of obtaining DNA profiles from spent 12-guage shotgun shells. Attendees will also be educated about the effect of the shooter's gender, the type of shell, and the order in which the shells were loaded on the completeness of the DNA profile obtained.

This presentation will impact the forensic science community by demonstrating that genetic profiles can be obtained from spent shotgun shells.

According to the FBI in 2005, shotgun crimes accounted for five percent of homicides by firearms. This is second only to homicides by

handguns.[1] Typically when investigators arrive at the scene of the crime, the only evidence related to the gun is a spent shell casing. When the shells are handled and loaded into the shotgun, DNA is transferred through the loss of epithelial cells. It has been shown previously that touch DNA can yield DNA profiles from spent bullet casings from a handgun. However, fewer epithelial cells may be shed during the handling of shotgun shells because less pressure is required to load the shotgun. It is hypothesized that profiles can also be obtained from spent shotgun shell casings.

Previously, it was believed that the difficulty of obtaining DNA profiles from fired cartridge cases was due to the high temperatures to which the cartridge is subjected in the gun barrel. Moreover, the small amount of DNA deposited through handling of the cartridge was thought to be negligible. This is analogous to the conditions of a shotgun.

Subjects involved in the present study were asked to load a 12-guage shotgun with three shotgun shells. After loading, each subject fired the shotgun. The shells were collected post ejection by retrieving them with sterilized wooden sticks and placed in a bag, which was assigned a random number. The bags were color coded according to the order the shotgun shells were shot by an individual not involved in the study, creating a blind study. Reference buccal swabs were collected and assigned the same number associated with the shooter's ejected shells. This allowed the research subjects to never be directly linked to their identification number.

The experimental design involved twenty study subjects, ten males and ten females. The ratio of males and females was chosen to test the effect of gender on the completeness of the genetic profile obtained. Past studies with extremely small sample sizes have suggested that there may be sexual dimorphism in shedding behavior, with males being higher shedders. This study will contribute to the other studies and a meta-analysis of all the studies. The subjects fired both high brass and low brass shotgun shells to study the effect of the type of shell on the results. High brass shotgun shells were originally created to be able to hold more powerful ammunition. The appearance of these two types of shells differs in that the brass on low brass shells only extends about half an inch up the plastic. The high brass shells have more exposed brass. The loading order of the shells was also analyzed in order to observe if there was any effect on the data.

DNA from the casings was transferred using a double-swab technique with 20% SDS as the surfactant. An organic extraction was then performed on the DNA swabs. Multiplex PCR was performed on the samples using the AW12106 miniplex developed at Duquesne University. This miniplex utilizes five loci: D8S1179, D16S539, D5S818, TPOX, and amelogenin. The miniplex was specially designed for DNA segments less than 200 base pairs. This is useful for extremely degraded DNA samples. The samples were then genotyped using a genetic analyzer and compared to the reference samples collected. A partial profile was considered to be amplification of one to four loci. The completeness of the genetic profiles obtained was examined in connection with the variables previously stated.

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Shotgun Shells, Touch DNA, Firearms

A21 Internal Validation of Robotic Liquid Handler for Real-Time PCR Set-Up

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After attending this presentation, attendees will gain an understanding of an internal validation study for a robotic liquid handler, and have seen sample data.

This presentation will impact the forensic science comunity by providing an example of an internal validation of a liquid handler robot.

In an effort to reduce backlogs and increase throughput, the Austin Police Department (APD) DNA Unit has implemented the use of automation in many steps of analysis. The newest automation for the ADP DNA Unit was a robotic liquid handler designed for real time PCR (rtPCR) plate set up. An internal validation was performed to ensure the reliability and precision of the robot when used for rtPCR set up of samples to be quantified utilizing a commercially avalibly quantification kit. This validation study included evaluation of precision, contamination, comparison to manual methods, and mock casework. Standards prepared by the robot resulted in an average Ct standard deviation of 0.196 and average slopes of -3.26, showed no signs of contamination, and were shown to perform similar to validated manual methods.

Validation, Automation, qPCR

A22 Indentification of Barrel Fingerprints (Striations) of Lead Core and Splinter of Jacket of Bullets

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The goal of this presentation is to inform the attendees of the importance of analyzing the striations on small or likely to be destroyed splinters on the jacket and lead core of the bullet when attemting to ascertain the weapon responsible for firing.

This presentation will impact the forensic science community by discussing the importance of finding the weapon responsible for firing to aid in the detection of crimes.

When bullets are fired from high velocity firearms, the jacket of the bullet is often broken into fragments. The degree of fragmentation depends on the velocity of the bullet, the striking energy, the position and angle of travelled path, the hardness of target, etc. Impact of the bullet may lead to the complete separation of the lead core and its fragments. Due to the impact and striking of various objects, the striations on the surface or a portion of the bullet may be missed, obliterated, or interfered with. The jacket pieces (splinters) due to additional rubbing and impact marks may not be identifiable even to the extent of elimination on the basis of class characteristics, although they bore characteristics rifling marks (striations) initially. This presentation also discusses the benefit of utilizing marks other than the usual striations/rifling marks/barrel finger printing to identify the lead core and jacket pieces/splinters.

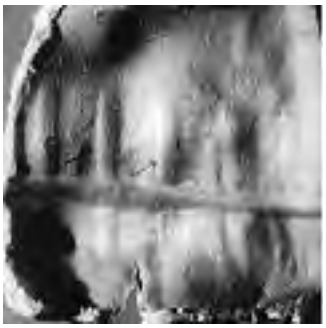
When a bullet is fired through a rifle, it is engraved with characteristic rifling marks/fingerprint from the inside of the barrel. The

depth and nature of imparting depends upon the condition of rifling irregularities of the barrel, diameter of the bullet, the construction material of the bullet, etc. Therefore, these imparting marks, whenever present, can be quite useful when the normal identification procedure is not available

To experimentally study the marks on the under surface of jackets and the lead core, the firings were conducted with high velocity firearms. The jacket of the recovered bullets was cut open and the lead core was removed. A few rounds were fired so that the bullet hit the target thereby causing splintering of the bullet. In addition, bullet fragments from actual cases and controlled unfired bullets were also studied.

Result and Discussion: The examination of the under surface of the jacket and the lead core revealed, in some cases, the presence of identifiable characteristic rifling marks/fingerprint marks on the inside of the barrel. The engraving in most of these was sufficient for the identification of class characteristics like twisting, angle, and width of rifling.

Figure 1:



Class characteristic rifling marks/fingerprint of the barrel under the surface of the jacket.

Figure 2:

Class characteristic rifling marks/fingerprint of the barrel marks on the inside of the lead core.

Lead Core, Fragment, Bullet

A23 Methodology Used to Estimate the Measurement of Uncertainty: Accuracy, Reliability, and Validity Obtained for a Firearms Section Bullet Classification Procedure

Dana M. Punte, MSFS, and Patrick W. Wojtkiewicz, PhD, North Criminalistics Laboratory, 1115 Brooks Street, Shreveport, LA 71101*

After attending this presentation, attendees will have an understanding of a measurement of uncertainty and how to perform a measurement of uncertainty on firearms measurement procedures.

This presentation will impact the forensic science community by discussing how research defining error rates for the discipline of firearm and tool mark identification is needed to associate error with methods, assure reliability of methods, provide statistical proof to ensure "soundness" of methodologies to deter attacks by the defense (*Daubert*), and promote further understanding for uncertainty of measurement required for ISO 17025 accreditation. Uncertainty of measurement is crucial for forensic evidence analysis, which will be used by the justice system to make decisions where someone's life or freedom may be at stake.

This project addresses several aspects of accuracy, reliability, and measurement validity for the method utilized at the North Louisiana Criminalistics Laboratory to measure physical characteristics of bullets. The National Academy of Sciences Report (2009) spoke to the Firearm and Toolmark Identification discipline as lacking established statistical error rates for methodologies commonly used to measure physical aspects of weapons. Therefore, with no known error rates, the reliability of these methods is undocumented. In order to obtain a measurement of uncertainty for physical characteristics of bullets, a digital micrometer measuring instrument was utilized to determine the diameter and width of land and groove impressions. Guidelines published by ASCLD/LAB *International,* "Estimating Uncertainty of Measurement Policy" followed. Recommendations from NIST 6919, NIST 6969, and Guide to the Expression of Uncertainty in Measurement (GUM) per ACLASS for uncertainty of measurement were also considered.

Test samples (fired bullets) were obtained by firing several firearms of differing calibers with differing types of ammunition. Participants measured the diameter and width of land and groove impressions of each test sample. Descriptive statistics were calculated to propagate the overall error for the entire sample population. A propagation equation can be described as a compilation of errors via vector addition to incorporate many small errors into one all-encompassing error range, and was used to calculate the overall representative error for the methodology. A ninety five percent confidence interval was calculated around the population mean and the resultant value was compared to the theoretical value. The theoretical values were obtained from the GRC File published by the FBI. Statistical significance of the measured result was determined by assessing whether the calculated confidence range encompassed the theoretical value. If the theoretical value was found to not encompass the calculated range then the error was classified as systematic and was accounted for with a method adjustment.

A bottom-up approach for a measurement of uncertainty was utilized for this research. The method for measuring bullet characteristics was mapped out onto flow diagrams and sources of potential error were established. Cause and effect diagrams were developed to determine the significance of each contributor to the overall measurement of uncertainty for the method. Contributors encompassed within the error budget consist of errors that are both measureable and immeasurable; therefore, an assessment of the errors was performed to determine what errors could be accounted for statistically.

Thus far, measurement trials have been performed which display variance within the results. A window of uncertainty has been established for the method, and various aspects within the measurement method were shown to contribute a significant amount of error. Currently, measurement factors such as instrumentation, methodology, and analyst contributions are being reviewed to improve the reliability of measurements. Trials are still underway to collect additional data for statistical propagation. Solid conclusions will be made when a sufficient amount of data is collected to perform the statistical calculations.

ASCLD/LAB- International, Measurement of Uncertainty, Propagation of Error

A24 Automated Searching of an Ignitable Liquids Library of Summed Ion Spectra by Target Factor Analysis

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The goal of this presentation is to describe the use of summed ion mass spectra combined with target factor analysis (TFA) to identify ignitable liquids and pyrolysis products in fire debris samples.

This presentation will impact the forensic science community by addressing the ability of combining summed ion spectra and target factor analysis as a method for supplementing current techniques of pattern recognition employed in fire debris analysis.

This presentation will describe the use of summed ion mass spectra combined with target factor analysis (TFA) to identify ignitable liquids and pyrolysis products in fire debris samples. Ignitable liquid residues recovered from prepared-in-laboratory fire debris samples were identified by searching a library of ignitable liquid summed ion spectra as TFA test spectra. A second test of this method was applied to determine if pyrolysis products from a particular substrate could be identified by using the summed ion spectra from a library of previously burned substrates as the TFA test spectra. The importance of this method for the fire debris analysts lies in the method's ability to identify an ignitable liquid residue in the presence of significant pyrolysis background.

The summed ion spectrum, created by summing the intensity of each ion across all elution times in a gas chromatography-mass spectrometry (GC-MS) data set retains sufficient information content for the identification of specific components in complex mixtures.[1] The summed ion spectrum is information rich and much faster to calculate than the covariance map of the data set.[2] In traditional fire debris analysis, the chromatographic patterns of total ion, extracted ion, and target compound chromatograms are used to classify an ignitable liquid according to the American Society for Testing and Materials (ASTM) E 1618 standard method. A complementary method of applying principal components analysis (PCA) followed by target factor analysis (TFA) to the summed ion spectra of fire debris samples allows for rapid, automated searching against a library of ignitable liquid summed ion spectra. Receiver operating characteristic (ROC) curves measure how well the model predicts the ASTM-class identification of the ignitable liquid in the fire debris sample based on the correlation between the predicted summed ion spectrum and the test spectrum from the ignitable liquids library.

The summed ion spectra method combined with TFA has been used to correctly identify the particular ASTM classification of ignitable liquids used in the laboratory sample burns for each of the ASTM E 1618 classifications except for the light petroleum distillate classification (the miscellaneous classification was not examined) with a correlation of 0.92 or better. Low correlations between the test and resulting spectra for the light petroleum distillate class were attributed to the high volatility of liquids falling into this classification, resulting in minimal post-burn ignitable liquid residue.

The area under the curve (AUC) from the ROC analysis was above 0.92 for all of the ignitable liquid classifications except for the aromatic liquids and the oxygenated solvents. The AUC indicates the probability that the method will rank a randomly chosen ignitable liquid from the correct classification higher than a randomly chosen ignitable liquid from the incorrect classification. The low AUC for the aromatic liquid and oxygenated solvent classifications indicated difficulty in correctly identifying the broader ASTM classification of ignitable liquid; however, TFA showed a high correlation between the test and resulting spectra for the specific ignitable liquid used in the test burn. The low AUC from the ROC analysis (designating correct identification as the proper ASTM classification) can be explained by the significant variation within the aromatic and oxygenate classifications. Using the aromatic class, sub-classifications of light (C_4-C_9), medium (C_8-C_{13}), and heavy (C_9-C_{20+}) as positive qualifiers for the ROC analysis resulted in an AUC increase from 0.41 to 0.98. The sub-classifications of the aromatic ASTM classification closely parallel subdivisions of the class into single-ring and multi-ring aromatics. Sub-classification cannot be applied to the ASTM oxygenated solvent classification because clustering of the oxygenated solvent classification does not result in groupings of liquids giving similar mass spectral profiles and therefore does not improve the ROC AUC results. These preliminary results indicate that TFA is a promising method for identifying the ignitable liquid present in fire debris, especially in the presence of a significant pyrolysis signature. Statistical analysis of the performance of the method supports this conclusion and points to the summed ion spectrum/TFA as a method of supplementing current techniques of pattern recognition employed in fire debris analysis.

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Fire Debris, Ignitable Liquid, Summed Ion Spectra Method

A25 Development of New Reagents for the Detection of Latent Fingerprints

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After attending this presentation, attendees will have an idea regarding new derivatives for fingerprint detection obtained by modifying the molecule of lawsone. A comparison analysis between the new developed compounds and currently used ones in the forensic industry is presented.

This presentation will impact the forensic science community by introducing new fingerprint detecting reagents. Additionally, comparing new fingerprint reagents with enhanced properties to the ones currently in use is of great importance.

After attending this presentation, attendees will know that a new class of fingerprint detecting reagents has been developed. These new compounds present a chemical structure derived from the molecule of lawsone (2-hydroxy-1,4-naphtoquinone) and have very favorable chemical and spectroscopic properties. This presentation will impact the forensic community and the general public because the compounds investigated are used for detecting latent fingerprint and represent an

alternative to the more commonly used products, such as ninhydrin, DFO and 1,2-indanedione. Fingerprint development is one of the most widely used techniques for indentifying possible offenders in criminal cases. Because not all fingerprints can be detected easily, a wide range of optical, physical, and chemical techniques have been presented for the detection and enhancement of latent (hidden) fingerprints. In particular, fingerprints on porous surfaces (cardboard, paper) demand a chemical development to be examined. Ninhydrin is one of the most widely used chemical reagents in forensic investigation. It reacts with the amino acids in the sweat left behind by the print, producing a dark blue-purple colored print known as Ruhemann's purple. In order to detect high fluorescence, the Ruhemann's purple compounds are treated with metal salts such as zinc (II) and cadmium (II) chloride at very low temperatures. This allows significant gain in sensitivity by improving the contrast on various backgrounds and improving the number of prints which may be visualized. Over 90 ninhydrin analogs have been synthesized, some with improved properties over ninhydrin; however none have shown to be more advantageous than its parent compound, thus not replacing ninhydrin. 1,8-diaza-9-fluorenone (DFO), 1,2,-indanedione, and genipin are some of the most recent examples. DFO is commonly used in forensic investigations because it is very sensitive to latent prints on paper and exhibits high fluorescent yields; however, heat is required for development and a much paler print is produced when compared to ninhydrin. 1,2-indandione has been documented to be promising, but isn't as fluoregenic. The potential of genipin, a natural product produced from the extract of Gardenia fruit, has also been proposed. Genipin offers the advantage of colored/luminescent compounds when reacted with amino acids in a single reaction. However, genipin is costly, the chemical structures of its products are not known to date, and it's only soluble in very polar solvents—which is not ideal for fingerprint analysis on documents since de-inking problems may result.

The latest reagent studied for latent fingerprint analysis on paper surfaces is 2-hydroxy-1,4-napthoquinone, commonly referred to as lawsone. Lawsone is natural and safe. Lawsone is thought to be the compound responsible for the staining properties of henna, which is extracted from the leaves of *Lawsonia inermis*. Lawsone reacts with the amino acids left behind in sweat residue, producing purple-brown impressions of ridge details which are also photoluminescent. This reagent shows to be very promising; however, its drawback is its solubility. A high concentration of polar solvent is required to dissolve the compound, which may cause unfavorable de-inking problems.

The molecular structure of lawsone was modified and a series of derivatives were prepared in order to improve the solubility and to enhance the fluorescence properties. Comparative fluorescence studies between lawsone, the new derivatives, and the commonly used fingerprint detecting reagents were performed. In addition, the mechanism of reaction between lawsone and several aminoacids was investigated both synthetically and computationally.

Fluorescence, Lawsone's Derivatives, Fingerprint Detection

A26 Development of Aged Latent Prints: How Old Is Too Old?

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After attending this presentation, attendees will understand the problems involved with the enhancement of aged latent prints on porous surfaces.

This presentation will impact the forensic science community by serving as a demonstration of the ability of DFO, ninhydrin, and 1, 2-indanedione to develop aged latent prints on porous surfaces.

Three of the current and most widely used chemical formulations for the development of latent prints will be discussed, as well as their application to the development of aged latent prints. Statistical data from this research will show the effectiveness of 1, 8-diazafluoren-9-one (DFO), ninhydrin, and 1, 2-indanedione formulations on the development of latent prints ranging in age from less than one year to twenty one years old. Ninhydrin is a chemical reagent that reacts with the amino acids in the latent print residue to form a purple coloration along the friction ridges of the latent print, known as Ruhemann's purple. Ninhydrin is one of the more common chemical processes used for the development of latent prints on paper. Developed from a ninhydrin analog, DFO reacts in much the same manner as ninhydrin, responding to the amino acids present in the latent print residue. However, DFO produces a light pink coloration along the friction ridges that is only slightly visible to the naked eye. When examined under an alternate light source of 470 to 570 nm and with an orange filter, the details of the latent print fluoresce, becoming much more visible. With further research into ninhydrin analogs, 1, 2-indanedione was discovered as a latent print development technique. 1, 2-indanedione also reacts with the amino acids in the latent print residue, and like DFO, the developed latent print is barely visible to the naked eye, but fluoresces when viewed under an alternate light source with an orange filter. However, research has shown that 1, 2-indanedione has a higher sensitivity to the amino acids in the latent print residue, allowing for a higher frequency of enhanced latent prints. This study examined whether the advantage of using 1,2-indanedione's sensitivity could be exploited to detect latent prints on "aged" documents. The envelopes were handled in the mailing process and at the time of receipt were then stored in a light tight container until the time of chemical processing for this study. The envelopes were processed using the DFO, ninhydrin, and 1, 2-indanedione methods. The latent prints that developed using all three processes were given the following score: (1) no ridge detail developed; (2) few ridge details developed; (3) comparable ridge detail developed; and, (4) AFIS quality ridge detail developed. The DFO processed envelopes produced positive results on 35% of the twenty envelopes processed with 10% of those being considered identifiable. The ninhydrin processed envelopes produced positive results on 40% of the twenty envelopes processed with 15% of those being considered identifiable. The 1, 2-indanedione processed envelopes produced positive results on 95% of the twenty envelopes processed with 85% of those being considered identifiable. This data was analyzed by Chi Square test and these differences were statistically significant with 1,2-indanedione having a higher identification rate then either DFO or Ninhydrin, over the age range tested. There was no difference in the ability to detect latents in the "older" (16-19 yrs, N=20 latent prints; 11-14 yrs, N=58) and the "younger" latents (< four-years

old, N=22), p value =.167. In criminal investigations, the development of latent prints often lead to evidence that will provide substantiation of an individual's involvement in a crime. With the passage of time, the degradation of the latent print residues reduces the probability of developing identifiable latent prints on evidentiary items. It can be concluded that the degradation of the amino acids within the latent print residue was not too significant to allow for a reaction with the chosen chemical processes. 1, 2-indanedione showed to be the best process to use for developing aged latent prints on paper, producing the highest quantity and quality enhanced latent prints.

Aged Latent Prints, Porous Surfaces, Chemical Development

A27 Collection of Human Remains Volatiles by Non-Contact Dynamic Airflow Sampling

Lauryn E. DeGreeff, BA, BS, Florida International University, 11200 Southwest 8th Street, Miami, FL 33199; and Kenneth G. Furton, PhD, International Forensic Research Institute, Florida International University, University Park, Miami, FL 33199*

After attending this presentation, attendees will learn that the scent of human remains is composed of specific volatile compounds and can be easily collected by dynamic airflow sampling.

This presentation will impact the forensic science community because the results presented indicate the possibility of using GC/MS analysis of human remains odor to confirm or reject the alert of a human remains detector canine.

Human remains detector canines or HRD canines are utilized by law enforcement and disaster relief agencies to locate human remains in a variety of environments. Such canines have the ability to distinguish between living and deceased humans, as well as between human and animal remains. The unique scent associated with human remains and detected by the canines evolves during the decay process as the body's building blocks, proteins, nucleic acids, carbohydrates, and lipids, are broken down into smaller components. As these macromolecules break down, volatile organic compounds are released into the surroundings and can subsequently be detected by HRD canines as early as four minutes after death.

Currently, in the United States, canines are used to locate live people with the assistance of a non-contact, dynamic airflow sampling device. This device is a field-portable, dynamic headspace sampling vacuum. It was designed to collect the scent of living humans from a variety of objects. However, this vacuum has the potential to be used for the collection of volatile compounds originating from other sources beyond living humans. This research would be among the first to apply dynamic airflow sampling with such a device to the collection of human remains odor.

The device consists of a small vacuum pump with a Teflon-coated plastic hood affixed to the top. The hood has been designed to hold a small piece of material or gauze with a stainless steel plate. For collection, it is swept over the subject or object of interest while "vacuuming" any volatile compounds associated with the object onto the collection medium. For this research, the scented material is then removed and placed into a vial, where it is allowed to equilibrate over night. The volatile compounds that have escaped from the material into the headspace are sampled using solid phase micro extraction with GC/MS.

The collection medium and vacuum flow rate were first optimized using standard compounds. The standard compounds used were VOCs known to be associated with cadaver scent. Low, medium, and high flow rates were compared. It was determined that the collection of volatiles was better at the medium and low flow rates depending upon the collection material. Also, the collection and release of the standard VOCs from several types of collection materials were compared. The optimum collection material differed for each compound, thus a combination of several materials were used to maximize scent collection.

To determine the key compounds that could be used to identify the presence of a dead body, the scent from deceased peoples were sampled with the vacuum and analyzed using SPME-GC/MS. A large sample population of deceased bodies, at varying stages of decomposition, was sampled. Samples were collected by sweeping the vacuum over the body for one minute using a combination of pure cotton gauze and Dakron polyester material as the collection medium. The results of this study show that universal compounds do exist in the scent of deceased human material.

Applying dynamic airflow sampling in this way would be beneficial to the law enforcement community. Occasionally HRD canines may indicate the presence of a body when no body is actually present. This occurs because canine olfaction is so sensitive that canines are likely to indicate the presence of a body in a location where there was once a body even after the body is no longer present. This approach permits the use of the sampling vacuum for the collection of human remains volatiles from a location where a body may have once been located, based on the indication of an HRD canine. Key compounds found in the scent using the sampling vacuum with SPME-GC/MS detection could be used to prove or disprove the canine's indication. The results presented indicate that it may be possible to confirm or reject the alert of a HRD canine scientifically.

Human Remains Odor, HRD Canine, Odor Detection

A28 The Development of a Universal Non-Target Calibration Compound(s) for the Daily Reinforcement and Determination of Detection Limits for Detection Canines

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After attending this presentation, attendees will understand the goal of this study, developing a calibration compound for which the reliability of the biological and instrumental detectors can be studied. Attendees will also learn the criteria used for calibration compound selection and the results obtained from the laboratory and field studies.

This presentation will impact the forensic science community by increasing the value of the detection canine's responses. By defining the working parameters of the detection canine, the responses to specific odors will withstand greater scrutiny from the legal system as the handler will be able to provide documentation that the detection canine was working within acceptable limits when the tests were completed, thus making the detection canine as objective and reliable as a laboratory instrument.

Detection canines are widely used in many forensic fields and have been proven to be valuable assets while investigating a case. The use of detection canines as biological detectors is one of the most widely accepted methods for reliable odor detection due to the ability of the canine to quickly and reliably locate the source of an odor to which they

are trained. The goal of this study is to develop a calibration compound for which the reliability of the biological and instrumental detectors can be studied. Currently there are no set practices to ensure that a biological detector is working at a reliable and suitable standard on a daily basis. As instruments in a laboratory are calibrated to ensure they are in proper working order, developing a universal compound for which biological detectors can be calibrated would be useful. By training the canine to alert to a calibration compound before each working day, the handler can record if the biological detector is working to suitable standards. This compound has the potential to also be used in selecting future biological detectors by determining the time it takes to train the canine to alert to the compound and the sensitivity of detection the canine can achieve.

Compound selection was based on three criteria: safety, scarcity in the natural environment, and a non-dominant odor compound used by detection canines. Since the calibration compound will be used daily, it must pose no danger to both the handler and canine, therefore limiting the compounds to those having no health hazards. The compound must be rarely seen in the environment to ensure that when the canine alerts, it is not alerting to a commonly seen environmental odor. The odor must be unique for all detectors to ensure there is no cross detection. For example, if the compound is a dominant odor of an explosive compound, training a drug canine to alert to the calibration compound will pose a problem because if the canine alerts in the field, it may be alerting to an explosive containing the dominant odor of the calibration compound rather than a drug odor. Several compounds meeting these criteria have been tested and the best potential calibration compounds are compared in this study. These calibration compounds are rarely seen in the environment, safe for daily use, and have not been found to be an odorant for any of the detection canines tested to date. Examples of odorants identified as dominant odor compounds used by detector canines include piperonal for 3,4-methylenedioxymethamphetamine (MDMA) and 2-ethyl-1-hexanol for plastic explosives.

After training the detector canines to the calibration compound, a series of field trials are performed to test the canine's limits of detection for that compound. Once trained to the calibration compound, the limits of detection are determined by performing scent line-ups in which various amounts of the compound will be exposed and the lowest concentration of compound for which the canine can still alert to will be recorded. This test is repeated with the same canine and with multiple canines under similar conditions until reliable statistical analyses can be performed.

The development of a universal non-target calibration compound for detection canines will increase the value of the detection canine's responses. By defining the working parameters of the detection canine, the responses to specific odors will withstand greater scrutiny from the legal system as the handler will be able to provide documentation that the detection canine was working within acceptable limits when the tests were completed thus making the detection canine as objective and reliable as a laboratory instrument.

Detection Canines, Calibration, Detection Limits

A29 Ethylene Glycol in Medical Devices

Irene Tan, Poh Ling Chia, BSc, Chin Chin Lim, MSc, MBA, and Yuk Lin Yong, BSc, Health Sciences Authority, 11 Outram Road, Singapore, 169078, SINGAPORE*

After attending this presentation, attendees will have learned of the methods employed in identifying the chemical content of hot/cold packs and the use of a derivatization technique to quantify the amount of ethylene glycol detected in these packs using gas chromatography-mass spectrometry (GC/MS).

This presentation will impact the forensic science communitiy by discussing how ethylene glycol is a toxic substance. It was used in some local medical devices as an anti-freeze ingredient instead of the non-toxic propylene glycol. The results of laboratory analysis led to the recall of some Hot/Cold Packs from the local market.

The Medical Device Branch (Health Product Regulation Group) of Health Sciences Authority was first alerted to the possible presence of ethylene glycol in hot/cold packs due to a case of accidental poisoning in Australia when a young child chewed through the plastic packaging of a pack and consumed its content, which contained the toxic ethylene glycol. Ethylene glycol is harmful or fatal if swallowed. It may cause allergic skin reactions and can be harmful if inhaled or absorbed through the skin. Extended exposure over a period of time, if the compound is heated, may lead to pulmonary edema and central nervous system depression. As a result, the Medical Device Branch acquired fourteen types of the Hot/Cold packs from the local markets and submitted the packs to the laboratory for analysis.

The hot/cold packs were analyzed by fourier-transformed infrared spectroscopy, Raman spectroscopy, and gas chromatography-mass spectrometry. Of the fourteen types of hot/cold packs analyzed, five of them were found to contain the toxic ethylene glycol while the other nine types contained either propylene glycol, glycerol, sodium acetate, or water plus either a polyacrylamide or polyacrylate type polymer. All five of them were of the same brand. The qualitative analysis of the hot/cold packs and the quantitative analysis of ethylene glycol in these packs will be presented in the poster.

Ethylene Glycol, Toxic, Hot/Cold Pack

A30 Statistical Analysis of Visible Absorption Spectra and Mass Spectra Obtained From Dyed Acrylic Fibers

Katie M. White, BS, Mary R. Williams, MS, and Michael E. Sigman, PhD, University of Central Florida, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will learn more about the applications of statistical analysis to the comparison of fiber dye spectra.

This presentation will impact the forensic science community by presenting an objective method for the comparison of absorption profiles in which spectral similarity is assessed at a known significance level.

Among various techniques, fiber examiners presently utilize microspectrophotometry to obtain the absorption spectra of known and questioned samples. Comparison of the questioned and known spectra is relatively straightforward when absorption profiles are visually distinct, but the task becomes more challenging when dyes exhibit highly similar absorption profiles. A recent report by the National Academy of Sciences indicated the need for the forensic science community to "minimize the risk of results being dependent on subjective judgments." Hypothesis testing provides an objective method of comparing absorption profiles and assessing their similarity at a known significance level.

The objective of this study is to examine the levels of Type I and Type II error for fiber discrimination based on hypothesis testing using parametric and nonparametric analysis of visible absorption spectra and ESI mass spectra. Samples of blue acrylic yarn from different sources were used in this study, two pairs of which came from the same manufacturer but had different color names. Samples were chosen to

represent yarns that, in bulk, were considered visually indistinguishable by color. No identifying information about the yarn dyes was known. *In situ* dye absorption profiles were obtained using microspectrophotometry. Dye extracted from the fibers was also used to collect absorption profiles and mass spectra.

Microspectrophotometry measurements in the visible spectral region were collected using spectrometers interfaced to a polarized light microscope (PLM). Several fibers were taken from each yarn source, with each fiber cut into segments and multiple measurements taken along the length of each segment. For analysis of the extracted dyes, fiber segments were heated in a solvent system of pyridine-acetic acid-water (20:5:75, v/v). The extracts were evaporated and resolvated with methanol for absorption spectral and direct infusion electrospray ionization mass spectrometry analysis. Appropriate blanks were prepared and analyzed under the same conditions.

Normalized absorption spectra of the dyes in the fibers were analyzed using a parametric test, which assumes normal distribution of the test statistic, and a non-parametric permutation test, which is not bound by this restriction and guarantees the specified significance level. In hypothesis testing, rejection of the null hypothesis when it is true is considered a Type I error, while failing to reject the null hypothesis when it is false indicates a Type II error. Type I and Type II error will be discussed for segments taken from the same fiber, for different fibers taken from the same source, and for fibers taken from different sources. The sensitivity of this statistical approach will also be discussed in terms of how instrumental parameters and sampling method may affect the error rates. Results from the parametric and non-parametric tests will also be compared. In addition, selected ion intensities from the mass spectra of the extracted dyes were normalized and analyzed using principal components analysis (PCA). PCA scores were compared using cluster analysis based on the Euclidean distance. Hypothesis testing methods will also be investigated for the analysis of this data.

This research was conducted at the National Center for Forensic Science, a State of Florida Type II research center.

Statistics, Fiber Dyes, Microspectrophotometry

A31 Fast Forensic Analysis of Methamphetamine and its Enantiomers Using Ion Mobility Spectrometry

Howard K. Holness, MBA, Florida International University, 11200 Southwest 8th Street, CP330, Miami, FL 33199; and Jose R. Almirall, PhD, Department of Chemistry, Florida International University, University Park, Miami, FL 33199*

After attending this presentation, attendees will learn of a novel analytical method, Chiral Ion Mobility Spectrometry (CIMS), for the separation of enantiomers found in amphetamine type substances (ATS). The technique will introduce, for the first time, the separation of enantiomers found in methamphetamine and could open the possibility of utilizing the data obtained in determining the provenance of seized drugs.

This presentation will impact the forensic science community by helping to determine sources of supply, drug trafficking routes, and connections between different seized batches of drugs. The cost of conducting chiral separations has previously made this technique impractical in routine analysis. However, CIMS serves to alleviate this cost barrier by providing a high speed and low cost analytical technique with results comparable to that obtained from previously established and more expensive chiral separation techniques.

Chiral Separations have long since been a challenging aspect of analytical chemistry. There currently exists thousands of chiral separation phases predominantly used in liquid chromatography, gas chromatography, and capillary electrophoretic assays. The chiral phases themselves are expensive while the time and resources required in selecting the appropriate phase for a particular enantiomer is another prohibitive factor. Second only to Cannabis, ATS are the most widely abused illicit drugs in the world to date. Nearly all ATS are optically active and, as such, exist as enantiomers. Abused ATS are synthesized from precursor compounds that are often found in the end product. These impurities from the manufacturing process vary widely, depending on the kind of drug being manufactured and the steps taken during purification. For Methamphetamine, common precursors are ephedrine and pseudoephedrine, both being chiral in nature. The ability to detect and ultimately separate these enantiomers as impurities in seized drugs has been proven in previous studies and has also been used to determine provenance leading to connections between seizures by utilizing capillary electrophoresis with UV detection and GC-MS analysis.

Chiral IMS, much like drift tube IMS, relies upon separation of charged species under atmospheric pressure as they move through an applied electric field while under the mild interaction of a counter-flowing chiral modifier. Steps taken in introducing the chiral modifier and the variations in resolving power will be displayed. The easy "on the fly" setup will also show the creation of a dual mode separation system that is able to conduct non-chiral drift tube separations for rapid screening and identification of unknown substances and then, through the touch of a button, the system becomes chiral to conduct enantiomeric separations.

Results obtained to date have identified an IMS counter flow gas that may be used to effect separation of ephedrine and pseudoephedrine enantiomers, which are currently indistinguishable by using standard GC-MS techniques. This first reporting of a CIMS separation will be used as a stepping-stone in developing techniques that rely upon previously ignored chiral data within the forensic arena.

This presentation will ultimately demonstrate the capabilities of CIMS, through the conversion of a standard commercially available drift tube IMS system to separate enantiomers of ATS, namely ephedrine and pseudoephedrine. The results of the study will be discussed and compared with similar data obtained from other techniques. The development of a high speed, low cost chiral separation system will become a valuable forensic tool for the analysis of ATS and enantiomers and could lead to provenancing of illicit drugs of abuse.

Enantiomer, Chiral, Ion Mobility Spectrometry

A32 A Study of Complex Mixtures From Fire Debris by Summed Ion Spectra

Michael E. Sigman, PhD, and Mary R. Williams, MS, University of Central Florida, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will comprehend the complexity of fire debris analysis and appreciate the use of summed ion spectra from GC-MS analysis to quickly compare reference liquids to fire debris samples.

This presentation will impact the forensic science community by elucidating information about the complex mixtures of ignitable liquids and substrate materials found in fire debris.

In fire debris analysis, a complex mixture is extracted from fire debris, which may contain an ignitable liquid residue and pyrolysis

products from burned substrates at the fire scene. Typically, these complex mixtures are analyzed by gas chromatography - mass spectrometry producing a 3D data file [m/z, time (scan), and intensity axes]. Total ion and extracted ion chromatograms are generated from the time and intensity data and are comprised of a series of peaks where each peak is a constituent in the complex mixture. Pattern recognition of a total ion chromatogram is the basis for classifying an ignitable liquid residue according to the ASTM E1618 standard method. A complementary method of summing the intensity of each m/z across the chromatographic time range produces a summed ion spectrum. The summed ion spectra allows for rapid automated searching against a library of reference spectra and a measurement of similarity between the spectra. An ignitable liquid residue spectrum can be compared to libraries of ignitable liquid and burned substrate reference spectra.

Summed ion spectra were created from existing GC-MS data files obtained in the Ignitable Liquid Reference Collection (ILRC) database. Summed ion spectra of pyrolysis products from substrates were obtained from the GC-MS data of burned substrate materials. Similarity comparisons between normalized summed ion spectra were performed by custom software written in-house. The automated search produces a list of library entries and their similarity with the sample spectrum in rank order from most similar to least similar. When searching against both ignitable liquid and substrate libraries, the search produces a list of the most similar combination of ignitable liquid reference and burned substrate reference spectra with the percentage of their relative contributions to the sample spectrum. A comparison of summed ion spectra similarities was performed by cluster analysis based on the Euclidean distance between the similarity measurements. This study compared: (1) ignitable liquids within the same ASTM classification; (2) weathered ignitable liquid spectra to their corresponding un-weathered liquid spectra; (3) burned substrate spectra; and, (4) burned substrate spectra to ignitable liquid spectra. Automated searches of summed ion spectra against ignitable liquid and burned substrate reference libraries were conducted on fire debris samples.

The results indicate ignitable liquids can be further grouped by various classifiers within given ASTM classifications. Cluster analysis demonstrates weathered ignitable liquids were more similar to their corresponding un-weathered ignitable liquid than to other ignitable liquids. Gasolines with the same amount of weathering were more similar to one another than their corresponding un-weathered gasoline. Cluster analysis demonstrates the majority of products from burned substrate materials are not similar to one another. The majority of ignitable liquids are not similar to the products of burned substrate materials tested. Results from automated searching of a fire debris sample spectrum against ignitable liquid and burned substrate reference libraries contained numerous high similarity matches with ignitable liquids of the same ASTM classification, except for liquids in the light carbon range.

Software developed at UCF can rapidly perform the comparisons between complex mixtures found in fire debris based on their summed ion spectra. Large libraries of spectra can be compared to elucidate information about these complex mixtures. The software can be applied to compare fire debris sample spectra to libraries of ignitable liquid and burned substrate reference libraries for ASTM classification and/or identification of the ignitable liquid residue.

Fire Debris, Complex Mixtures, Summed Ion Spectra

A33 Optimization of Thermal Chemistry Variables in Trace Explosives Detection

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After attending this presentation, attendees should have a better understanding of the complex chemistries that exist when studying explosive molecules alone and in mixtures in explosives trace detection.

This presentation will impact the forensic science community by providing a better understanding of the impact that thermal chemistry variables have on the maximum sensitivity of trace explosives.

The National Institute of Standards and Technology (NIST), Surface and Microanalysis Science Division, is working to build a chemical metrology program to support the widespread operational deployment and effective utilization of explosive trace detectors (ETD's) currently used throughout the United States for Homeland Security screening directives. The research goal is to optimize the detection of trace explosives by optimally manipulating the analytical conditions in the ETD's and thereby increasing the overall sensitivity of detection to potential threat compounds. There are many types of ETD's currently deployed in the United States, but the most common systems are based on ion mobility spectrometry (IMS). In a typical screening implementation, technicians swipe the surface of luggage, packages, cargo, etc. with a "trap" composed of cloth, paper, or Teflon coated materials. Traps are then introduced into the IMS instrument where the explosive particles are vaporized by rapid heating via a thermal desorber. The explosive vapor is then introduced into the ion source region where it is ionized using Beta emission from a ^{63}Ni source. After ionization, the analyte ions are injected into a drift tube where their atmospheric gas phase mobility is determined by their time of flight in a weak electric field. Ions traverse through the drift tube at different rates depending on their size, shape, and charge, and the resulting measured drift time is compared to a reference library of known explosives/narcotics for identification. Typically, thermal desorbers within ETD's are set to a relatively high temperature of 230-280 °C. This temperature range allows for the best chance of detection of a wide range of explosives (and narcotics) simultaneously. In this work, a series of experiments were conducted to optimize the desorber temperature for several common explosives based on 0.1-100 ng of deposited residues. By modifying the desorber temperature, order of magnitude increases in sensitivity were obtained for several high explosives. Optimal temperatures (giving the highest IMS sensitivity) were 60 °C for TNT, 100 °C for PETN, 140 °C for RDX, and 200 °C for HMX. These desorber temperatures are not in the typically used range noted above, and this data will be discussed in the context of developing optimized conditions for screening applications. Ongoing research is focused on developing similar optimization protocols for some of the more complex explosives such as plastic bonded explosives (C4, Semtex, and Detasheet) and ammonium nitrate fuel oil (ANFO). In addition, solution mixtures of the high explosives were analyzed to determine whether the enhanced sensitivity is also observed when multiple target analytes are present within a sample. Additional experiments designed to provide insights into the possible mechanisms of the observed sensitivity enhancements are also presented. These mechanisms include the concept that rather than vaporizing the sample in the desorber, there is liquid particle emission of the explosives. Preliminary studies indicate that upon rapid heating similar to that in ETD's, solid explosives desorb by first entering into a liquid phase before reaching gas phase equilibria.

During this process, aerosol emission via a bimodal distribution of droplet sizes was observed, including 100-200 nm droplets that egress into the vapor phase from the tops of droplets following a bursting of liquid-based bubbles and larger mm-sized droplets that emit from the desorption area after the droplet cavity collapses upon itself. The summation of presented data represents the complex chemistries that exist when studying explosive molecules alone and in mixtures. These detailed efforts may result in a better understanding of the chemical and physical processes involved in explosives trace detection.

Explosives, IMS, Explosives trace detectors

A34 Operators as Sources of Error–Improved Efficiency Through Pipetting Technique Training

Keith J. Albert, PhD, Bjoern Carle, PhD, and Wendy Vaccaro, BA, Artel, 25 Bradley Drive, Westbrook, ME 04092*

After attending this presentation, attendees will understand how operator pipetting technique can be measured and improved to have confidence in laboratory work so the results can be trusted.

This presentation will impact the forensic science community by bringing to light the variability in pipetting technique and performance from operator-to-operator (technician-to-technician).

Data integrity and confidence in assay results are critical measures of a laboratory's quality system. No matter which tests or assays are performed, robust and trustworthy results must be the highest priority for any laboratory, especially in forensics-related assays, where the results may have to hold up in court. In the material presented herein, the focus is primarily on operator pipetting and pipetting technique when using manual, hand-held pipettes. Though pipetting is sometimes considered a mundane, routine task in the laboratory, where everyone *thinks* they are good at pipetting, it is shown that poor operator technique can be universal, but can be overcome with technique training. Because pipetting poorly can inadvertently, unknowingly, and severely impact assay results, it is of imperative importance that pipetting is taken seriously in the laboratory.

Many regulatory bodies have established guidelines designed to help laboratories achieve and maintain good quality practices, while providing a sense of confidence in the quality of work performed at an accredited facility. Not meeting quality standards is an expensive failure for any laboratory. Questionable and unreliable results may lead to several consequences. Of particular relevance to calibration and testing laboratories, as well as medical and reference laboratories are: ISO 17025, ISO 15189, ISO 15195, as well as FDA regulations on cGLP and cGMP. All of these guidelines place a strong emphasis on operator competency, assessment, and documentation.

In one facet of the this presentation, a case study is discussed where the goal was to assess the proficiency pertaining to pipetting skills of professionals who use pipettes daily in quality control processes in their companies. In brief, it is clearly evident that several pipette users delivered liquid volumes, which would exceed even the most liberal tolerance limits for accuracy and precision in any SOP.

In the best case scenario, tests and assays will have to be repeated, incurring labor and material costs, which can be quite substantial. If questionable or incorrect results have been released, consequences are usually much more severe and costly, and can include misdiagnosis, poor patient outcomes, and significant legal challenges by affected parties.

Pipetting Error, Laboratory Results, Operator Pipette Technique

A35 An Efficient, Systematic Approach to Serology Screening of Sexual Assault Evidence

Katherine Welch, MSFS, Tiffany Best, BS, Anna Timanova, PhD, Lisa A. Gefrides, MS, and Roger Kahn, PhD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand the pros and cons of a new processing regime for sexual assault evidence. Elimination of semen confirmation on swabs prior to extraction along with full AP mapping of clothing and bedding will be compared to conventional kit screening and the use of an alternate light source to identify potential semen stains. Laboratories will be able to assess which approach will allow them to increase throughput and reduce the backlog of sexual assault cases without sacrificing effectiveness.

This presentation will impact the forensic science community by comparing different strategies for sexual assault evidence screening to help laboratories evaluate which will result in increased throughput and reduced costs for a laboratory without sacrificing effectiveness.

Forensic serology is a term used to describe the process of identifying biological fluids on items of evidence collected from crime scenes. Most crime laboratories use a combination of presumptive and confirmatory testing methods on sexual assault cases to test for body fluid stains such as semen, blood, and saliva in order to isolate stains for DNA testing. Examining evidence using conventional testing methods is time consuming and costly due to the labor intensive nature of the work and the fact that it cannot be automated.

Common practice for sexual assault kit testing is to first test kits swab for the presence of acid phosphatase and then to confirm the presence of semen either by microscopic identification of spermatozoa or by detection of prostate specific antigen (PSA). If kit swabs are negative, both microscopic and PSA testing must be performed to ensure the sample is truly negative. When there are no semen positive sexual assault kit samples, an alternate light source is used to aid in identifying potential semen stains on other evidence items that are invisible in ambient light. Screening evidence in such a manner enables analysts to isolate stains on clothing and bedding items and determine the nature of a stain prior to DNA testing.

One goal of the Harris County Medical Examiner's Office Forensic Biology Laboratory is to streamline this process to be more efficient without sacrificing effectiveness. Two processes have been identified where procedural modifications may streamline case processing of sexual assault cases. The first focuses on sexual assault kit processing while the second focuses on screening non-sexual assault kit evidence such as clothing and bedding.

The first improvement is to perform differential DNA extraction on all sexual assault kit swabs instead of using conventional presumptive and confirmatory testing to determine which swabs to send for DNA testing. Following extraction, all swabs are quantified using the Quantifiler Duo system, in which both the total amount of human and male DNA is determined. Swabs with a minimum male quant value of 0.003 ng/uL continue to DNA testing while those that have less than 0.003 ng/uL terminate processing at this point. The confirmation of semen can be done by either visualizing spermatozoa from the slide made from the sperm fraction pellet during differential extraction or by performing PSA testing. Eliminating the acid phosphatase step increases efficiency because in current processing, semen is routinely confirmed twice, once during serology screening by PSA or slides and again during differential extraction by microscopic confirmation of spermatozoa. The added

benefits of this modified process are that DNA extraction can be automated and this approach has the ability to detect male DNA from any cells instead of only from sperm cells.

The second potential process improvement for increasing efficiency is full AP mapping. Currently, analysts examine sexual assault evidence in visible light and a second time under alternate light. Afterward, the areas identified as possibly containing semen are then tested for acid phosphatase. By systematically AP mapping an entire object, the need for visual examination under two different types of light is removed. The fact that the testing is systematic has the additional benefit of detecting semen positive stains that cannot be visualized with AP or visible light. Using this approach, clothing and bedding of dark color or with a fluorescent background will be as easy to examine as lighter fabrics. This approach has the added benefit of saving laboratory space because the need for dark rooms is diminished.

The purpose of this study is to describe the validation of both modified serology procedures. A comparison will be made to show the traditional versus modified procedure and which: (1) is most efficient; (2) performs better; and, (3) is most cost effective.

Serology, Sexual Assault, Efficiency

A36 Determination of Forensic Signatures for Growth Media in Bacillus Spores Using Matrix Assisted Laser Desorption Ionization (MALDI) Spectrometry and Microbial Adherence to Hydrocarbon (MATH) Assays

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After attending this presentation, attendees will understand the significance of the effect that different media compositions have in the derivation of protein profiles of Bacillus spores and its utility in the characterization of pathogens recovered as evidence.

This presentation will impact the forensic science community by providing potential tools to establish protein signatures of Bacillus spores grown on different media which can be used to provide leads in microbial forensic investigations.

The variety and abundances of proteins found either inside Bacillus spores or on its membrane surfaces can vary significantly with the types of metabolic substrates available to the cell during vegetative cell growth and sporulation. To investigate the relationship between spore protein profiles and growth medium, *Bacillus cereus* T-strain spore cultures were grown on 12 different media containing a range of different protein and amino acid substrates. Each spore culture was then analyzed with Matrix Assisted Laser Desorption Ionization (MALDI) spectrometry and Microbial Adherence to Hydrocarbon (MATH) assays to characterize the whole-cell and cell-surface proteins, respectively.

Results suggest that protein signatures do vary among spore cultures grown on different protein/amino acid substrates. Whole-cell protein profiles detected by MALDI suggest that eight spore cultures can be reproducibly differentiated (G, BHI, LL, NSM, CDSM, BE, PepBE, G4TN). In addition, biomarkers m/z 5724, 6278, 6982, and 7514 are exclusively associated with spore cultures grown in BHI, CDSM, PepBE, and G4TN respectively. Results from MATH assays also suggested that many of the spore cultures have unique protein profiles that are related to the medium used for growth. Profiles for spore cultures grown in media with higher concentrations of complex protein sources (CAB, BHI, and Sch) showed consistently higher hydrophobicity values (~40%-64% in 200µl hexadecane) compared to cultures grown in nutrient limited media (G, BE, G4TN, PepBE, GPN, CDSM; 10%-32% in 200µl hexadecane). This suggests that the concentration of protein used in the culturing media has a significant effect on the concentration of hydrophobic proteins associated with the spore membrane. However, as in the MALDI profiles, differences in cell surface hydrophobicity could not be directly correlated with specific protein/amino acid components in any of the media suggesting that the relationship between substrates and protein signatures in *Bacillus cereus* T-strain spores depends on more complex metabolic relationship between substrate and biochemical phenotypes. Nevertheless, both MALDI spectrometry and MATH assays show promise as analytical tools to analyze spore cultures and could be combined with other types of biomolecular phenotyping, such as Fatty Acid Methyl Ester Analysis, to build larger databases useful for microbial attribution in biocrime investigations.

Protein Profiles, Growth Media, Bacteria

A37 Estimating Area of Origin Through the Use of Void Patterns and Shadows

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After attending this presentation, attendees will understand the basic method for determining the area of origin through the use of the Void Pattern Shadow Matching method (VPSM).

This presentation will impact the forensic science community by discussing how matching provides a quick and accurate alternative which can be used when an immediate estimate is needed. Since VPSM requires no equipment other than a flashlight, it would be easily accessible to everyone. VPSM requires no contact with evidence and can therefore be used without compromising the integrity of the scene. Finally, since it requires fewer measurements than any other method in use, the potential for human error is reduced.

The presentation of this material will describe the basic method for determining the area of origin of a spatter pattern in a bloodletting event through use of the Void Pattern Shadow Matching method. Results obtained through the method will be compared to results of the Stringing and Backtrack methods to determine relative accuracy. The research hypothesizes that it is possible, if a void pattern is present and the object that created it is still in its original position, to estimate the area of origin by duplicating the void with a shadow thrown by a controlled, external light source.

It is suggested that the technique used in this research be termed "Void Pattern Shadow Matching (VPSM)". For VPSM to be utilized a void pattern must be present and the object which created it must still be in its original position. A light must then be directed at the object and adjusted until the shadow it creates exactly duplicates the void pattern behind it. The position of the light source will represent the area of origin. VPSM shows the best results when two void patterns are matched simultaneously using shadows cast from an LED flashlight with a one-inch lens.

Researchers conducted an experiment in which blood spatter was generated from a sponge set on a cinder block 27.75 inches from the target area and 34 inches above the floor. The target area consisted of a

set of shelves holding various household objects with a backing of white poster board. The spatter left void patterns which were visible on the poster board backing. Estimations of area of origin were obtained using Backtrack, Stringing, and the Void Pattern Shadow Matching methods, and all results were compared to the known area of origin. Evaluations were then conducted to determine the relative accuracy of the methods.

The VPSM results were three inches above the known area of origin and horizontally exact. The Stringing method gave results that were 3.45 inches lower than the known area of origin and diverged by 2.6 inches from the known point of convergence. Backtrack results showed a deviation of 3.85 inches from the area of origin and 3.7 inches from the point of convergence.

In this experiment, the Void Pattern Shadow Method proved to be the most reliable when compared to the other methods tested. It is concluded that VPSM is an acceptable alternative when circumstances allow for its use.

Blood Spatter, Void Patterns, Light

A38 Assessing Touch DNA Collection Methodologies for Obtaining a Genetic Profile

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After attending this presentation, attendees will have learned about the collection of Touch DNA using three chemical surfactants, a tape lift methodology, and a combination of surfactant followed by a lift technique.

This presentation will impact the forensic sciences community by demonstrating that this new method could be useful in many crime labs for optimal collection of touch DNA, used in conjunction with double-swabbing techniques.

Attendees of this presentation will learn about the collection of Touch DNA using three chemical surfactants, a tape lift methodology, and a combination of surfactant followed by a lift technique. Touch DNA is DNA obtained from epithelial cells which have been shed or sloughed. The following collection methodologies were used: double swabbing technique using ddH2O (control); 1:1 EtOH; 20% SDS; hydrophilic tape; and a combination of the hydrophilic tape lift followed by the most successful swabbing surfactant. This study hopes to impact the forensic science community by demonstrating that this new method could be useful in many crime labs for optimal collection of touch DNA, used in conjunction with double-swabbing techniques.

A total of twenty test subjects were used; ten of each sex, each asked to wear a t-shirt for one twelve hour period. The t-shirts were purchased, washed once and given to the participants in a paper bag with wear and handling instructions. The study participants were blinded to the experiment, and were from an age cohort of 20-25 years old. The t-shirts were stored in their individual brown paper bags in the pre-PCR laboratory at room temperature until they were processed.

The shoulder area of the t-shirt was used for the swabbing/lift experiment. This work builds on an earlier study conducted in our laboratory (Schantz, et al AAFS Feb ’09), and a pilot study conducted by the first two authors. The previous work indicated that the shoulder area from the seam down towards the torso (9 cm from the shoulder seam on the front and back of shirt) was in consistent contact with the wearer. Moreover, the treatment condition for swabbing and lifting where randomly assigned to one of six quadrants laid out in on a template, prior to cutting for each t-shirt. This allowed all treatments to be evaluated with different cutting areas from each t-shirt.

After each swab or lift, the sample was digested at 55^{0}C with Proteinase K and a stain lysis buffer. It was found that a longer digestion time, thirty-six hours rather than the standard overnight incubation increased DNA recovery. Swab tops, or tape pieces were taken from their digestion tube and placed in a spin basket in a new 2.0 ml tube, then the digested lysis material was then carefully pipetted into the new tube. The tubes were centrifuged for two minutes at 4,500 g, the flow though was used as the starting material for an organic extraction. A standard organic (P:C:I) extraction was performed, along with a microcon concentration step. Samples were quantified and then amplified with ProfilerPlus, and run on a 3100 Avant Genetic Analyzer. Samples were examined for each treatment condition, by sex, and by individual. Reference samples were then processed to confirm the allelic base pair (bp) sizes.

Touch DNA, Surfactant, Genotyping

A39 Optimization of Touch DNA Collection Techniques Using Alternative Swabbing Solutions

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After attending this presentation, attendees will learn about the optimization of swabbing techniques using various solutions for acquiring low-copy number (LCN) DNA evidence from touch samples.

This presentation will impact the forensic community by improving the effectiveness of recovering cells/DNA from swabbed evidence. Various laboratory and commercial detergents were utilized, determining the highest quantity of DNA obtainable from touch samples. This will better allow DNA profiles to be generated when standard swabbing techniques may not produce enough DNA for complete analysis.

There has been minimal research into how to best obtain DNA from touch samples. Most laboratories simply moisten a swab with sterile water before swabbing evidence. The double swab technique, in which a surface is treated with a moistened swab followed by a dry swab, is also utilized, as it has been shown to recover more DNA from surfaces than a single swab in some instances. A sodium dodecyl sulfate (SDS) solution has also been used for swabbing, with the thought that the detergent might help loosen cells adhering to the surface. However, none of these methods has been objectively studied in order to maximize DNA yields.

Many components of a fingerprint/cell are relatively insoluble in water, including oils, lipid membranes, and some proteins. To make them water soluble, detergents or soaps, which have surfactant properties, can be added. These lower water tension and surround the non-polar molecules, allowing them to dissolve in water. Given this, it was hypothesized that adding surfactants to the water used to swab an object might more readily release cellular material, thereby increasing DNA yields.

Swabs moistened with sterile water were compared to those moistened with laboratory or commercially available detergents. Fingerprints were deposited using medium pressure on different substrates that had been bleached, autoclaved, and/or UV irradiated. The prints were swabbed, and DNA isolated using a standard organic extraction procedure. DNA yields were quantified using a Quantifiler™

Human DNA Quantification Kit and real time PCR, and relative yields compared. The ability to produce STR profiles was then examined. Statistical analysis allowed determination of if there was a significant difference among the various solutions in DNA recovery, and if this was associated with more complete STR profiles.

Low Copy Number DNA, Swabbing Solutions for DNA, DNA Quantity and Quality

A40 Quantitative Analysis of DNA Distribution on Cigarette Butt Filter Paper

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After attending this presentation, attendees will have learned the results of a quantitative study regarding the distribution of DNA on smoked cigarette butt filters. The data can then be used to make informed decisions when selecting from a limited sample in order to avoid complete consumption of available evidence.

This presentation will impact the forensic science community by providing forensic scientists with a better idea of the location and amount of DNA evidence that can be found on cigarette butt filters which have been found indoors or left outdoors for unknown periods of time. This will allow for more accurate sampling of cigarette butt filters and enable the analyst to defend against speculation that evidence was inappropriately consumed.

DNA evidence from cigarette butt filters can be an important part of reconstructing a crime and the sampling of this type of evidence is controlled so as to prevent consuming more than 50% of a sample. The Washington State Patrol (WSP) Crime Lab is one of many laboratory systems in the country that follow a common practice of preserving at least half of an evidence sample to be made available for independent testing by the defense team or retesting in the future. Recently, a question was raised about the effectiveness of this practice in regard to leaving half of a cigarette butt filter when there is no way to ensure DNA is equally distributed on the filter paper.

DNA distribution on smoked cigarette butt filters can be quantitatively mapped by taking measured cuttings of the filter paper, noting their location, and quantifying the amount of DNA on each cutting. The DNA in this experiment was quantified using a Quantifiler® Kit and a 7500 Sequence Detection System. The percentage of total DNA on each cutting can then be compared to the other cuttings to define where the highest percentage of DNA can be found on the filter paper of cigarette butts.

Preliminary testing on twenty four cigarette butt filters has shown that when paper from a cigarette butt filter was sliced parallel to the seam of the cigarette in a consistent pattern, DNA was spread uniformly. However, it was also found that when paper from a cigarette butt filter was sliced perpendicular to the seam of the cigarette, DNA was not spread equally. In short, trends of DNA distribution have been observed.

Data from an experiment in quantification of DNA distribution on the filter paper of 50 randomly collected smoked cigarette butt filters which have been cut into 200 samples. Twenty-five of those cigarette butt filters were collected outdoors while the other twenty-five were collected indoors in an attempt to mimic crime scene situations as closely as possible. The 50 cigarette butt filters consisted of multiple brands from multiple unknown smokers. The results of this experiment will allow DNA analysts to more confidently and accurately sample this type of evidence while preserving the necessary DNA for future testing.

Cigarette Butt Filter, DNA Distribution, Sampling

A41 Evaluation of Evidence Recovery Methods From Improvised Explosive Devices

Stephen K. Gicale, BS, and David R. Foran, PhD, Forensic Science Program, 560 Baker Hall, Michigan State University, East Lansing, MI 48824*

After attending this presentation, attendees will become familiar with how the order of processing a deflagrated improvised explosive device (IED) affects the ability to recover DNA.

This presentation will impact the forensic science community by identifying how different IED forensic analysis techniques affect the ability to obtain a genetic profile of the assembler.

Over the past decade, researchers have shown that it is possible to obtain a genetic profile from low copy number (LCN) DNA, generally defined as less than 100 picograms. One example of this is DNA obtained from skin cells deposited on a surface after a person has come in contact with it, or so called touch DNA. However, given the small quantities of DNA found on touch samples, and that such DNA is often highly degraded, it is important to optimize DNA isolation and purification procedures in order to maximize the quality and quantity of DNA recovered.

As part of terrorist-related activities, IEDs are commonly used in attacks, owing to ease of assembly and concealment, and the convenience of remote detonation. Recent studies at Michigan State University's Forensic Biology Laboratory, in collaboration with the Michigan State Police Bomb Squad, have examined the feasibility of obtaining DNA profiles from deflagrated IEDs. While these efforts have met with some success, questions still exist regarding how best to process an IED so as to maximize the likelihood of identifying its assembler. In particular, an IED may be processed for fingerprints prior to, or in lieu of, its submission for DNA processing. At a minimum this is likely to include cyanoacrylate fuming, or can be more extensive. Whether or not these procedures are detrimental, or perhaps advantageous, to subsequent DNA isolation and analysis is unknown.

In the research presented, conducted as a blind study, volunteers were asked to mock assemble IEDs by handling steel pipes and end caps, as well as provide a buccal swab. In preliminary tests one-half of the end caps were fumed prior to DNA extraction, and DNA yields and quality (STR profiles) were compared to non-fumed devices. Subsequently, handled bomb components were filled with smokeless powder, and deflagrated in a controlled environment. Fragments were collected and again either fumed on not fumed, followed by DNA extraction, quantitation, and STR analysis. STR profiles were developed, and their accuracy determined through comparison to the buccal swab results.

DNA, Improvised Explosive Device, Super Glue Fuming

A42 Characterizing DNA Contamination on the Outer Packaging of Forensic Biology Evidence

Rhonda C. Williams, PhD, Lisa Gefrides, MS, and Roger Kahn, PhD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will appreciate the extent to which DNA contamination may be present on the exterior of evidence packaging. This presentation will characterize the DNA contamination found on outer packaging with respect to case type, rate, and possible sources. At the end of this presentation the attendee will be able to review their own evidence examination procedures and revise them if needed.

This presentation will impact the forensic science community by highlighting a potential contamination risk for evidence examination in forensic biology laboratories. Recognizing that outer evidence packaging has the potential to contain DNA will allow laboratories to put preventive measure in place to reduce or eliminate this potential contamination risk.

Forensic biology laboratories try to achieve the highest standards of contamination-free casework. Many strategies are used to eliminate contamination from individuals, consumables, or other case samples. Even with all the precautions used in the laboratory, a rare contamination event may be observed. One potential source of contamination in the laboratory may be overlooked – the outer packaging of submitted evidence.

In general, evidence items are packaged by law enforcement prior to being submitted to a crime laboratory. Packaging is usually done in an uncontrolled location such as crime scene, a residence, or a hospital. The outer packaging may be handled without gloves or with contaminated gloves. DNA may be introduced onto the exterior of evidence packaging by the collector or the transporter. The outer packaging may also be contaminated by contact with surfaces at the collection location or with surfaces encountered during transport.

To investigate the frequency and extent of DNA contamination on outer evidence packaging, the exterior of evidence packaging for three types of cases (homicide, sexual assault, and burglary) was swabbed and subjected to STR DNA testing with the ABI Profiler Plus and COfiler test systems. In the study, the exterior surface of randomly selected evidence from ten burglaries, ten homicides, and ten sexual assault kits were swabbed. The swabs were extracted and processed using the laboratory's standard procedure for evidence samples. Of the ten homicide cases, four bags produced partial profiles containing eight or fewer alleles. The three of the ten bags from burglaries exhibited partial profiles containing twnty or fewer alleles. Of the ten sexual assault kits that were tested only one produced a partial profile of eight alleles. Overall, 27% of the exterior packaging tested contained enough DNA to produce at least a partial profile with an average of 6 alleles (range 1-20 alleles).

While more profiles were obtained from the outer packaging of homicide and burglary cases (40% and 30%, respectively) than sexual assault kits (10%) it is unclear whether this observation is due to the type of case or the material of the outer packaging itself. Sexual assault kits have a smooth, less porous surface than brown paper bags in which evidence is commonly packaged. It may be that sexual assault kits are less likely to accumulate DNA than the comparatively rough surface of brown paper bags. Another consideration is that sexual assault kits are collected in hospital environments which are likely to be cleaner environments than a typical crime scene. Interestingly, the DNA recovered from the exterior packaging of only one case, a homicide case, was consistent with the profile of the evidence from the case. Of the other seven partial profiles obtained, the profiles were either not associated with the case (five cases) or there was not enough genetic information to make a determination (two cases).

The observation that the DNA on the exterior of evidence packaging does not match the DNA on the inside suggests that the DNA may have been deposited by personnel transporting the evidence to the crime laboratory or anyone coming into contact with evidence packaging who did not wear gloves or a mask. The exterior packaging may also collect DNA from its environment, possibly from the containers that the evidence is transported in or from another surface it came into contact with, including another evidence container.

To be safe, we recommend that laboratories treat exterior evidence packaging as if it is contaminated with DNA. The packaging should be kept separated from the area used to examine evidence. Gloves should be changed after touching the exterior packaging and before touching anything else in the laboratory, especially evidence. These safeguards should reduce the possibility of introducing DNA from external evidence packaging onto items or samples cut for DNA processing.

Contamination, STR, Evidence Packaging

A43 Touch DNA From Property Crimes – CODIS Success Stories

Nikia S. Redmond, MSFS, Katherine Welch, MSFS, Lisa Gefrides, MS, and Roger Kahn, PhD, Harris County Medcal Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand the impact that processing items from property crime scenes can have on the number of CODIS hits. The presentation will focus on DNA analysis of items containing touch DNA to prove that they are almost as successful as body fluid containing cases in obtaining a profile for comparison and CODIS entry, as well as in attaining CODIS hits. Examples of successful property crime cases from touch DNA will be presented to display the utility of collecting and examining these types of evidentiary items. The impact of entering property crimes into CODIS and the number of resulting CODIS hits will be discussed and compared to those of personal crimes.

This presentation will impact the forensic community by encouraging law enforcement and laboratories to collect and process evidence with touch DNA from property crimes for purposes of CODIS entry. Inevitably, the more profiles entered into CODIS the more CODIS hits will be made leading to an increase in solved crimes, benefitting law enforcement and the community. This is especially true for property crimes because they are several times more likely to lead to CODIS matches than personal crimes.

The majority of evidence submitted to crime laboratories from property crimes is in the form of blood evidence obtained from a crime scene. However, perpetrators do not always leave blood at the scene. Instead, the perpetrator may leave DNA in the form of saliva, semen, or touch DNA. Analysis of touch DNA evidence items from property crimes can dramatically increase the number of CODIS entries and the success rate of potentially solvable crimes.

Touch DNA in property crimes can be regarded as DNA transferred from a person to an object in the form of epithelial cells. Touch DNA can be obtained from objects handled by a perpetrator at a scene. In addition,

personal items left behind at the scene may prove to be effective sources of touch DNA. The surfaces of clothing and items such as hats, masks, and gloves left at crime scenes may be analyzed in an effort to capture the DNA profile of the wearer. Items such as watches, screwdrivers, knives, and flashlights may be thoroughly swabbed in the areas most likely touched by the user. These types of evidence samples usually contain minimal amounts of DNA and should be processed to capture the maximum DNA yield. All of these items can result in DNA profiles for comparison and CODIS entry.

The Harris County Medical Examiner's Office (HCMEO) Forensic Biology Laboratory has been testing evidence from property crime cases and submitting them for entry into CODIS since 2005. DNA profiles from both touch and body fluid containing items have been uploaded into CODIS from property crime evidence. Five hundred and thirty-two property crime cases were analyzed and reported at the HCMEO during the four month interval from March through June, 2009. Of these, 313 (59%) produced interpretable DNA profiles, almost all of which were eligible for CODIS entry. One hundred ninety-two (36%) of the property crime cases reported were touch DNA cases while the remaining 340 (64%) contained blood or saliva evidence. Touch DNA cases yielded CODIS-eligible profiles 27% of the time while body-fluid containing cases yielded CODIS-eligible DNA profiles 73% of the time. While the touch DNA success rate was roughly 2.7 times less than the rate for items containing body-fluids, the CODIS hit rate for cases entered during this period was similar (36% of touch cases and 55% of body-fluid containing cases produced CODIS matches).

This presentation will discuss the success rate of property crime cases in comparison with personal crime cases, both in producing CODIS eligible profiles and in the number of CODIS hits obtained. This presentation will also provide case examples of touch and other non-blood evidence collected at property crime scenes that have hit in CODIS so that the attendee will better understand the utility of touch DNA to solve crimes.

Touch DNA, Property Crime, CODIS Hits

A44 Visualizing Fingerprints From Fired Casings for DNA Extraction

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After attending this presentation, attendees will learn if the visualization of fingerprints by a non-destructive means, such as with a hyperspectral imaging system, increases the DNA yield of "touch DNA," over the conventional double swabbing method of the entire evidence surface.

This presentation will impact the forensic science community by providing information about the effectiveness of target swabbing over the traditional double swabbing of a larger area of crime scene evidence.

Previously, it has been shown that touch DNA can be retrieved from fired bullet casings. In this study, fingerprint visualization will be attempted on fired casings using hyperspectral imaging, and a targeted swabbing will be performed to determine the effect on ability to retrieve DNA. It is believed that a target swab will concentrate the DNA retrieved due to decreased, but more directed sampling. Casings from a 9 mm handgun, 40 mm handgun, and 12-gauge shotgun were examined. A blind study was conducted using ten shooters, five from each sex. Each shooter fired five rounds from the 9 mm and the 40 mm handgun, as well as two cartridges from the shotgun. For a negative control, two unfired and untouched cartridges from each type of ammunition were set aside for later analysis. For the positive control, two unfired cartridges from each type of ammunition were handled and bagged like the samples. Each shooter also provided an archival FTA card reference sample for comparison and identification after genotyping. These reference samples will be processed after the experimental samples.

Prior to shooting, all cartridges were placed under UV light so any archival DNA present was destroyed. The spent casings were collected using wooden stirrers that were similarly decontaminated under UV light and placed into individually labeled bags. The casings will be examined using hyperspectral imaging and swabbed only where fingerprints are visualized by the imaging software. DNA will be extracted from the swabs using a modified organic extraction protocol and quantified on a UV/VIS spectrophotometer. The extracted DNA will be genotyped using an in-house multiplex, containing four common STRs and the sex marker, Amelogenin.

The use of hyperspectral imaging allows for the visualization of fingerprints on various surfaces, including complex and interfering backgrounds. Forensic scientists are limited in their ability to obtain a complete DNA profile after many fingerprint processing techniques are carried out, and latent prints are often destroyed during swabbing. With the use of a hyperspectral imaging instrument, this study aims to establish the ability to visualize fingerprints and swab for DNA on the same sample.

Hyperspectral Imaging, Fingerprints, Touch DNA

A45 A Comparative Analysis of Low Copy Number (LCN) DNA Testing: How Low Can You Go?

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After attending this presentation, attendees will understand the importance of determining the lowest amount of DNA that can be reliably analyzed to give a full profile and the comparison of data between three commercial multiplex short tandem repeat (STR) kits will be discussed, as well as the value and relevance to the forensic community.

This presentation will impact the forensic science community by discussing how the term Low Copy Number (LCN) DNA is typically used when there is less than 100 - 125 pg of genomic DNA present in a sample.[1,2] More and more labs are attempting to process lower amounts of DNA without realizing the consequences of doing so. STR typing kits will generally fail to amplify all of the loci present or even one or both alleles present within a locus at these low levels of DNA. Partial incorrect profiles are generated that can be misleading without taking additional precautions including replicate testing.[3,4] In these cases, there are too few copies of the DNA template to provide reliable polymerase chain reaction (PCR) amplicons, causing preferential amplification to occur.[5] Next generation manufacturers' kits are being made more sensitive with improved PCR master mixes and more robust DNA polymerases. This can potentially lead to labs pushing the envelope and getting results that may not represent the true DNA profile of the originating source due to stochastic effects including allele dropout or drop-in.

Methods and Materials: Multiple LCN experiments were performed to evaluate three different samples that are heterozygous at every locus in the AmpFlSTR Identifiler™, AmpFlSTR MiniFiler™, and PowerPlex 16 HS PCR amplification kits. Completely heterozygous samples were used in order to evaluate peak height ratios (PHR) and potential imbalance due to stochastic effects (as compared to 9947A which is often used but has many homozygous loci). Each sample was tested in triplicate at multiple concentrations, including several considered to be LCN amounts (1 ng, 200 pg, 150 pg, 125 pg, 100 pg, 50 pg, and 10 pg) and at different PCR ranging from 28 to 34 cycles.[3,6] They were tested in triplicate to determine the consensus profile, where an allele cannot be scored (considered real) unless it is present at least twice in the triplicate samples.[2,3,6,7] The heterozygote peak height ratios (PHR) were calculated and compared at different concentrations and PCR cycling.[2,4] Results will be shown with different multiplex kits. In addition, post-PCR purification was performed on some of the samples to evaluate the impact of salt removal on signal strength and data interpretation. Post-PCR purification requires a change in interpretation threshold. Therefore, thoughts on setting interpretation thresholds to avoid stochastic effects will be described. The value of anchoring DNA quantitation results to a calibrated reference material will also be discussed.

Summary of Results: Consensus profiles from triplicate samples at different concentrations and PCR cycling, peak height ratio calculations, and stutter percentages will be presented, as well as a thorough comparison of results between multiplex STR kits.

Conclusions: DNA typing is typically reliable when concentrations are as low as 100 – 125 pg. LCN profiles (<100 pg DNA) are affected by stochastic variation resulting in an increase of PHR, an increase in allelic drop out, and an increase in locus drop out that can lead to incorrect genotypes even when triplicates are evaluated.

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Short Tandem Repeat DNA Typing, STR Multiplex Kits, Consensus Profiles

A46 Application of Circular Ligase to Provide Template for Rolling Circle Amplification of Low Amounts of Fragmented DNA

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After attending this presentation, attendees will be familiarized with the use of a ligase enzyme that circularizes DNA, which in turn may serve as a template for Rolling Circle Amplification and the product of that amplification can be subjected to DNA analysis.

This presentation will impact the forensic science community and/or DNA community by providing a new protocol for analysis of degraded/low copy number (LCN) DNA.

Degraded/LCN template is a frequently encountered obstacle when performing DNA analysis. The described methodology attempts to recover useful information from such templates using a robust form of Whole Genome Amplification (WGA), termed Rolling Circle Amplification (RCA), in which a circular DNA template is amplified by degenerate primers and a highly processive polymerase. Because human genomic DNA exists in linear form, a novel commercially-available circular ligase (CL), which circularizes linear ssDNA, was investigated towards the goal of producing templates which are suitable for RCA. Also described is a polyacrylamide gel electrophoresis (PAGE) method for the detection and analysis of template circularization.

Initial studies on CL involved optimization of ssDNA template circularization utilizing synthetic DNA oligonucleotides. These studies involved varying reagent concentration, incubation temperature, and reaction time. Circularization was observed to increase with increased enzyme amounts, however a maximum activity level was observed. High concentrations of manganese chloride were found to adversely affect the circularization of longer DNA templates via non-specific degradation.

The application of CL for circularizing dsDNA, the native form of human DNA, was also investigated. dsDNA was first heat denatured and snap-cooled, to generate ssDNA templates for circularization. However, while these were immediately subjected to CL, the results revealed that complementary ssDNA strands readily re-annealed to form dsDNA just prior to circularization. CL-treated dsDNA templates nonetheless formed exonuclease III-resistant products suggesting that CL is directly active on dsDNA templates. Furthermore, restriction digestion analysis confirmed that the dsDNA was circularized. In contrast, control experiments using T4 DNA ligase resulted in the formation of linear concatemers of dsDNA. CL optimization studies on dsDNA were conducted; however, no variation in template circularization was observed when incubation time, temperature, and ATP concentration were altered.

Additional experiments revealed that specific 5' and 3' terminal nucleotides of the linear CL template can affect the efficiency of circularization. To this end, an adaptor sequence was developed to contain nucleotide ends which are optimal for ligation. Ligation of such adapters to both ends of a linear template which contained suboptimal terminal nucleotides yielded successful circularization.

The results described form the foundation for further development of a method to analyze degraded/LCN samples via the circularization of

human DNA fragments and subsequent RCA. The technique shows promise for obtaining partial or perhaps complete nuclear DNA and/or mtDNA profiles from compromised samples.

Degraded/LCN DNA, Template Circularization, Rolling Circle Amplification

A47 Low-Template DNA Analysis: Applicability and Risk Assessment

Tamyra R. Moretti, PhD, Nuclear DNA Analysis Unit, FBI Laboratory, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will understand the difference between traditional and LCN DNA analysis, and appreciate many issues associated with LCN analysis and its potential applicability to specific human biometrics applications.

This presentation will impact the forensic science community by increasing understanding and awareness of a DNA testing strategy that is gaining in popularity in the U.S. forensic community. Attendees will appreciate that the gain of increased DNA detection sensitivity must be balanced against the potential for loss of fidelity and reproducibility in the analytical process that is incurred by LCN procedures. While LCN analysis warrants further consideration and development, laboratories must be mindful of the additional quality assurance and training requirements that it necessitates.

The fact that human biological material can be transferred onto objects via physical contact presents criminal investigators with a potential means of associating evidentiary items with individuals by way of DNA typing. Traditional analytical conditions are routinely used in DNA testing of touched objects and other items containing low-level DNA. However, over the past decade, forensic scientists have explored the possibility of enhancing existing DNA analysis methodologies to maximize the ability to obtain DNA profiles from low-template samples. Strategies such as increasing the amplification cycle number, modification of capillary electrophoresis conditions, desalting amplified samples, and whole genome amplification have demonstrated increased detection sensitivity down to the single-cell level. Experimental studies conducted at the FBI Laboratory, Nuclear DNA Analysis Unit (NDNAU), have explored the transfer of skin cells onto objects and the ability to obtain DNA typing results that are suitable for matching purposes using traditional and enhanced analysis methods. These studies showed that enhancement strategies can alter the performance characteristics of the PCR and result in demonstrable losses of fidelity and reproducibility in the analytical process. Consideration is given to factors that affect the accuracy of DNA typing results, given the increased risk of allele drop-in and contamination with low copy number analysis. The potential exists for DNA test kits, reagents, and supplies to contain biological contaminants that may be detected together with, or instead of, sample DNA. Studies demonstrated detectable DNA in consumable products and explored the efficiency of decontamination efforts. This presentation aims to explore the applicability of low copy number DNA analysis and increase awareness of issues associated therein. At present, guidelines have not been established in the U.S. for validation or the complex interpretation procedures associated with low copy number analysis. It is essential that, as interest in these strategies increases, the forensic community be mindful of the additional quality assurance and training requirements that would be necessitated with implementation and informed auditing. Deliberation of ways to improve the recovery of DNA from evidentiary items, augment quality control practices, and prevent DNA typing errors have made low-level DNA analysis a potentially useful tool that warrants further development and consideration for certain human biometrics applications.

DNA, LCN, Interpretation

A48 Generating DNA Profiles From Immunochromatographic Cards Using LCN Methodology

Reena Roy, PhD, Penn State University, Forensic Science Program, 325 Whitmore Lab, University Park, PA 16802; and Tam Ho, MPS, Penn State University, Forensic Science Program, 107 Whitmore Laboratory, University Park, PA 16802*

After attending this presentation, attendees performing DNA analysis will learn the optimum use of evidence which is limited in size.

This presentation will impact the forensic science community by providing a method which allows forensic scientists to identify the body fluid as well as the donor of the body fluid.

Biological fluids such as blood, saliva, and semen encountered at crime scenes are valuable sources of physical evidence in forensic casework since it can be used in the identification of an individual via DNA analysis. However, some of these evidence samples may not originate from humans or be mixtures of body fluids between humans and animals. Currently, various presumptive tests are available for detection of body fluids such as blood, saliva, semen and other body fluids. Once the presence of a certain body fluid is indicated on a piece of evidence confirmation of the nature of the stains are performed. Several confirmatory tests are available in the forensic science community for determining the species of origin of a biological stain. Species identification of a biological fluid usually relies on the binding of an antibody to a corresponding antigen, resulting in a visual precipitation**.** These human specificity tests include the use of antibodies, and allow the scientist to determine if the stains are of human in origin. Each assay employs slightly different working mechanism. One type of confirmatory test, which is available to scientists, employs immunochromatographic assay on membrane strips.

The one-step immunochromatographic assays used to identify human body fluids such as blood, semen, and saliva are now widely used in the field of forensic science. These devices have been validated by many scientists and have been confirmed to be reliable, sensitive and specific for forensic casework. These tests are used replacing the traditional methods, such as cross-over electrophoresis, which can be time consuming. These monoclonal and polyclonal antibody based tests come in the form of one inclusive single device, similar to a pregnancy test, and provide results within ten minutes and are quite sensitive. In addition, these devices are small and easily portable so that the assays can be performed at the crime scene. The procedures for these tests are fairly simple to follow, and the results are very easy to interpret. Immunochromatographic tests thus provide a convenient and versatile method in forensic casework.

The goal of this research was to obtain DNA profiles from immunochromatographic test devices which have already yielded positive or negative results with body fluids such as blood and saliva using Polymerase Chain Reaction method (PCR). The present research involved body fluid samples from 14 male and four female donors. Three different immunochromatographic cards for the identification of human blood and one for the identification of human saliva were used to confirm the presence of human blood and human alpha amylase. Two of these

cards used for confirmation of human blood are also known to react with blood from ferret.

Each body fluid was detected using the appropriate immunochromatographic card. The used cards were kept at room temperature for various lengths of time. The membranes were removed at the end of the designated times and the entire strip was extracted using a low copy number (LCN) extraction procedure. The extracted DNA was purified and concentrated using a Microcon® 100 device, and quantified using the Applied Biosystems (AB) Quantifiler™ kit on the AB 7500 Real Time PCR System. The extracted DNA was amplified using a reduced amplification volume and higher PCR cycle numbers for both the AB AmpFlSTR® Identifiler™ and AmpFlSTR® Yfiler™ kits.

While the best results were obtained when membranes were extracted at the end of one week, it was possible to obtain complete STR DNA profiles from most of the cards which were stored at room temperature for almost three months. These profiles were consistent with the profiles obtained from the donors' reference samples. Figure 1 is the Y-STR DNA profile obtained from a RSID-Blood immunochromatographic card. It is consistent with the DNA profile obtained from the donor's reference buccal swab (Figure 2). DNA profile was obtained from all of the three types of immunochromatographic cards used in this study to confirm the presence of human blood and from one type of device which detects human alpha amylase.

Given these results, when evidence samples are limited in size an analyst may confirm the presence of a blood and saliva and identify the donor of a particular body fluid by performing DNA analysis using only the immunochromatographic cards. This procedure could also be used should there be a question about the presence of ferret blood at the crime scene. These immunochromatographic cards can be used to determine the identity of the human donor by performing DNA analysis from the same cards.

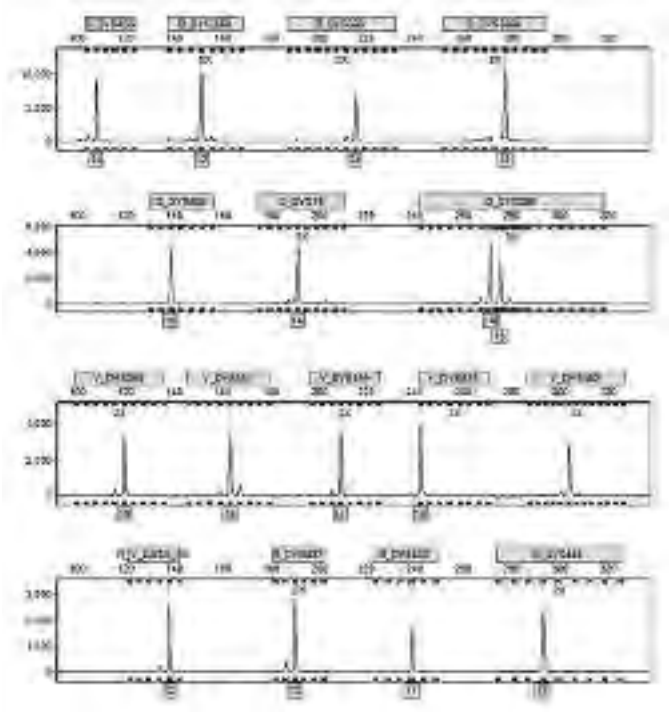

Figure 1: Y-STR DNA profile generated from a two month-old RSID™-Blood Card

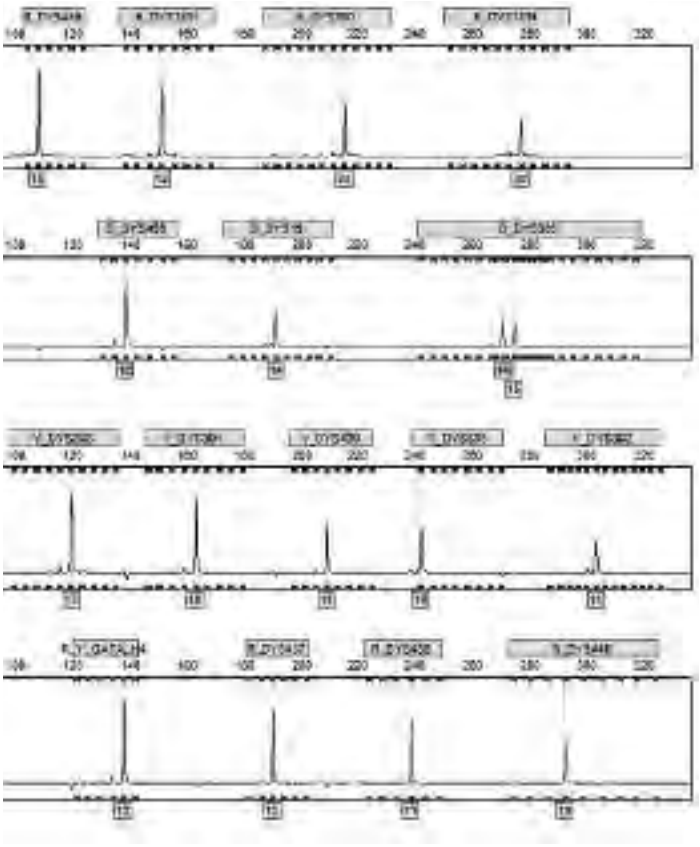

Figure 2: Y-STR DNA profile generated from the donor's reference buccal swab

DNA, LCN Methodology, STR DNA

A49 Airbags as Sources of DNA Evidence for Motor Vehicle Incident Reconstructions

Dean P. Hildebrand, PhD, Steen Hartsen, BSc, and Jason Moore, BSc, British of Columbia Institute of Technology, 3700 Willingdon Avenue, Burnaby, BC V5G 3H2, CANADA*

After attending this presentation, attendees will gain an understanding of the utility of deployed drivers' airbags as potential sources of DNA evidence for motor vehicle incident (MVI) reconstruction investigators.

This presentation will impact the forensic science community by highlighting that careful evidence collection techniques and the application of sensitive STR technologies can provide investigators with the capability of associating an individual with a deployed airbag to allow inferences to be drawn with respect to occupant position during a crash.

After attending this presentation, attendees will gain an understanding of the utility of deployed drivers' airbags as potential sources of DNA evidence for motor vehicle incident (MVI) reconstruction investigators. With careful evidence collection techniques and the application of sensitive STR technologies, investigators have the capability of associating an individual with a deployed airbag to allow inferences to be drawn with respect to occupant position during a crash. Based on the investigators' experiences, the majority of drivers involved in MVI investigations are the registered owners (RO) themselves. Because they are potentially regular users of the vehicle precautions must,

therefore, be taken to ensure that any DNA associations found relate to the incident in question and not to innocent secondary transfer events.

In the first phase of this study, driver's airbag cassettes were removed from Japanese and North American automobiles and deployed under controlled laboratory conditions while secured to a custom rack. Airbags deployed in such a manner allowed the investigators to assess the "background" trace evidence associated with the bag prior to crash-related human contact. The bags were carefully searched under ambient and ultraviolet lighting and the numerous visible and fluorescent markings were photographed. The airbags were sampled for background DNA by cutting out areas of fluorescence and swabbing select areas on the front of the airbag that would be expected to contact a driver. All DNA samples were subjected to a standard organic extraction method (plus micro-concentrator device) and quantification with Applied Biosystems *Quantifiler™*.

In the second phase of this study, driver's airbag cassettes were reinstalled in their respective steering wheels and mounted on the rack. Red paint was applied to each wheel and cassette and the airbags deployed. Under these conditions it was clear where contact was made with the airbag during deployment and deflation and how potential secondary transfer mechanisms may come into play. These results highlight the importance of careful airbag collection and packaging techniques.

In the final phase of this study, the potential for secondary transfer of biological evidence to the airbag was assessed. Driver's airbag cassettes were reinstalled in their respective steering wheels, thoroughly cleaned to remove any biological material and then vigorously handled by a known individual to simulate driver contact. These airbags were then deployed, collected, searched and analyzed for DNA as previously described. Where applicable, standard and mini-STR analysis was performed using Applied Biosystems *AmpFLSTR Profiler Plus™* and *MiniFiler™*, respectively.

The results from this study add to the knowledge and experience of forensic scientists and accident investigators that wish to utilize deployed airbags from motor vehicle incidents as part of a reconstruction. With proper evidence collection and analysis, such evidence can add important information to the investigation but should be applied with the particular case circumstances in mind.

DNA, Airbag, MVI

A50 The Effectiveness of Bleach for Eliminating Contaminating DNA on Laboratory Surfaces

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After attending this presentation, attendees of this presentation can expect to gain practical knowledge of the multiple factors that affect the ability of sodium hypochlorite, the active ingredient in commercial bleach, to eliminate amplifiable DNA contaminating laboratory surfaces. Issues to be addressed include bleach concentration, method of application, time of exposure, age of solution, and bleach brand manufacturer.

This presentation will impact the forensic science community by providing laboratories a comprehensive reference to evaluate the effectiveness of their current decontamination procedures with sodium hypochlorite and to improve decontamination methods, if needed.

Commercially available bleach is the most common means of removing DNA from laboratory surfaces, tools, and equipment in forensic biology laboratories. While there is an abundance of literature on the effects of bleach on microorganisms, the effectiveness of bleach on the elimination of DNA has not been systematically studied.

Most laboratories have protocols for the preparation and shelf-life of diluted bleach, although these protocols vary within the forensic community. Variables include the concentration of sodium hypochlorite in water (v/v), the manner of bleach application, the action of cleaning, and the time of exposure. Furthermore, forensic laboratories do not monitor the performance of their bleach solutions to determine whether an effective concentration is being utilized. All of these factors will affect the laboratory's ability to decontaminate surfaces.

Sodium hypochlorite in aqueous solution rapidly oxidizes to sodium hydroxide and free chlorine when it is exposed to light and air which eventually renders it ineffective for DNA decontamination. Many generic brands of bleach are not marked with their date of manufacture so it is impossible to tell the relative amount of sodium hypochlorite expected in unopened bottles of bleach. The fresher the bleach is, the higher the percent sodium hypochlorite present in the solution. Since individual laboratories retain their bleach solutions for different lengths of time, a working bleach solution may not be at an effective concentration for DNA decontamination when it is used. Likewise, a laboratory might assign arbitrary expirations dates to their bleach dilutions requiring them to be discarded while they are still effective. Many forensic biology laboratories require bleach dilutions be made daily. Without definitive knowledge of the life-span and the effective concentration of bleach solutions, a laboratory may not be consistently decontaminating laboratory work areas.

To address the effectiveness of bleach at removing DNA from surfaces, different concentrations of bleach, the method of bleach application, and time of exposure to bleach were studied. Scrubbing is a more effective method than submersion in bleach for DNA removal. To completely remove DNA from a surface, a sample requires more than 10 minutes of submersion in a 5% bleach solution or 3 minutes of submersion in 20% bleach. However, a 5% bleach solution can eliminate DNA from a surface immediately if scrubbing is used. When a lint-free towel is submerged in a dilution of 1% bleach and used to scrub a contaminated laboratory surface, 89% of contaminating DNA is removed from the work surface. Bleach dilutions of 5% and above will remove 100% of the contaminating DNA present. Interestingly, scrubbing with water alone removed 96% of DNA from a surface while scrubbing with 95% ethanol removed 40% of the DNA from a surface. While bleach is certainly more effective than water or ethanol in the removal of DNA, these findings suggest that the action of scrubbing plays the most important role in DNA removal. Also, ethanol should not be used alone as a decontamination strategy because it is not as effective at removing DNA even when combined with scrubbing.

The stability of 10, 15, and 20% bleach solutions exposed to and protected from light was monitored over a period of several days. Bleach dilutions protected from light were stable for at least five days while bleach dilutions exposed to light began to be less effective at DNA removal at five days. Final results of tests of the stability of bleach solutions protected from light will be presented.

Finally, the effectiveness of name brand Clorox ™ and two generic brands of bleach were compared. The generic brands of bleach performed as well or better than Clorox bleach. Only slight differences were

observed between brands and that may be the result of differing sodium hypochlorite concentrations. Additional studies of the precise concentration of sodium hypochlorite in bleach will be presented.

STR, Sodium Hypochlorite, Contamination

A51 The Recovery of Spermatozoa From the Oral Cavity

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After attending this presentation, attendees will have a better understanding of the factors that contribute to recover spermatozoa from the oral cavity.

This presentation will impact the forensic science community by emphasizing how the recovery of physical evidence, such as semen in the oral cavity is of utmost importance in that it can provide valuable information and corroborate or refute statements.

Sexual assault investigations can often be problematic. These cases are rarely witnessed and conflicting accounts often occur between victims and suspects. Rapes occur under different circumstances such as stranger rape, acquaintance or date rape, and spousal rape. It is for this reason that the recovery of physical evidence, such as semen and saliva, is of utmost importance in that it can provide valuable information and corroborate or refute statements. This study evaluates two methods of collection of spermatozoa in the oral cavity. The collection methods consisted of flossing and swabbing the oral cavity. Recovery of spermatozoa was considered as a function of three variables: the method of collection (floss vs. swab); the post-coital interval; and the effect of oral activity (teeth brushing, eating, drinking, etc.) during the post-coital interval.

Each sample was extracted using a differential extraction procedure with the resultant epithelial cell fraction being discarded. The sperm fraction was stained using hematoxylin and eosin, and examined microscopically under x200 and x400 magnification. The spermatozoa visualized were counted individually. The two collection methods gave different results in the ability to recover spermatozoa. As a general trend, the average count of spermatozoa recovered for both swabbing and flossing decreases over time, with the greatest decline seen within 1.5 to 3 hours post-copulation. Collection of spermatozoa as a function of oral activity also suggests a sharp decrease in recovery as oral activity increases. In this study, the floss collection method recovered spermatozoa on three occasions where the preceding swab collection failed to recover spermatozoa. This study also revealed incidences where the combination of swabbing and flossing could significantly increase the yield of spermatozoa for DNA analysis.

Spermatozoa, Oral Swabbing, Oral Swabbing

A52 Chapped, Pale Lips? Just Shimmer!

Reena Roy, PhD, Penn State University, Forensic Science Program, 325 Whitmore Lab, University Park, PA 16802; Lily Wong, BS, and Chelsie Van Sciver, Penn State University, Forensic Science Program, 107 Whitmore Laboratory, University Park, PA 16802*

After attending this presentation, attendees will learn to use methodology which optimizes the yield of DNA. DNA analysts will learn that it is now possible to obtain DNA profiles from objects such as lipstick or chap sticks.

This presentation will impact the forensic science community by allowing analysis of touch evidence by LCN methodology.

The goal of this research was to obtain DNA profiles from different types of touch evidence samples such as lipstick, lip gloss, lip shimmer and other similar items that are normally used on human lips. The present research involved objects used by several male and female donors. The surface of each sample which came in direct contact with the lips was swabbed with the tip of a sterile cotton swab. The tip of each swab was cut and extracted using a modified extraction procedure. This modified method of extraction is used when the amount of template DNA is lower than the amount normally needed (approximately 0.3 to 0.5ng/µl) to obtain a full STR DNA profile upon amplification. The assay included cell lysis in a buffer containing 0.01% SDS and Proteinase K.

Some of the samples were also extracted using a robotic system. This automated instrument and the reagents in the provided extraction kit use magnetic bead technology and a silica-based purification system. These samples were subsequently subjected to the modified extraction procedure. All of the extracted DNA samples were purified and concentrated using a filtration method. After the concentration was completed by the filtration method each DNA sample was eluted from the membrane with 10µl of the TE^{-4} buffer.

The eluted DNA was quantified using a DNA quantitation kit and a Real Time PCR System. The lowest amount of DNA detected from these samples was 0.0009ng/µl. Human DNA was also detected from a make-up brush that was used to apply lip gloss on the lips of a female donor. The quantified DNA was amplified using a reduced amplification volume and higher PCR cycle numbers using primers contained in commercially available autosomal and Y-STR kits. After amplification, samples were injected on a 3130xl Genetic Analyzer to generate DNA profiles. The data was analyzed using DNA analysis software.

The reference samples from the donors of the objects were also collected and extracted using a conventional DNA extraction method. These reference samples were amplified using the recommended amplification cycle and the same amplification kits. The samples were injected and analyzed using the same instrument and the same software.

Complete STR DNA profiles were observed when the extracted DNA from the items that touched the lips of the donors was amplified at 34 cycles. A partial DNA profile was obtained from a sample with less than 0.0009ng/µl of DNA. STR DNA profiles obtained from these lipstick sample and similar items were consistent with profiles generated from the donors' reference samples.

Given these results, when evidence samples are limited in size, an analyst may confirm the identity of the body fluid donor. This method thus can be used where the victim or the suspect is missing or the body fluid from the victim or the suspect is no longer available for DNA analysis. In these circumstances, lipsticks or similar objects may be the only available evidence. Obtaining DNA profiles from these types of evidence can help in the investigation of the crime and aid in the identification of a missing person.

DNA, STR DNA, LCN

A53 Application of mini-STRs to Low-Copy Number

Nicole M. Paes, BS, 2501 Lake Road, Apartment 34, Huntsville, TX 77340; and David A. Gangitano, PhD, 455 Wildwood Forest, Apartment 4206, Spring, TX 77380*

After attending this presentation, attendees will understand some principles regarding low-copy number DNA samples and where they can

be found in everyday scenarios. Attendees will also learn how to potentially increase the yield of DNA from such highly degraded samples using a novel method of collection, extraction, and amplification.

This presentation will impact the forensic science community by shedding light on a new method of collecting highly degraded DNA samples, such as those commonly found in crime scenes. The presentation will detail a novel collection method for low copy number DNA samples and possible ways to increase DNA yield from said samples.

This study tests the combination of mini-short tandem repeat (STR) polymerase chain reaction (PCR) amplification kits to low-copy number DNA samples, such as fingerprint residues, with the use of a double swab technique utilizing sodium dodecyl sulfate (SDS) on both swabs during collection to yield full DNA profiles for identification purposes.

DNA typing of low-copy number and degraded DNA samples can be problematic when using STR markers. Low-copy number DNA samples are typically categorized as being less than 200pg and complete amplification of all markers is difficult. The use of mini-STR markers, which employs smaller fragments, helps to increase the probability of complete amplification. The most common samples of low-copy number encountered are fingerprints. When a fingerprint is left, the residue is made up of sweat, oils, and epithelial cells from the individual. The use of SDS, which is a surfactant, is being explored for collection of fingerprint residues. A typical surfactant will absorb oils and fats, so its use for fingerprint residues will hypothetically increase DNA yield. It is theorized that the surfactant will break open the cells, which contain lipid membranes, to release the DNA and surround the oil residues of the print.

The addition of extra DNA polymerase, post-PCR purification using centrifugal filters, the use of increased purified sample during analysis, and an increased injection time were tested. Three different knife handles (wood, plastic, and metal) and a doorknob were handled by six individuals. Skin debris samples were taken from the neck of three female individuals in areas where moderate rubbing by a male individual had occurred hours earlier. This study used a double swab technique using 20% SDS on both swabs in combination with the mini-STR PCR amplification kit (D13S317, D7S820, D2S1338, D21S11, D16S539, D18S51, CSF1PO, and FGA).

The wood handled knife and doorknob obtained the most number of full profiles out of the objects tested for samples with and without clean-up methods (five and four out of six samples, respectively). For samples without clean-up, full DNA profiles were obtained from five of the six individuals tested and in the skin debris sample portion, no full male DNA profile was obtained. Full DNA profiles were observed in 14 out of 24 samples (58%) and six out of 24 (25%) showed no profile. The CSF1PO locus showed the greatest number of samples with successful amplification of all autosomal loci (17 out of 24), while D7S820 and FGA showed the lowest number (15 out of 24).

An increased injection time and use of increased purified sample for clean-up showed excess DNA for analysis. Only the techniques of additional DNA polymerase prior to PCR and post-PCR purification were used. After clean-up, full DNA profiles were also obtained for five out of the six individuals and one full male DNA profile was obtained for one set of individuals in the neck skin debris portion (16.67% ± 16.67%). The amount of full DNA profiles and no profile samples was unchanged from those seen with the regular mini-STR protocol. All autosomal loci showed successful amplification above 70% after the clean-up protocol, with AMEL being the only loci out of the nine loci tested showing a decrease after the clean-up protocol (17 to 15 out of 24 samples). No positive fingerprint samples were obtained for subject 01B.

Results indicate that the use of SDS and the mini-STR PCR amplification kit may give a full DNA profile from fingerprint residues and the use of the clean-up techniques studied did not increase the number of full DNA profiles obtained. Caution needs to be taken when dealing with low-copy number samples since there is an increased risk of contamination, allele drop-in and drop-out and heterozygote imbalance.

Mini-STRs, LCN, Fingerprints

A54 A SNP Based Assay to Predict Hair Pigmentation

Cheryl A. Schaeper, BS, Sara L. Jubelirer, BS, and Kimberly L. Anderson, BS, Forensic Science Program, 560 Baker Hall, Michigan State University, East Lansing, MI 48824; Mark D. Shriver, PhD, Department of Anthropology, Pennsylvania State University, University Park, PA 16802; and David R. Foran, PhD, Forensic Science Program, 560 Baker Hall, Michigan State University, School of Criminal Justice, East Lansing, MI 48824*

After attending this presentation, attendees will learn how human hair pigmentation can be predicted based on single nucleotide polymorphisms (SNPs).

This presentation will impact the forensic science community in the identification of victims, suspects, and unidentified remains when reference samples are not available for traditional forensic DNA comparison. The ability to predict hair pigmentation will permit a more accurate description of an individual's physical appearance, thereby increasing the ability of family, friends, detectives, and the like, to make an identification, which is critical in many investigations.

Hair pigmentation is determined by the interaction of many genes and their corresponding protein products during melanogenesis. Two pathways exist for this, one that leads to eumelanin, a black/brown pigment, while the other leads to pheomelanin, a red/yellow pigment. It is the relative abundance of these two products that determines hair color.

Previous research has lead to a SNP assay that correlates with red hair pigmentation. However, due to the more complicated nature of the eumalanin pathway, a similar assay for blonde/brown hair pigmentation has not yet been developed. In an effort to begin understanding the factors that contribute to blond/brown hair color, researchers have investigated SNPs within genes in the eumalanin pathway. Examples include tyrosinase; tyrosine related protein 1; solute carrier families 24 member 5, 45 member 2, and 24 member 4; oculocutaneous albinism type II; KIT ligand gene; immune regulatory factor 4; and HEct domain RCc1 domain protein 2. However, an individual's population ancestry also influences hair pigmentation, so it needs to be accounted for.

In order to develop a SNP-based assay for hair pigmentation that considers ancestry, 18 SNPs within the aforementioned genes were amplified and genotyped from African-Americans with at least 25% West African ancestry; Europeans with at least 90% European ancestry; and Brazilians with at least 25% West African ancestry. The genotypic data along with the melanin index, a numerical measurement of melanin content, were combined and used to create a predictive model for hair pigmentation. Significant SNPs in the prediction of hair pigmentation and a preliminary model based upon these SNPs will be presented.

Hair Pigmentation, Single Nucleotide Polymorphism, DNA

A55 Examples of Database Lab Case Approach for Chimeric Samples

Natasha K. Pranger, BS, Monica M. Price, BS*, and Robert T. Dorion, BA*, Washington State Patrol CODIS Crime Laboratory, 2203 Airport Way South Suite 250, Seattle, WA 98134*

After attending this presentation, attendees will see two different examples of chimera data sets from convicted offender DNA samples that were received as part of the convicted offender program in Washington State. Chimerism has been defined as the presence of two genetically distinct cell lines in an organism. The troubleshooting and follow-up work to eliminate contamination as a possibility and confirm these two individuals as chimeras will also be presented.

This presentation will impact the forensic science community by providing two different examples of chimeras to study and deliberate about analysis and interpretation strategies.

DNA samples received by the Washington State Patrol (WSP) CODIS Laboratory are typically buccal cells transferred to FTA paper. One such DNA sample was received for a convicted offender by the WSP CODIS Laboratory and was initially typed by an outsourcing laboratory. The results were an apparent mixture. The same mixture was observed when the sample was re-typed in-house with the same amplification kit. After a search against the staff elimination database yielded no results, it was initially assumed that the sample had been contaminated by the collecting agency. Years later, another sample was received for the same individual by the WSP CODIS Laboratory and typed by a different outsourced lab using a different amplification kit. A mixed profile was obtained. In-house typing resulted in the same profile. Research into whether or not a duplicate submission had been received for the individual was conducted and the earlier sample submission was noted. Comparison of the "mixed" profiles from all four typing attempts resulted in the same profile.

A similar situation occurred with a DNA sample received for a different individual. In this case, the sample was extracted twice in-house and resulted in the same apparent mixture. A duplicate sample taken by a different collector was received about a month later. The duplicate sample was typed and the same mixed profile was seen.

Both profiles were determined to be eligible for upload to NDIS. Attempts to collect additional tissue or body fluid samples were unsuccessful.

Samples from both individuals were sent to NIST for further analysis. At the time of this writing, the results had not been returned. If the results are available at the time of the poster presentation, they will be presented as well.

This poster provides two different examples of chimeras. For analysts in DNA databasing laboratories, there is an expectation for a single-source profile; mixed profiles are generally assumed to be contamination. Where possible, typing a duplicate sample for an individual could provide additional confirmation of whether or not the sample was contaminated or if it is exhibiting chimerism. For DNA casework laboratories, mixtures are assumed to be from multiple contributors. While chimeras are rare, they are a possibility. Typing of reference samples may or may not exclude this possibility, as chimeric profiles may only be observed in one body fluid or tissue and not another.

Chimera, DNA, CODIS

A56 Direct Amplification of Genotyping From Scrape Tissues

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After attending this presentation, attendees will be able to determine when the sample size is inadequate for conventional extraction or when rapid DNA typing, a simpler and higher yield method for genotyping from human soft tissues, is required.

This presentation will impact the forensic science community by demonstrating how a new method of direct amplification genotyping is sufficient and suitable for further PCR diagnosis screening.

Every year a number of disasters occur throughout the world, claiming the lives of thousands of individuals. These disasters may occur due to many reasons but are broadly classified as environmental, medical, industrial, vehicular, and terroristic. In case of disasters, many genetic analyses require isolation of genomic DNA not only from blood, but also from various kinds of human soft tissues. However, it is a common experience that the DNA extraction procedure is time consuming and results in loss of some DNA. In order to address the situations when the sample size is inadequate for conventional extraction or when rapid DNA typing is required, a simpler and higher yield method has to be developed. Scrape preparations were collected from seventeen autopsied individuals. Approximately 0.5 g each of liver, lung, kidney, and heart tissues were obtained from each individual. The genotypes of D1S80, 15 STR loci D8S1179, D21S11, D7S820, CSF1PO, D3S1358, TH01, D13S317, D16S539, D2S1338, D19S433, vWA, TPOX, D18S51, D5S818, FGA, and Amelogenin were investigated using 0.5 mg of scrape tissue yielding over 70 ng/µl of DNA in 500 µl of digest buffer. The genotypes of the D1S80 locus were successfully identified from 0.5, 1.0, 1.5, 2.0, 2.5, or 3.0 mg of scrape preparation for all seventeen cases. Multiplex STR analysis was conducted using different amounts of scrape preparations from four tissues in all cases. The results indicated that when the amount of tissue was less than 2.0 mg, the STRs were genotyped from the DNA templates in the digests in all cases. This study has demonstrated for the first time the ability to isolate a good quantity of DNA from minute amounts of tissues. The yield of DNA is sufficient and suitable for further investigations such as PCR diagnosis screening when rapid DNA genotype is necessary. A second important result of the present study is that the simple DNA isolation procedure can avoid contamination, which may occur during complicated DNA extractions.

Direct Amplification, Soft Tissues, Genotyping

A57 A Comparison of the Extraction of Buccal Cells From DNA Collection Cards Using Magnetic Bead and Organic Extraction Methods

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After attending this presentation, attendees will have a basic understanding of the potential application of a magnetic bead extraction procedure in a DNA databank setting with respect to the analysis of challenging known samples.

This presentation will impact the forensic science community by providing data that can be used when choosing an extraction method for DNA collection cards that are considered challenging samples. A comparison of a magnetic bead extraction method with an organic extraction method will allow forensic analysts to evaluate the efficiency, suitability, and practicality of both methods for use in a DNA databank laboratory.

DNA must be extracted from the protected environment of cells and separated from other cellular material in order to obtain a genetic profile. The quality and quantity of DNA obtained from the sample determines the level of success in obtaining a complete profile, therefore the efficiency and sensitivity of the extraction method employed is extremely important.

DNA cards are commonly used in forensic DNA laboratories as a method for the collection and storage of samples collected using a buccal swab. Most often, a genetic profile can be obtained from these samples by adding a punch of the DNA collection card directly to the amplification tube. Occasionally, amplification using this method fails. Organic extraction is the method the Alabama Department of Forensic Sciences (ADFS) DNA Databank employs when dealing with challenging samples on DNA cards from convicted offenders. However, even with the use of an organic extraction method, some samples still fail to yield a complete genetic profile. A low quantity of DNA present on the card is thought to be one of the primary underlying reasons for the failure to obtain a full profile.

Extraction methods utilizing magnetic bead techniques have been developed to improve the overall yield of DNA isolated from both routine and challenging forensic samples, as well as enhance the concentration and purity of the DNA. Validation studies of magnetic bead kits have demonstrated that the DNA yields were equal to or better than those obtained from other methods, the kits were able to efficiently remove PCR inhibitors during the extraction process, STR profiles generated from extracted DNA were complete and conclusive, and automation of these techniques is possible. While these magnetic bead kits have been proven to recover DNA from a variety of samples, recovery of buccal cells from DNA collection cards has not yet been demonstrated.

The goal of this study was to evaluate the efficiency of a magnetic bead extraction method to recover DNA from DNA cards impregnated with buccal cells and provide a complete genetic profile. Anonymous DNA samples were provided by the ADFS DNA Databank and consisted of DNA collection cards containing buccal cells. Study samples previously had undergone three unsuccessful attempts to amplify DNA on the DNA card as well as at least one attempt using an organic extraction method. All samples used in this study were considered challenging forensic samples.

A magnetic bead extraction kit was used to extract DNA from the samples. If enough of the sample remained, an additional organic extraction was performed. The protocol currently in use by the ADFS DNA Databank, which is proprietary, was followed for the organic extractions. The extracted DNA was quantitated using real-time PCR and STRs were amplified. The performance of the magnetic bead extraction kit and the organic extraction method was compared.

DNA Extraction, FTA Cards, Databanking

A58 Developing a Simple Method to Process Bone Samples Prior to DNA Isolation

Richard Li, PhD, Department of Science, John Jay College of Criminal Justice, 445 West 59th Street, New York, NY 10019*

After attending this presentation, attendees will understand the principle of this simple method to process bone samples prior to DNA isolation.

This presentation will impact the forensic science community by developing an alternative cleaning method to physical cleaning procedures, such as sanding.

Forensic scientists are called upon to identify human remains in criminal cases. A number of methods are used to identify human remains. The most common of these methods includes identification of facial characteristics; recognition of individualizing scars, marks, or other special features; comparing dentition with premortem dental records; and by fingerprint comparisons. In many situations, these methods cannot be used because of extensive putrefaction and decomposition of the remains. Human remains undergo a series of changes during decomposition. The rate of degradation of human remains varies greatly with environmental conditions (such as climate, bacterial growth, and insect and animal scavengers). After a period of time, soft tissues may be lost, while bone tissue may remain stable. In this type of case, DNA typing is a useful tool for identifying human remains.

Thus, bone tissue is often used for recovering DNA samples for the purpose of human identification. However, bones are challenging biological samples for DNA isolation since bone samples are difficult to process. Due to the potential of having co-mingled remains, contamination by physical contact, environment-born inhibitors, and bacterial contamination that interferes with forensic DNA analysis, the outer surface of a bone fragment must be cleaned using a current method, such as sanding. This initial cleaning of the bone is a labor-intensive and time-consuming step. Moreover, it is difficult to adapt the current method for automation. To address these issues, an alternative sample processing method for bone samples was developed in this study. Trypsin, secreted in the digestive system, is a proteolytic enzyme that breaks down proteins through a process referred to as proteolysis. Trypsin was chosen due to its ability to degrade various types of proteins. Trypsin also has been utilized in enzymatic maceration methods for processing bone samples in anthropological laboratories. In this study, the trypsin-based maceration technique was adapted to the sample processing method prior to DNA isolation from bone samples. By incubating samples with the trypsin solution, the outer surfaces of the bone fragment samples were removed. The trypsin-processed bone fragment or a portion of the fragment can then be used for DNA isolation.

The data obtained suggests that this method can be used in the initial sample preparation for cleaning the outer surface of human bone samples prior to DNA isolation. The use of the trypsin-based procedure potentially reduces the amount of labor required by a physical method

such as sanding. This method potentially has a low risk of cross-contamination between samples and diminishes safety concerns for laboratory analysts due to the exposure of bone powder. This method could be adapted for automated DNA isolation for human identification of bone samples, namely, from mass fatality incidents.

The application of trypsin on DNA isolation of bone will be presented. In particular, the yield of isolated DNA will be evaluated and the quality of the DNA will be accessed.

Bone, Forensic DNA, Trypsin

A59 Pathogen Detection Using a Unique Liquid Array Technology

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After attending this presentation, attendees will have knowledge on a novel, bead-based liquid array hybridization system and its capabilities in detecting low concentrations of pathogens.

This presentation will impact the forensic science community by demonstrating that detection of bacterial DNA with a new technology that incorporates the established capabilities of flow cytometry, microspheres, lasers, and digital signal processing is rapid and efficient. This proof of concept study demonstrates how instruments combining these technologies in a unique way can be used to successfully identify the source of a DNA sequence and is not an endorsement of the vendors supplying the components of the system.

Since the anthrax scare in 2001, the threat of modern biological related terrorism has become a reality. Bio-terrorist attacks are difficult to prevent and patients cannot be treated correctly without a proper diagnosis. This dilemma requires that there be a rapid means to identify pathogens in the environment and in a patient in order to respond with the proper vaccinations and care more readily. Techniques that can perform several assays on a single sample have become a necessity. Multiplexing DNA-based technologies are ideal for pathogen detection, specifically because they can provide rapid, positive identification of biological weapons. In this research, selected sequences of PCR amplified microorganisms' genomes were identified with a novel technology that combines bead-based liquid array hybridization with flow cytometry.

This unique system consecutively analyzes up to 96 samples per run with up to 100 probes per sample. Liquid kinetics allows for three-dimensional exposure and thus a multitude of collisions can occur between the polystyrene microspheres and the sample. If there is complementarity between the oligonucleotide probe affixed to the bead and a DNA sequence in the sample, a positive identification is reported.

Part of the 23S ribosomal RNA gene, *rrl*, was successfully amplified in four microorganisms: *Bacillus cereus*, *Escherichia coli*, *Salmonella enterica* and *Staphylococcus aureus*. A biotin tag was incorporated at the 5' end of one the strands of each PCR product. This strand included the reverse complement of the 20-base-pair probe attached to a microsphere set, which was designed as a probe for the particular microorganism. One probe was created for each DNA target sequence, producing four bead types to combine and utilize in a multiplexed assay. The instrument classifies the microspheres by using a red diode laser (635 nm) to detect the fluorescence emitted by the internal dyes of the microspheres and a green diode laser (532 nm) to detect and quantify the target DNA by measuring the intensity of the fluorescence emitted by the reporter.

PCR products were positively identified by specially designed, multi-analyte profiling beads, which are spectrally addressed. After unknown samples and a microsphere mixture were combined, hybridization was detected by adding the reporter fluorophore streptavidin-R-phycoerythrin to the reaction. In all cases, the fluorescent response was greatest for the bead set homologous to the target DNA present. The assay was highly specific and no false positives were observed. However, a few reactions resulted in false negatives, as the fluorescent intensity was sometimes less than the minimum value for a positive identification (>2 times background fluorescence). In attempts to rectify some cross-hybridization between *E. coli* and *S. enterica*, hybridization temperature and salt concentration were adjusted, yet the problem persisted.

A sensitivity test performed on decreasing concentrations of PCR amplicons showed that a very low amount of DNA could be detected and that the instrument response was directly proportional to the input concentration. The lower limit of detection was determined to be 0.5 ng for *B. cereus* and *E. coli* and 2 ng for *S. enterica*. The lower limit of detection for *S. aureus* could not be determined, as the instrument response was still very high for samples at concentrations as low as 0.25 ng.

Future studies will include analyses of pathogens that are more closely related. Additional markers will be included to increase the specificity of the assay and positively distinguish between species that have very similar nucleotide sequences. Sensitivity and mixture studies will be performed on these additional microorganisms and probes to design a robust multiplexed assay for pathogen detection.

Multiplexed Detection, Pathogens, Bioterrorism

A60 Myth Busting: Can Lip Balm Aid in DNA Transfer?

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The goal of this presentation is to demonstrate to the forensic community how the quality and quantity of DNA extracted from epithelial cells transferred from the lips to a drinking vessel can be impacted by the use of lip balm.

This presentation will impact the forensic science community by adding to the current knowledge base regarding the transfer of epithelial cells from an individual to an inert surface. Though much research has been conducted on saliva as a vector for DNA transfer, this research has expanded upon the available information by systematically analyzing an additional element: lip balm.

The media portrays DNA analysis as a relatively quick and easy forensic tool that can serve as the silver bullet that magically solves any forensic investigation. However, practicing forensic scientists know that extracting analyzable DNA from crime scene evidence is not as straightforward as the media portrays it to the general public. While several studies in published academic journals have demonstrated that epithelial cells from both saliva and the skin surface will transfer to a touched object, no research has been systematically undertaken to test if common skin and lip protection, such as lip balm, will help or hinder the recovery of DNA profiles from inert surfaces such as aluminum cans and ceramic mugs. The goal of this research is to conduct a pilot study to

assess how lip balm will influence the transfer of DNA from an individual's mouth to a drinking vessel. Data is also presented that compares DNA quality, based on PCR amplification success, and DNA quantity, based on agarose gel amplicon intensity, among vessels contacted with lip balm coated lips versus bare lips.

Original Chapstick brand lip balm was employed in this research due to its unisex use, and aluminum soda cans and coffee mugs were selected as the drinking vessels in this project due to their prevalent use by the general public. DNA was extracted from three aluminum cans and three coffee mugs from which the participant drank without the use of lip balm. DNA was also extracted from three aluminum cans and three coffee mugs from which the participant drank with the use of lip balm. Appropriate positive and negative controls were used to monitor for contamination during the research analysis. The authors chose to test for the presence of amplifiable nuclear DNA because of its individualizing nature in forensic investigations. The authors also employed the HUMTHO1 primers because of their common use in forensic genetic investigations, primarily due to its inclusion in CODIS. The results of this study show that DNA extracted from drinking vessels that came into contact with lips covered in lip balm yielded the most successful PCR amplification results based on amplicon intensity. It was also discovered that although lip balm does aid in the quantity of DNA transferred, the quality is lower when compared to DNA transfered from bare lips due to the increased smearing of the bands present on the agarose gels. In general, DNA collected directly from lips covered in lip balm yielded a better quantity of DNA which suggest that its use should increase chances of collecting transfer DNA from inert surfaces.

DNA, Transfer, Lip Balm

A61 A Correlation Study Between Sample Age, Human Salivary a-Amylase Activity, and DNA Quantity on Postage Stamps

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After attending this presentation, attendees will be informed of an optimized extraction method for obtaining profile data from aged postage stamp samples. Attendees will also be presented with the current findings obtained in this study with regards to a possible correlation between salivary a-amylase activity and DNA quality and quantity in degraded samples such as old postage stamps.

This presentation will impact the forensic science community by demonstrating that DNA and a-amylase appear to remain present on postage stamp samples over periods of time up to at least 83 years (both remained present on stamps that dated back to 1925). It also presents the findings that the starch-iodine test for a-amylase activity is not a reliable predictor or presumptive test for the quality and quantity of DNA on postage stamp samples.

The George Washington University Department of Forensic Sciences received a donation of 15 postcards mailed between 1918 and 1946 to the same address; all of the postcards were supposedly stored together in the same environmental conditions (unknown) until their donation to the university in 2008. The 15 postcards included six different types of postage stamps with either red or green dyes, a cost of one or two cents, and all but one of the stamps were United States postal stamps, with the other being a Canadian postal stamp. It was hypothesized that using a simple test for α-amylase, testing for the presence of active salivary α-amylase in a postage stamp sample could potentially be used as an indicator for the quality and quantity of DNA in the sample. Ultimately it was thought that this could be used as a screening tool to infer the likelihood of obtaining an interpretable STR profile.

Starch-iodine agarose plates were used to test for the presence of α-amylase activity on all postage stamp samples. A modified organic extraction method with ethanol and Microcon 100 purification and concentration was used to extract any potential DNA from all postage stamp samples. The extractions were quantified using Real-time PCR and amplified with a commercially available DNA kit. Low Copy Number (LCN) amplification was performed on samples that exhibited characteristics of degradation.

Out of the 15 postage stamp samples, ninety-five percent of the samples resulted in detectible α-amylase activity, and eighty percent of the stamps resulted in detectable amounts of extracted DNA. Of the eighty percent of the samples that resulted in detectible amounts of extracted DNA, approximately forty percent of the samples resulted in an STR profile of greater than or equal to eight of the 16 kit loci, and fifteen percent of the samples resulted in full STR profiles with all 16 kit loci. Various levels of contamination were observed from unknown external sources. The data provided no support for any correlation between the age of the stamp and the α-amylase activity and DNA quantity and quality obtained.

It was concluded that due to the lack of a correlation between the α-amylase activity and DNA quantity and quality on postage stamp samples, testing for salivary α-amylase activity is not a reliable presumptive test for the likelihood of obtaining a DNA profile from postage stamp samples. The age of the postage stamp samples also did not seem to affect the presence of α-amylase activity or DNA as greatly as other unexamined factors such as the actual action of licking the stamp, the handling of the stamps, and the stamp components such as dyes and adhesives.

Postage Stamp, Salivary a-Amylase, DNA

A62 Investigations on the Recovery of DNA From Footwear and Gloves

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After attending this presentation, attendees will have learned of the factors that contribute to successful recovery of DNA from footwear and gloves.

This presentation will impact the forensic science community by providing a potential approach to recovering touch DNA from footwear and gloves.

Shoes and gloves may be recovered at the scene of home invasions, homicides, and sexual assaults. The perpetrator may either discard the gloves used to commit the crime in the vicinity of the scene or when fleeing the scene. In addition, shoes that are not adequately secured may be discarded as the perpetrator flees the scene. Further, footwear impressions are invariably left at a crime scene but few are collected and analyzed. These impressions can provide class characteristics and may also yield features that permit an individualization to be made between the impression and the footwear. As suspects are identified, they may

deny owning the shoes or gloves found at the crime scene; they may also deny having worn the shoe found in their possession. In these instances, establishing a positive association between the suspect and the evidentiary item becomes crucial.

One approach to establishing this association is by recovering trace ("touch") amounts of DNA from the interior surface of the items and to compare the profile with a reference sample (oral swab in the proposed study). This comparison will assist in the investigation by providing information that will either include or exclude the suspect. This study investigates methods for obtaining DNA profiles from the interior surfaces of footwear and gloves. Various types of footwear and gloves were sampled using a tape-lift procedure to recover trace amounts of "touch" DNA from interior surface of the items. The samples were extracted using a commercial kit prior to mitochondrial and nuclear DNA analysis. This presentation will summarize the factors that contribute to the successful recovery of DNA from footwear and gloves.

Touch DNA, Gloves, Footwear

A63 The Evaluation of Multiple Commercially Available Extraction Chemistries for Forensic Laboratory Use

Mallory Mest, BS, Marshall University Forensic Science Center, 1401 Forensic Science Drive, Huntington, WV 25701; and Amy McGuckian, MSFS, and Cecelia A. Crouse, PhD, Palm Beach County Sheriff's Office, Crime Laboratory, 3228 Gun Club Road, West Palm Beach, FL 33406*

After attending this presentation, attendees will learn more about various extraction chemistries available for forensic labs. The chemistries are compared side by side to assist other forensic scientists to learn about the results that can be produced by using each kit.

This presentation will impact the forensic science community by assisting DNA or forensic biology labs in determining which extraction chemistry may best suit the needs of their lab.

The Palm Beach County Sheriff's Office Forensic Biology Unit has observed a dramatic increase in the number of touch, environmentally challenged, and inhibited evidentiary samples submitted for DNA analysis. This generally means samples with low or degraded DNA template levels resulting in partial, inconclusive, or negative DNA profiles. In order to extract optimum purified DNA concentrations from these types of samples, a matrix analysis of three extraction protocols was conducted. Samples were evaluated using EZ1 DNA Investigator Kit extracted on the EZ1 Advanced XL, DNA IQ Casework Sample Kit extracted on the Maxwell®16 and PrepFiler™ Forensic DNA Extraction Kit extracted manually.

Four comprehensive evaluations were conducted including: (1) a contamination assessment study using liquid blood samples extracted using the EZ1 and Maxwell®16; (2) a template concentration sensitivity study using a female dried blood dilution series comparing all three chemistries; (3) an inhibition study with all three extraction protocols in which saliva samples were spiked with tannic acid, humic acid, or hematin; and, (4) an extraction of mock evidence prepared from "touch" samples. The contamination assessment was conducted with 200 ml of liquid blood and blank samples arranged in a checkerboard fashion. The results indicated no DNA carryover from the samples to the negative controls for the two automated systems. The sensitivity studies were conducted on samples containing 45 ng to 1.0 pg based on quantification results. PrepFiler extractions routinely provided DNA profiles from concentrations down to a 1:512 dilution. DNA IQ provided routine profiles from concentrations down to a 1:32 dilution, with inconsistencies seen at dilutions less than 1:32. Qiagen provided routine profiles to a dilution of 1:128. Samples were spiked with known Taq inhibitors and extracted using PrepFiler, DNA IQ, and EZ1 Investigator. All three chemistries show the ability to remove inhibitors. PrepFiler was successful in this study with removing hematin, but not in removing humic acid or tannic acid. This may be due to improper washing during the manual extraction process. Mock "touch" samples provided a higher yield of profiles using both the PrepFiler and Qiagen extraction chemistries over DNA IQ. Data from all four studies will be presented.

Although each of the chemistries and instruments provide unique advantages, the results obtained from PrepFiler and Qiagen were consistently predictable. The results of this evaluation have been submitted to the Forensic Biology Unit and will be used to determine a chemistry that would provide an optimum extraction method that produces accurate and reliable results. The information presented in this poster may assist other laboratories in choosing an extraction method that is sensitive enough to extract low DNA template concentrations as well as remove inhibitors and avoid contamination.

All extraction protocols and evaluation methodologies will be presented including qPCR and AB3130xl PowerPlex16 data analysis.

Extraction Chemistries, Commercially Available Kits, DNA Analysis

A64 Comparative Study on Stability of DNA in Alternative Sample Tissues for Use in the Identification of Decomposed Cadavers

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The goal of this presentation is to identify several alternative sample tissues for the DNA identification of decomposed cadavers and compare their DNA yield and stability over variable postmortem intervals (PMIs). The effectiveness of each tissue at providing consistent short tandem repeat (STR) profiles will be determined and evaluated in comparison to the performance of the other tissues. The tissues at the focus of this presentation are vitreous humor, cartilage, tendons, and nails.

This presentation will impact the forensic science community by informing attendees about the possible usefulness of alternative sample tissues for DNA identification of decomposed cadavers, their resistance to degradation, ease of collection, amount of DNA recoverable from each tissue, and the stability of nuclear DNA contained in these tissues. These data will be considered comparatively in order to determine the most suitable alternative sample tissue for DNA identification of decomposed cadavers.

Identifying highly decayed cadavers is a frequent difficulty in death investigations. Developing a DNA profile of such cadavers using STRs typically requires sampling of hard tissues such as bone, because the DNA yield from soft tissues decreases exponentially after death. Bone has been shown to provide sufficient quantities of DNA for amplification over a wide range of PMIs; however, the extraction process is time-consuming and laborious, requiring bone segmenting with an electric saw, several washing steps including decalcification, and pulverization using specialized implements. If alternative sample tissues that are

simpler to collect and extract could be identified, forensic DNA analysts would benefit from having additional sample choices that may be less expensive and more expedient to process.

The alternative sample tissues chosen for study in this presentation were selected for their potential to resist postmortem degradation due to their anatomical location and matrix properties. Vitreous humor, found in the eye, is anatomically isolated and has been used previously in postmortem toxicology analyses of alcohol. Cartilage and tendons were chosen because they have a fibrous, collagen-rich structure lacking in vascularization that inhibits autolysis and bacterial putrefaction. Previous studies have already shown that nails offer substantial quantities of DNA. However, in this presentation nails will be compared with other alternative tissues.

All tissues will be extracted, quantified, and amplified using the same method: Samples will be washed prior to extraction in distilled water and ethanol or detergent. Solid tissues will be powderized to facilitate sample preparation. Extraction will be performed using a silica-based spin column method, following the manufacturer's protocol. Real-time PCR will be used for DNA quantitation and determination of inhibition. Amplification will be performed using an STR miniplex kit specialized for 16 loci with the following cycling parameters: a one min hold at 96°C; followed by 30 cycles of 30 s at 94°C, 30 s at 60°C, and 45 s at 70°C; and a final extension for 30 min at 60°C. Amplified extracts will be subjected to capillary electrophoresis for 5-10 s at 15 kV. Allele designations for each of the 16 loci analyzed will be made using allele-typing software.

The percentage of full profiles obtained from DNA analysis of each tissue relative to the total number of samples analyzed will be the gauge of the experiment's success. Consideration will also be given to the tissue most capable of yielding full STR profiles for the most advanced states of decomposition and longest PMIs. Each of the alternative sample tissues studied will be compared against the others to determine which yields the most DNA of the highest quality for degraded specimens and gives full STR profiles with the most consistency. A recommendation will be made based on the results as to which alternative sample tissue provides the greatest potential for use in DNA identification of decomposed cadavers.

DNA Stability, Decomposed Cadaver, Alternative Tissues

A65 Identification of Korean War Era United States Service Members From Highly Commingled Remains

Suzanne L. Shunn, MS, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, MD 20850; Audrey Meehan, BS, and Alexander F. Christensen, PhD, Joint POW/MIA Accounting Command – Central Identification Laboratory, 310 Worchester Avenue, Hickam Air Force Base, HI 96853; and Suzanne M. Barritt, MS, and Louis N. Finelli, DO, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, MD 20850*

After attending this presentation, attendees will understand some strategies employed by AFDIL and JPAC-CIL in identifying individuals from highly commingled remains, specifically from the Namjong-gu region of the K208.

This presentation will impact the forensic community by demonstrating a use of established forensic methods for the identification of commingled remains. The poster will further impact humanity by highlighting the ongoing efforts of AFDIL and JPAC-CIL to bring missing United States service members home.

A key component of the mission of the Armed Forces DNA Identification Laboratory's (AFDIL) Mitochondrial DNA Section is to assist the Joint POW/MIA Accounting Command – Central Identification Laboratory (JPAC-CIL) in the identification of U.S. service members missing from past military conflicts. This includes individuals missing from World War II, the Korean War, the Cold War, and the Vietnam War. In order to accomplish this mission, a combination of methods including mitochondrial DNA (mtDNA) analysis (performed by AFDIL), anthropology, archeology, odontology, and circumstantial evidence are used. Although mtDNA analysis alone cannot positively identify an individual, it may be very useful in situations involving commingled remains lacking a firm archeological context.

Between 1990 and 1994, 208 sets of skeletal remains from the Korean War were repatriated to the United States from the Democratic People's Republic of Korea (DPRK). These samples are colloquially referred to as the K208. Using anthropology and mtDNA analysis, these putative 208 individuals were instead found to be a severely commingled set of remains and to contain more than the purported number of individuals. Currently AFDIL has indentified 271 different mtDNA sequences from these samples.

The K208 remains were attributed by the North Koreans to 20 different proveniences, each designated by a village name. These villages correlate with locations in which U.S. servicemembers are known to have died. Some of these geographic series have turned out to be more commingled than others, due to different original burial circumstances and recovery practices. The region focused on in this presentation is Namjong-gu in which 42 sets of remains are present and 55 different mtDNA sequences have been obtained thus far. This village was the location of a prisoner-of-war camp used to hold U.S. personnel during the spring of 1950, where numerous prisoners died and were buried. Segregation of individuals is further complicated by numerous samples sharing common mtDNA haplotypes. In Namjong-gu, 14 samples belong to the most common Caucasian mtDNA haplotype with a minimum number of individuals (MNI) of three based solely on bone type. In the entire K208 population, 115 skeletal elements belong to this haplotype. Additionally, AFDIL does not have reference mtDNA sequences from maternal family members of all service members missing from this region. Despite these challenges, six individuals from Namjong-gu have been identified and returned to their families, as well as 33 individuals from this entire population of repatriated remains. So far, identifications have focused on the least commingled remains.

The views expressed herein are those of the authors and not The Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the U.S. Department of Defense.

Commingled Skeletal Remains, Mitochondrial DNA, Korean War

A66 Utility of "PrimeStore" in the Long Term Storage of DNA for Forensic DNA Analysis

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After attending this presentation, attendees will have learned about the factors affecting long-term storage of DNA.

The presentation will impact the forensic science community by investigating the issues affecting long-term storage of DNA.

Forensic evidence must be maintained for many years as the backlog in casework samples is eliminated. The cost to retain evidence in freezer space can be significant, but if effective preservatives could be added to

the biological evidence for room temperature storage, storage cost could be reduced. To encourage suitable preservation and storage of forensic evidence, the National Institute of Justice (NIJ) recommends determining cost effective methods for storage of evidence. This study researches the utility of PrimeStore in comparison with organic osmolytes on the long-term storage of DNA from biological samples as well as in improving the downstream analysis of STRs (short tandem repeats) in forensic samples. Prime store is presently being used to preserve viral nucleic acids and other biological samples. Preliminary data shows that DNA incubated with PrimeStore using an optimization assay can be amplified using STR primers without inhibition. We have previously shown that osmolytes (trehalose and sorbitol) can be used to stabilize blood samples. To assess the ability of PrimeStore to improve the storage of biological samples in comparison with organic osmolytes, PrimeStore is incubated with DNA samples extracted from biological samples for various time periods and held at extreme environmental conditions (e.g., high temperature and humidity). DNA from these samples, as well as those incubated with organic osmolytes, is then analyzed by STR analysis. The goal is to determine if PrimeStore can protect DNA from oxidative damage using a novel assay involving an aldehyde reactive probe. These studies will provide data for the effectiveness of PrimeStore in protecting DNA from damage due to environmental factors over extended periods of time in comparison with organic osmolytes.

DNA, Storage, Degradation

A67 Purification of Sperm DNA From Vaginal Swabs Using DNase I

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After attending this presentation, attendees will understand that sperm DNA can be isolated quickly, easily, and with high purity and yield from vaginal swabs by selectively degrading the victim's DNA using a nuclease, DNase I.

The presentation will impact the forensic science community by allowing crime labs to obtain DNA profiles from suspected rapists more quickly, easily, and in those rape cases where the number of sperm on the vaginal swab is limited.

The profiling of sperm DNA present on vaginal swabs taken from rape victims is a proven tool for identifying and incarcerating rapists. Large amounts of the victim's epithelial cells contaminate the sperm present on swabs, however, and complicate this process. The standard method for obtaining pure sperm DNA from a vaginal swab is to digest the epithelial cells with Proteinase K and to then physically separate the victim's solubilized DNA from the sperm by pelleting the sperm heads and repeatedly washing the sperm pellet, up to five times in some protocols. The sperm pellet washing steps are labor intensive, difficult to automate, and result in sperm loss. An alternative approach that does not require washing steps is to digest with Proteinase K, pellet the sperm, and then destroy the residual victim's DNA with a nuclease. This method is found to be fast, easy, and effective for obtaining abundant and highly pure male DNA from post-coital swabs taken as long as forty four hours after sex. The nuclease degrades the solubilized victim's DNA but does not affect the sperm DNA which is sequestered in the sperm heads and is not in solution.

Results: Fifteen post-coital vaginal swabs taken from up to forty four hours after sex were processed using the nuclease protocol. DNA was quantitated before and after purification for both total and male DNA using Quantifiler Duo from Applied Biosystems. All swabs taken from 10 minutes to 44 hours after sex yield a similar amount of total unpurified DNA (2.2-7.3 ug). The amount of male DNA on each swab dropped by a factor of 25 from 1,573 ng at 10 minutes to 63 ng at 44 hours, while the percentage of male DNA present on the swabs dropped from 33% to 1.5% of total DNA. After nuclease-based sperm DNA purification, the yield of male DNA for each swab was between 19-667 ng, more than enough for STR profiling. Importantly, the purity of the male fractions was exceptional, being greater than 95% male for each male fraction, including that taken from the 44 hour swab. STR profiling of the male fraction taken from the forty four hour swab gave a clear male profile.

Sperm DNA, Vaginal Swab, Nuclease Treatment

A68 Differential Extraction Conditions and the Premature Lysis of Spermatozoa: Effects on DNA Mixture Quantification and Amplification

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After attending this presentation, attendees will observe the effect Proteinase K concentrations, SDS concentrations, incubation times, and temperatures have on differential extraction efficiencies and the premature lysis of spermatozoa. This will allow attendees to optimize a preferential extraction procedure that will minimize sperm and non-sperm DNA mixtures. The attendees will also be able to differentiate between the differences in DNA concentrations derived from the extraction procedure versus the qPCR methods. Discussions on how to correct for qPCR irreproducibility will be discussed.

This presentation will impact the forensic science community by clearly demonstrating which differential extraction procedure to use in the laboratory to optimize the chemical means of sperm and epithelial DNA single source recovery, helping the forensic analyst/researcher understand the errors introduced during qPCR, and showing the DNA analyst/laboratory how to minimize these errors.

Many biological samples deposited at and collected from crime scenes contain mixtures from two or more individuals. The elucidation of individual donors in mixed biological samples has traditionally been a problem with serological testing and remains an issue today. Determining (1) the total number of contributors; (2) whether all of the data are present; (3) the relative ratio of DNA from each contributor; and, (4) whether a known individual is included or excluded, continues to be one of the most difficult and time consuming areas of DNA testing and training.

However, if the sample contains a mixture of sperm and epithelial cells, the DNAs may be segregated during the extraction process by utilizing differential extraction. In most laboratories, this is performed by chemical means, via the exploitation of the varying stabilities of cell membranes. The success of this type of extraction is based on the fact that sperm cell heads contain protein disulfide bonds in their outer membranes, making them impervious to lysis by treatment with Proteinase K and surfactant. The first step usually entails incubation of the sample in the presence of Proteinase K and surfactant (i.e., Sodium Dodecyl Sulfate (SDS)) to lyse epithelial cells, while leaving sperm cells intact. Following epithelial cell lysis, intact sperm are pelleted by centrifugation, allowing the DNA from the epithelial cells to be removed

in the supernatant or "non-sperm fraction." Once removed, a second cell lysis is employed to extract DNA from sperm cells. In addition to Proteinase K and SDS, dithiothreitol (DTT) is usually added to reduce disulfide bonds in the sperm head, allowing access to the sperm's DNA resulting in a "sperm fraction."

It has been previously reported that considerable sperm lysis occurs simultaneously with epithelial cell lysis in the absence of DTT.[1] If sperm cells are lysed concurrently with epithelial cells there are two ramifications. First, DNA originating from sperm may be lost to the non-sperm fraction resulting in a lower DNA yield in the sperm fraction. Second, the profile obtained from the non-sperm fraction may be a mixture of DNA. The goal of this research was to analyze the effect Proteinase K concentrations, SDS concentrations, incubation times and temperatures had on differential extraction efficiencies and the premature lysis of spermatozoa.

The effect was quantified using the Quantifilier® Duo DNA kit, whereby the concentrations of male and female DNA in the non-sperm- and sperm- fractions were compared. To accomplish this, reproducibility studies designed to evaluate error in forensic qPCR analysis by assessing its source were performed. Methods designed to minimize qPCR errors were utilized to ensure differences in extraction concentrations did not stem from qPCR deviations. Three qPCR external calibration methods were explored, where the method which uses a validated curve as the external calibrator, is recommended due to its ability to increase sample throughput, reproducibility and eliminate the need to quality check DNA stocks from manufacturers. Finally, all samples were amplified utilizing the Identifiler® PCR Amplification kit and male/female mixture ratios of both fractions were analyzed and compared to those derived from quantification.

Comparisons between expected and observed ratios illustrated the quantity of female DNA in the sperm fraction is substantially affected by the absence of Proteinase K. Additionally, there was no indication of simultaneous sperm and epithelial cell lysis in the absence of DTT at Proteinase K concentrations ranging from 10 – 300 µg/ml. All other conditions exhibited minimal variation in DNA concentration when measured by qPCR. Therefore, despite the various protocols used for the differential lysis of epithelial and sperm cell mixtures encountered in casework, the method is robust and successful at most conditions tested.

Reference:

[1] Norris, Jessica V., et al. "Expedited, Chemically Enhanced Sperm Cell Recovery from Cotton Swabs for Rape Kit Analysis." Journal of Forensic Sciences 52 (2007): 800-5.

DNA, Extraction, qPCR Error

A69 Quantification of Nuclear DNA Obtained From Hairs Based on Root Appearance

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After attending this presentation, attendees will understand the macroscopic and microscopic assessment of hairs to determine suitability for nuclear DNA, and nuclear DNA preparation, extraction, and profiling of hairs.

This presentation will impact the forensic science community by aiding forensic examiners in the isolation of hairs best suited for nuclear DNA analysis, by more thoroughly exploring of the appearance of the root ends of hair and the correlation to the amount of DNA obtained.

This paper, by more thoroughly exploring of the appearance of the root ends of hair and the correlation to the amount of DNA obtained, will aid forensic examiners in the isolation of hairs best suited for nuclear DNA analysis.

Hairs in forensic casework are often times analyzed macroscopically and microscopically prior to nuclear DNA analysis. This is done to determine suitability of these hairs for nuclear DNA analysis. A more through exploration of the appearance of the root ends of hair and how that correlates to the amount of DNA obtained would aid forensic examiners in determining those hairs that are the best suited for nuclear DNA analysis. In this paper, casework results from hairs whose root ends were examined both visually, and tested for nuclear DNA were examined. During the visual exam, hairs were mounted in Permount, photographed, removed from the slides, and rinsed with xylenes. Then they were washed prior to DNA testing, extracted using a SEB, DTT, and Prok extraction buffer, quantitated using Quantifiler, amplified using Identifiler, and run on the genetic analyzer to see if any nuclear DNA result s were obtained. The root appearance was divided into six categories, anagen roots with no tissue, anagen roots with tissue, telogen/catagen roots with much tissue, telogen/catagen roots with moderate tissue, telogen roots with slight tissue, and telogen roots with very slight tissue. These results were analyzed to determine what percentage of full, partial, and no profiles were produced by each root type. These results will show which hair roots are the best for nuclear DNA testing and which hairs may be better suited for mitochondrial or other forms low quantity DNA testing.

Findings of this study, including the possible impact of future nuclear DNA testing on hair, other factors to consider with these results, and future research to explore these factors further will be discussed.

Hair, Root, DNA

A70 A Comparison of a Dual Human/Male Quantitative PCR System and Serological Methods for Screening Sexual Assault Samples

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After attending this presentation, attendees will appreciate the potential for the use of dual human/male quantitation as a sensitive and discriminatory analysis method for detection of seminal fluid on internal sexual assault samples based on a comparison of its sensitivity to microscopic sperm search methods.

This presentation will impact the forensic science community by providing a comparison of a DNA based and a microscopic screening method for the analysis of internal sexual assault swabs; and by providing insight into how seminal fluid may be identified based on quantitation data using Dual Human/Male Quantitative following differential extraction.

Vaginal swabs from sexual assault kits are typically screened using serological and microscopic methods to identify chemical and cellular components of semen. This research compares these established methods with an alternate screening approach using a DNA quantitation system that detects both male and female DNA in a single reaction. A DNA based detection method for internal sexual assault swabs could allow for detection of small quantities of male DNA within a largely female

sample. Seminal fluid from three donors, one vasectomized and two non-vasectomized, was collected and applied to vaginal swabs in varying dilutions. Acid phosphatase, p30 testing, and microscopic sperm searches were performed on extracted whole swabs to determine the sensitivity of these approaches. Identically prepared swabs were concurrently subjected to differential extractions and quantified using a real-time PCR instrument with a dual human/male quantitative PCR system.

Both microscopic sperm searches and quantitation of male DNA using the PCR system reproducibly detected semen/male DNA when as few as 500 sperm cells were applied to vaginal swabs. Where dilutions targeting 50 sperm cells were applied to vaginal swabs, the dual human/male PCR system detected male DNA at measured concentrations of less than 1 pg/mL in sperm fractions in 4 of 6 samples, each with a volume of 25 mL. In these samples no spermatozoa were observed microscopically, demonstrating the enhanced sensitivity of the quantitative PCR system. Where possible, STR analysis demonstrated that the DNA detected was attributable to the semen donor.

No sperm were detected microscopically with an azoospermic sample, however male DNA was detected with the PCR system to a dilution of 1:12 800, well below the sensitivity of the serological chemical screening techniques investigated. As expected there was no fractionation of male DNA into the sperm fraction with any of the azoospermic samples.

In order to determine the parameters under which semen can be differentiated from other male body fluids, mixtures of male blood or saliva with vaginal swabs were also subjected to differential extraction and quantitation with the quantitative PCR system. These studies demonstrated that by evaluating the results of male DNA fractionation and quantitation it is possible in most cases to differentiate these body fluids from semen based on: i) absolute male DNA quantity in the sperm fraction; ii) the enrichment of total male DNA in the sperm fraction; and iii) the enrichment of male vs. autosomal DNA in the sperm fraction.

This research demonstrates that both microscopic sperm searches and DNA quantitation using a dual human/male quantitative PCR system are comparable in terms of sensitivity for screening vaginal swabs for the presence of spermatozoa. The quantitative PCR system is more sensitive than other serological techniques, even when liquid semen is directly applied to vaginal swabs, thereby making this technique better for the detection of azoospermic semen. It is also possible to define parameters based on DNA quantitation results that provide strong support for the presence of semen over other male bodily fluids.

Not only does the use of a dual human/male quantitative PCR system provide a sensitive and robust screening tool for internal sexual assault kit swabs, but it also provides information regarding the quantity of male DNA that can further be used to determine the most appropriate analysis technique (autosomal vs. Y-STR) for that sample. This study demonstrates that that this technique could replace the current serological methods in use, including acid phosphatase, p30 and microscopic sperm search techniques, with consequent improvement in processing efficiency.

Sexual Assault, Dual Human/Male Quantitative, Sperm Search

A71 Lessons Learned in the Application of the NIST DNA Quantification SRM 2372 to Quantitative Real-Time PCR Analysis

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The goal of this presentation is to assist attendees who are attempting to improve their DNA quantification analysis.

This presentation will impact the forensic science community by sharing information that will provide assistance to crimes labs to assess the accuracy of their protocols and the precision of their qRT-PCR instruments when determining the amount of target DNA to amplify for STR analysis of casework material.

One of the issues encountered in our laboratory system when qRT-PCR (Applied Biosystem Quantifiler™) analysis was implemented to replace the old hybridization dot/slot blot quantification procedures (Quantiblot™) was that the target amount of DNA amplified to obtain equivalent STR peak heights on the genetic analyzer changed substantially. The gap between the DNA concentration measured by qRT-PCR and other procedures such as UV absorbance could be substantial depending on the lot of qRT-PCR kits used during internal validation. Another issue was the lot to lot variability in concentration of the DNA standard (Standard A) provided in the qRT-PCR kit. Consistency in calibration of the target DNA concentration measured by the qRT-PCR to the amplified STR peak heights detected could be maintained from lot to lot by monitoring and adjusting the concentration of the standard. The availability of regression analysis parameters in qRT-PCR assays such as y intercept, slope and r^2 from the standard curve were welcome features; however, there were no internal calibrator controls provided with the kits like there were in the old hybridization based protocol.

The goal of this study was to improve DNA quantification and make the Applied Biosystem Quantifiler™ DNA qRT-PCR analysis traceable to the NIST SRM 2372 quantification standard. Neilson et al (FSI-Genetics, 226-230, #2, 2008) did a comparison of 5 different DNA quantification methods and came to the conclusion that the accuracy of the Quantifiler™ Human DNA Quantification kit could be improved by switching the DNA standard from the Raji cell line DNA provided in the kit to genomic DNA (G147A obtained from Promega). As part of the NIST SRM 2372 traceability implementation it was decided to do an evaluation of the Quantifiler™ Human DNA kit using both the DNA standard provided in the kit and the G1471 genomic DNA from Promega as an alternative standard. It was also decided to test a commercially prepared human genomic DNA from buffy coats (Roche) as a qRT-PCR calibrator control at two different concentrations. Work started using the Applied Biosystems 7000 SDS qRT-PCR instrument but the SRM 2372 did not give the expected results. Consequently the study continued with different plate configurations and a comparison analysis performed on the newer Applied Biosystems 7500 SDS qRT-PCR instrument.

The results of the study supported the following:

1) A material modification should be made to improve the Quantifiler™ Human DNA kit by changing the DNA standard and by adding a calibrator control. The G1471 genomic DNA as a DNA standard was found to provide a DNA concentration estimate of buffy coat pooled DNA concentrations that was very

close to the DNA concentration obtained from UV absorbance by the manufacturer. The calibration of target DNA amplified to the expected STR peak heights detected by the genetic analyzer is closer to that historically used for the old hybridization slot blot method.

2) There is an optimum plate configuration for the 7000 SDS qRT-PCR instrument for using the SRM 2372. In general SRM 2372 component A works better in columns 5 and 6 while components C and B work well in columns 1 through 4.

3) There is better precision for DNA quantitation when using the 7500 rather than the 7000 SDS qRT-PCR instrument. By loading a 96 well optical plate of uniform DNA concentration with Quantifiler Human and plotting the CT versus plate position it was ascertained that the 7500 has much more consistent readings across the plate then the 7000 SDS qRT-PCR instrument.

qRT-PCR, NIST SRM 2372, DNA quantification

A72 Validating the Use of a Human and Male Specific Quantitation Kit to Establish Minimum Amplifiable Quantities for Autosomal and Y-STRs

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After attending this presentation, attendees will understand how to establish and validate a minimum amplifiable quantity for terminating evidentiary sample processing. Termination at the quantification stage may be useful due to the expectation of results that will not lead to acceptable genotyping data for both autosomal and Y chromosome STRs. The audience will be led through the validation study and shown how to correlate quantification data to both detection and match interpretation thresholds (MIT). The goal is to establish quantitatively based cutoff values where evidentiary sample processing will be terminated.

This presentation will impact the forensic science community by demonstrating how the establishment of minimum amplifiable quantities for terminating evidentiary sample processing at the quantification stage will result in increased productivity and reduced costs for a laboratory. The termination of evidentiary processing of samples that are expected to yield no useful genotyping information will save a laboratory time at two different stages. First, the laboratory will save time in sample processing, as fewer samples will need to move onto subsequent and more expensive stages. Second, and more importantly, this will allow the laboratory to save time during the interpretation/report writing stage. In addition, this will prevent needless consumption of evidence. Validated early termination of evidentiary sample processing will have the added benefit of cost savings for the lab in analyst time, equipment usage, and reagent cost. Decreased analyst time per case will mean that a single analyst, as well as the laboratory as a whole, can process more cases overall. Increased productivity, reduced cost, and improved efficiency will benefit the individual laboratory, the criminal justice community, and the public that a laboratory serves.

A forensic biology laboratory should try to derive the maximum amount of information from each sample tested. However, it is inefficient, wasteful and not cost effective for a laboratory to process a sample that will lead to negative or uninterpretable results. The question becomes: is there a minimum amplifiable DNA quantity for effective evidentiary sample processing?

The FBI Quality Assurance Standards for Forensic DNA Testing Laboratories that went into effect July 1st, 2009 state: "In order for a laboratory to determine that evidentiary sample processing is to be terminated after DNA quantitation, the laboratory shall have a validation study to support that determination." A laboratory that chooses to establish a minimum quantity for amplification must perform an internal validation study in order to set the maximum quantity of DNA in an evidentiary sample that will not be amplified.

Here we describe a validation study using a human and male specific quantitation kit which establishes a maximum DNA quantity for the termination of evidentiary sample processing after the quantification stage. We performed amplification using four different STR typing systems (three autosomal and one male specific). All amplification was done according to the manufacturer's specifications on 96-well thermal cyclers. Samples were run on a 16-capillary electrophoresis genetic analyzer and analyzed using available genotyping software.

Initially, two different male samples were quantified in quadruplicate and the average quantity was used. Dilutions ranging from 0.001 ng/µL – 0.007 ng/µL were prepared and amplified in triplicate for both male samples using the maximum allowable sample volume. The amplified target amount ranged from 10 pg – 70 pg; based on previous work, this range was shown to produce genotyping data in the stochastic range for the different STR typing systems. To determine a stochastic range, the Match Interpretation Threshold (MIT) and peak amplitude threshold (PAT) must be defined. The PAT is the threshold above which a peak can be considered a true allele. The MIT is the threshold at which the taller of two heterozygous alleles must surpass for the sister allele to be reliably detected above the PAT. The stochastic range resides between the MIT and PAT as this is the range where allelic drop-out is expected to occur.

Sample data was analyzed with consideration to the PAT and MIT, in regards to the profile as a whole and at individual loci. A minimum amplifiable quantity was established as the amount of DNA that must be amplified to produce alleles above the MIT, also taking into account the variability of a human and male specific quantitation kit. Of 1,979 casework samples quantified between June and July of 2009, 18% of the samples could have terminated after the quantification stage assuming a quantification threshold for human DNA of 0.005 ng/µL. Of these, 25% percent are estimated to contain enough DNA in order to continue with processing if the same amount of sample was extracted and combined with the original extraction. Assuming a male quantification threshold of 0.003 ng/µL, 41% of the samples could have terminated after the quantification stage. Nine percent of these could be salvaged by performing a second extraction and combining both extractions together.

Establishing a minimum amplifiable quantity for amplification is expected to reduce the number of fully analyzed samples by 20%. We estimate that one amplification kit per month would be conserved in addition to the DNA processing and interpretation time that would be saved by implementing a quantification threshold.

Minimum Quant, Interpretation Thresholds, Quality Standards

A73 Acetylated Versus Non-Acetylated BSA When Processing Inhibited Samples

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The goal of this presentation is to demonstrate the differences between using acetylated and non-acetylated bovine serum albumin (BSA) in the amplification of mitochondrial DNA (mtDNA), particularly when working with inhibited and/or ancient skeletal remains and blood.

This presentation will impact the forensic science community by increasing the success rate of obtaining DNA sequence data from inhibited samples by using proper amounts of non-acetylated BSA during polymerase chain reaction (PCR) amplification.

One of the primary missions of the Armed Forces DNA Identification Laboratory (AFDIL) is to identify the remains of military personnel missing from previous United States armed conflicts. In many cases, the skeletal remains recovered have been exposed to harsh environmental conditions and inhibitory factors causing the osseous structure of the remains and total genomic DNA within the bones to be highly degraded due to the condition of the skeletal remains, mtDNA testing is routinely performed. Many samples have also been subjected to surrounding stressors, such as high/low pH and high levels of humic acid that can cause DNA recovered from the remains to be inhibited. During PCR amplification of these samples, it is important to know how to overcome potential inhibition. BSA can be added to PCR amplifications to help minimize inhibition by acting as a blocking agent. There are two types of BSA available, acetylated and non-acetylated. Publications that describe the amplification of ancient DNA often recommend BSA as an additive but almost never stipulate which type. Preparations of BSA usually contain high amounts of nucleases, so BSA is often treated with acetic anhydride in order to inactivate nucleases. However, this acetylation can modify the binding characteristics of BSA by transferring the acetyl group from the BSA protein to the polymerase, therefore minimizing the effectiveness in overcome inhibition. Non-acetylated BSA is a highly purified version of BSA that is tested for DNase, RNase, endonucleases, protease, peroxidase, and alkaline phosphatase activity, the absence of which is vital to maintain DNA or RNA integrity.[1]

The two types of BSA were tested to determine which one provided the greatest success when processing inhibited samples. The optimized concentrations of acetylated BSA and non-acetylated BSA were used in separate PCR amplifications against the common inhibitors humic acid and hematin, found in soil and blood, respectively. Humic acid and hematin solutions were prepared in house at concentrations ranging from 7.5ng/µl to 20ng/µl for humic acid and 10µM to 50µM for hematin. The sample used for the PCR amplification setup was high quality DNA of a known sequence. The samples were spiked with various concentrations of the inhibitors. For the master mixes containing acetylated and non-acetylated BSA, 2µl of Taq was added per sample. In addition, a master mix was prepared containing non-acetylated BSA with 1µl of Taq per sample. Amplifications using acetylated BSA failed to overcome inhibition at the varying concentrations of humic acid and hematin. However, all amplifications involving non-acetylated BSA, at both1µl and 2µl of Taq per sample, were successful. The two types of BSA were then compared using samples displaying low quantitative values. Similar to previous results, the non-acetylated BSA outperformed acetylated BSA during the PCR amplification of the samples.

Results obtained from the comparison of the acetylated and non-acetylated BSA, demonstrate that non-acetylated BSA should be used for the processing of degraded and/or inhibited mtDNA samples.

The opinions and assertions contained herein are solely those of the authors and are not to be construed as official or as views of the United States Department of Defense or the United States Department of the Army.

Reference:

[1] http://www.ambion.com/catalog/CatNum.php?AM2616

Bovine Serum Albumin, Inhibition, MtDNA and STR

A74 Collection of DNA From Spent Shotgun Shells Using dcDOP-PCR

Alexis Smith, BA, and Julia R. Patterson, BA, 341 Fisher Hall, 600 Forbes Avenue, Pittsburgh, PA 15282*

After attending this presentation, attendees will understand the principles of dcDOP-PCR, and how it can be used to obtain genetic profiles of DNA found on spent shotgun shells.

This presentation will impact the forensic science community because there is a need for validation of a technique that can analyze touch DNA that is severely degraded.

It is recommended that 0.5-2.5 ng of template DNA be used for commercially available STR multiplex amplification kits, however many samples processed consist of low copy number or severely degraded DNA. The goal of this research project was to evaluate a new low copy number technique, dcDOP-PCR, using fired shotgun shells as would be found at a crime scene. Specifically, the dcDOP-PCR technique will be compared to traditional PCR analysis.

According to the FBI in 2005, shotgun crimes accounted for 5% of homicides by firearm. This is second only to homicides by handguns.[1] Typically when investigators arrive at the scene of the crime, the only evidence related to the gun is a spent shell casing. When the shells are handled and loaded into the shotgun, DNA is transferred through the loss of epithelial cells. It has been shown previously that transfer DNA can yield DNA profiles from spent bullet casings from hand guns. It is hypothesized that profiles can also be obtained from spent shotgun shell casings. However, fewer epithelial cells may be shed in the loading of shogun shells as opposed to bullet casings because much less pressure is needed.

It is difficult to obtain STR profiles from fired shotgun shells due to their limited handling and the high temperatures to which the DNA is subjected. A modification of Whole Genome Amplification will be used known as dcDOP-PCR. This method uses a 10-N degenerate oligonucleotide primer in order to pre-amplify the sample. This produces a greater copy number of template DNA to be used in future PCR reactions and genetic profiling.

A group of twenty subjects consisting of ten males and ten females were selected to load and fire three shotgun shells with a 12-guage shotgun. The shells were then collected post-ejection with a sterilized wooden stick and placed in a paper bag. Each individual shooter was assigned an identification number used to label all of their fired shell casings. The shotgun shells also underwent a colored coding to designate the first, second, and third loaded shotgun shells from each other. All of the labeling was performed by an individual who was not involved in the analysis of the shotgun shells, creating a blind study. A reference buccal swab was also collected from each individual that was labeled with their identification number. At no time was the subject's name linked to their identification number during the processing of samples.

An equal number of males and females were used in this experiment in order to study the effect of gender on the completeness of the genetic

profile that was obtained. High brass and low brass shotgun shells were also used in the study to determine if the type of shell affected the genetic profile. The two shells differ in the appearance of their outer brass covering. The brass covering extends along the sides of the shotgun shell with a smaller area of plastic exposed on high brass shells. Low brass shells have a small brass ring at the bottom and more plastic exposed on the sides of the shell. This difference in textures may cause a difference in the amount of epithelial cells shed onto the casing. Lastly, the order of loading was analyzed to see if there was a statistical difference between the completeness of the genetic profiles for the first, second, and third loaded shells.

A double swabbing technique was used on the collected shell casings using a 20% SDS solution. The DNA was then extracted using DNA IQ and then pre-amplified using the dcDOP-PCR method. The samples were then amplified using the AW12106, a miniplex for small base pair DNA (< 200 bp) that was developed at Duquesne University. AW12106 utilizes five loci including D8S1179, D16S539, D5S818, TPOX, and Amelogenin. The samples were then genotyped using the ABI 3100-Avant Genetic Analyzer. The genetic profiles from the spent shotgun shells were compared to the genetic profiles obtained from the reference samples. A partial profile was considered to have one to four amplified loci. The completeness of the genetic profiles were also examined in conjunction with the variables of gender, shell type, and loading order.

Reference:

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Whole Genome Amplification, Degraded DNA, Fired Shotgun Shells

A75 Frequency of Apparent False Inclusions in Complex Y-STR Mixtures

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After attending this presentation, attendees will gain an understanding of the limitations of Y-STR mixture statistical analysis; use of a Y-STR mixture analysis tool (Y-MAT) that utilizes random mixtures from a database of over 2500 profiles; and, use of the Y-MAT to ascribe meaningful weight to Y-STR mixtures.

This presentation will impact the forensic science community by explaining how Y-STR analysis is a powerful tool for the forensic community. However, Y-STR mixture interpretation has a serious limitation in the inability to ascribe a meaningful statistical analysis. As such, partial matches to Y-STR mixtures can result in misleading conclusions. Y-MAT provides a method to obtain.

Y-STR analysis is a powerful tool in the DNA arsenal for human identification, particularly in the forensic arena. A serious limitation, particularly in forensic samples, is in interpreting mixtures that have more than one male contributor. The fallacy is that the Y-STR profile is donated as a block of loci, rather than as independent loci such as the autosomal loci used in conventional STR analysis. As such, partial profiles that are observed in a complex mixture may represent dropout, or alternatively may be an exclusionary event and therefore it is presently impossible to conduct a valid statistical analysis. But without statistics, the jury cannot properly weigh the significance of the evidence. If a suspect's Y-STR profile is observed in over ninety percent of the loci in a mixture, intuitively it seems reasonable that that he is likely one of the DNA donors. However, this could be misleading as a mixture of profiles from random individuals will often yield a profile combination that the suspect will match at 12, 13, 14, or even more of the 16 loci tested.

The development of a method will be described that, rather than comparing the mixture to individual profiles where dropout would confound the evaluation of the data, creates mixtures of two, three, or four random individuals from a database of over 2,500 individuals. This allows the determination of the expected frequency of partial or entire matches of an individual's Y-STR profile to the random mixtures. A software program was then developed that facilitates conducting literally thousands of comparisons in less than an hour. It also allows the incorporation of random individuals either from the entire database or it can be limited to a specific race. This tool enables the analyst and the jury to weigh the relative significance of the evidence.

The software program was applied to a real case involving a three person mixture. The suspect, in this case, was indicted by a match at 15 out of 16 loci from another agency's data that did not include statistics. Of 1,000 three-person random mixtures, the suspect was included in 254 at 15 loci and 105 at 16 loci. This data dramatically shows that the intuitive conclusion that the data implicates the suspect could be misleading as over one-third of random three-person mixtures would include the suspect. Thus the genetic data only weakly supports the conclusion that DNA source is that of the suspect. Combine this with the fact that autosomal data did not support the conclusion, and the finding reached by the jury could be significantly different.

Y-MAT continues to be developed to further investigate the discriminating power of Y-STR's in forensic science. As seen, the tool is proving useful in determining the probability of a selected suspect matching frequencies in criminal cases, thereby providing the ability of ascribing meaningful weight to Y-STR matching statistics. The preliminary indications are a lack of confidence in 4 person Y-STR mixtures, and a significant note of caution in ascribing probative significance in matches against mixtures of three.

Y-STR Mixtures, Random Matches, Y-STR Analysis Tool

A76 Weight of Evidence for DNA Profiles From Degraded Samples: Low Template Samples and Mixtures

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After attending this presentation, attendees will understand how the likelihood ratio can be used to assign statistical weight to comparisons between DNA evidence profiles and profiles from known individuals. This method is appropriate for low or high template samples, for single source samples or mixtures, for degraded or pristine DNA, and for scenarios with multiple sets of results for the same sample.

This presentation will impact the forensic science community, as the analytic method presented allows quantitative comparison between evidence and exemplar profiles when degradation and/or allelic drop-out may have occurred.

The generation of DNA profiles from small amounts of skin cells or degraded body fluids was historically not feasible. However, with the advent of more sensitive molecular technologies, it is now possible to obtain genotypes from these samples. The generation of STR profiles

from low-template or degraded DNA samples may be accomplished by several methods, such as increased PCR cycle numbers (Findlay et al. 1997; Gill et al. 2000),[1,2] nested PCR (Taberlet et al. 1996),[3] and purification of PCR product (Smith and Ballantyne 2007).[4] Using increased PCR cycle numbers, full STR profiles can reliably be obtained from 25 – 50 pg of DNA; partial profiles may be obtained from even lower quantities of starting DNA (Prinz et al. 2006; Caragine et al. 2009).[5,6].

While these advances have expanded the range of case types for which DNA evidence is useful, they have also introduced new analytic challenges. The comparison of known DNA profiles to evidence samples containing small amounts of DNA or degraded DNA can be challenging, as many of the results produce mixtures and/or partial DNA profiles. Alleles from known contributors may be absent or, conversely, extraneous alleles that cannot be attributed to known contributors may be present. These phenomena are commonly known as allelic drop-out or drop-in, respectively. Due to a higher occurrence of allelic drop-out and drop-in with low template or degraded samples, relative to high template or robust samples, the DNA Commission of the International Society of Forensic Genetics (ISFG) cautions that standard STR analysis methods may not be appropriate for low template samples (Gill et al. 2006)[7].

The standard statistic calculated when evidentiary and exemplar STR profiles are identical is the random match probability (RMP). The RMP can be used for single source evidentiary profiles and for mixtures when individual contributors' profiles can be deconvoluted (deduced). Two methods, Random Man Not Excluded (RMNE) and likelihood ratio (LR), are commonly used to quantify the statistical weight of mixed DNA profiles when contributors cannot be deduced. The DNA commission of the ISFG recommends the LR (Gill et al. 2006),[7] as it uses more of the available data and parameters for allelic drop-out and drop-in can be incorporated. That said, RMNE does not require specification of the number of contributors to a mixture and the calculation is more intuitive; therefore, RMNE is easier than the LR to explain to a jury. However, RMNE cannot be used if any of the exemplar profile alleles are missing from the evidence profile.

An analytic method has been developed for the comparison of evidence profiles from small or compromised DNA samples to known profiles while accounting for the probability of allelic drop-out and drop-in, starting with a framework similar to that presented in Curran et al (2005).[8] The method compares the probability of the evidence profile data under two competing hypotheses via a likelihood ratio. Specification of the hypotheses is flexible and the method can include data from multiple replicates of an evidence profile. Drop-out and drop-in parameters were estimated empirically in single source samples and in mixtures of DNA from two to four contributors with 6.25 pg to 500 pg of starting DNA. Estimates were obtained from purposefully degraded samples and from non-degraded samples.

The method has been implemented in a web-based software application. In this presentation, the analytical strategy will be presented and the software's performance will be demonstrated using mock casework profiles.

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4 Smith PJ and Ballantyne J (2007) Simplified low-copy-number DNA analysis by post-PCR purification. *J Forens Sci* 52:820-829

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Likelihood Ratio, Degraded DNA, Low Template DNA

A77 Casework Validation of Genetic Calculator Mixture Interpretation

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After attending this presentation, attendees will better understand how to conduct a DNA mixture validation study, how to measure the efficacy and reproducibility of any DNA interpretation method, and why computer interpretation of DNA evidence can be more informative than manual review.

The presentation will impact the forensic science community by enabling practitioners to conduct DNA mixture validation studies on interpretation methods that they would like to present in court.

Interpreting DNA mixtures can be challenging. With the advent of statistical computing, one can reproducibly infer consistent, highly informative results. Such reliable mixture inference is critical for the admissibility of scientific evidence. This paper establishes the *efficacy* of computer-based genetic calculator mixture interpretation by comparing inferred match information on adjudicated mixture cases relative to currently used manual methods. It also demonstrates the *reproducibility* of the computer's results.

The key mixture interpretation task is inferring a questioned genotype of an unknown contributor. When there is uncertainty in an inferred genotype, allele pairs are assigned a probability distribution that describes this uncertainty. Different mixture interpretation methods may infer different genotype distributions.

A genetic calculator provides a statistical computer approach that infers genotypes by hypothesizing all feasible solutions, comparing these with observed STR peak height data, and assigning higher probabilities to genotype hypotheses that better fit the data. Two quantitative inference methods were examined:

- TA1, which uses a known victim genotype to help infer the other unknown contributor, and

• TA2 that does not use a victim genotype, but instead infers two unknown contributors.

There are also qualitative list-based inclusion methods that apply peak thresholds:

• CLR, which uses a known victim genotype, and

• CPI, a qualitative approach that does not use a victim genotype.

The Likelihood Ratio (LR) is the generally accepted forensic science measure of match rarity. The LR gives the probability of a match between the evidence genotype and a suspect, relative to a match with a random person. The data-inferred evidence genotypes above (TA1, TA2, CLR, and CPI) each produce a LR match statistic when their probability distribution is substituted into a generic LR match formula.

The efficacy of the genetic calculator was determined by comparing its LR match information to other methods. In particular, the LR logarithm (i.e., order of magnitude, or powers of ten) was determined on eight adjudicated cases for the two unknown TA2 computer method, and compared with that of the reported CPI value. Whereas the average log (LR) information for CPI was 7 (LR = 10 million to one), the average match information on these same cases with TA2 was 13 (LR = 10 trillion). This shows a six order of magnitude improvement when using genetic calculator method TA2 relative to manual CPI.

Relative efficacy was also assessed when the victim profile was known, and just one unknown contributor was inferred. The average log (LR) match information reported on eight adjudicated CLR cases was 13 (10 trillion). The average genetic calculator TA1 match information on these same cases was 18 (quintillion), a five order of magnitude improvement. Thus, for both one and two unknown contributors, the genetic calculator mixture interpretation method is more informative than the manual CPI and CLR match statistics.

Reproducibility was measured on these sixteen mixture cases by obtaining duplicate computer solutions for each case. The average match information deviation between the two independent solutions was under half a log (LR) unit.

From this study it is concluded that a genetic calculator can provide reliable mixture interpretation. Specifically, when inferring either one or two unknown contributor genotypes, the genetic calculator is effective relative to current manual methods. Moreover, we quantified the genetic calculator's interpretation reproducibility using match information. The genetic calculator has already been admitted into evidence in a *Frye* jurisdiction. This validation study (assessing efficacy and reproducibility) establishes the genetic calculator's reliability for the additional prongs of *Daubert*.

DNA Mixture, Validation Study, Computer Interpretation

A78 Three Match Statistics, One Verdict

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After attending this presentation, attendees will learn how to present multiple DNA match statistics in court, how to testify on the results of computer-based DNA mixture interpretation, and why some DNA interpretation methods are more informative than others.

The presentation will impact the forensic science community by enabling practitioners to introduce in court computer-based interpretation of DNA evidence that can often provide more informative match results.

There is currently no consensus on the interpretation of DNA mixtures. Some groups advocate inclusion methods, while others prefer the likelihood ratio (LR). Key methodological distinctions include the use of qualitative or quantitative peaks, thresholds, and computer mixture interpretation. These issues all appeared in a recent criminal trial, and were integrated in a way that produced a harmonious resolution.

In 2006, Pennsylvania dentist John Yelenic was brutally murdered in his home. State Trooper Kevin Foley, boyfriend of the victim's estranged wife, was arrested for this crime. The major physical evidence was DNA extracted from the victim's fingernails. The STR data generated by the FBI laboratory showed a two person mixture largely containing the victim's own DNA, along with a seven percent unknown second contributor.

The prosecution presented three different DNA match statistics:

• A CPI (inclusion) statistic of 13 thousand was given by the FBI. The CPI method ignored both the victim profile evident in the data, as well as the quantitative peak height information.

• An obligate allele interpretation (subtraction) was done independently by Dr. Cotton. Her method did use the victim profile, though not the peak heights, and produced a match statistic of 23 million. The match improvement came from two loci that had four alleles.

• A quantitative computer interpretation (addition) was reported by Dr. Perlin. This approach used the victim information, together with quantitative peak heights, to produce a match statistic of 189 billion. The genetic calculator employed a comprehensive scientific model of the STR data generation process to infer unknown genotypes.

At the pretrial *Frye* admissibility hearing, it was explained that all three methods were LRs. Each method used progressively more of the evidence data, and all are generally accepted by the relevant scientific community. All methods were admitted into evidence.

At the 2009 trial, the three experts explained their underlying data assumptions to the jury. It was shown how each method analyzed the DNA to infer a genotype (up to probability), and how its LR match statistic followed automatically from the genotype. The jury was shown how a mixture interpretation that uses more of the available evidence becomes a more powerful DNA microscope. While the defense tried to show that multiple match statistics could be confusing, the prosecution's experts demonstrated how multiple interpretations are persuasive. The jury convicted the former trooper of first degree murder.

All three DNA LRs used in this case were correct, although some extracted more match information from the data than others. Given the weakness of the 13 thousand CPI statistic, the multiple DNA statistics proved instrumental in securing a just verdict. The jury had no difficulty understanding the different data assumptions behind each method, and was persuaded that more informative use of the data produced a greater LR. Based on this experience, we suggest that all scientific evidence and interpretations should be presented in court, and that experts withhold nothing from the jury.

DNA Match, Computer Interpretation, DNA Mixture

A79 New York State Police Validation of a Statistical Tool for Genotype Inference and Match That Solves Casework Mixture Problems

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After attending this presentation, attendees will have a better understanding of how expert system software for forensic genetic identity testing laboratories can facilitate analytical workflow by automating data interpretation and eliminating case file technical review bottlenecks while, at the same time, reducing examiner bias, introducing greater standardization, and preserving more identification information.

This presentation will impact the forensic science community by introducing them to the objectivity, time savings, and accuracy an expert software system for forensic DNA data interpretation can lend to their lab.

In today's forensic laboratory, a greater range of crime classifications are being considered for DNA analysis (i.e. property crimes) and ever more challenging evidence items are being submitted (i.e., low copy number). Many labs have responded to this increase in submissions by introducing automation into their workflow. The resultant increase in analytical capacity, in turn, has created bottlenecks at the data interpretation and case file technical review steps. To resolve these bottlenecks, the New York State Police Forensic Investigation Center has undertaken to test whether expert system A is capable of unattended STR DNA data review and interpretation.

In this validation study, re-analysis was made on forty-one adjudicated cases previously analyzed by qualified DNA analysts at the Forensic Investigation Center. To span the range of interpretation challenges commonly encountered in forensic casework, these 41 cases were distributed relatively equally between sexual assaults containing victim and suspect reference samples along with various evidence swabs; and more complex multiple-victim homicides involving upwards of twenty evidence items. A broad spectrum of samples commonly submitted as evidence ranging from vaginal swabs, anal swabs, oral swabs, penile swabs, dried secretions, blood stains, and semen stains; to weapons, cigarette butts, condoms, human hair, bite marks, and fingernail scrapings were included in the study (368 items in total).

The original data files generated by the NYSP were uploaded to expert system A, analyzed, and the data was then returned to the authors for retroactive comparison to the data gleaned from the corresponding case reports issued by the NYSP. Allele concordance was analyzed for all 368 items of evidence, monitored expert system A's ability to deconvolute mixtures across a range of mixing weights and complexities, evaluated the mixing weight percentages determined by expert system A, and compared the statistical weight obtained by traditional means (NYSP protocol) to those calculated by the software**.**

In this study, 4,958 alleles were first analyzed in 202 single-source profiles in forty one previously adjudicated cases, and found the genotypes inferred by the expert system to be in complete concordance. The results of deconvolution of a wide range of mixtures, whether in simple or complex cases, were in accord with those determined using standard validated procedures at the SP Crime lab. Without prior information concerning the STR profile of the suspect, the software effectively ascertained the profile of the perpetrator and, commonly, provided more profile information than the standard non-automated manual process. The software automatically provided likelihood ratios and, in every case examined, preserved more identification information as measured by comparison of match likelihood ratios.

The software conveniently utilizes STR DNA data accepted from in-house genetic analyzers, and, as intended, has demonstrated the potential to relieve bottlenecks due to increased automation. The interpretation of STR DNA data by expert system A offers enhanced objectivity through reduced examiner bias in forensic DNA casework. The software allows the genetic testing laboratory workflow to be designed so that there is no previous exposure of the reporting analyst(s) to the DNA profiles of a suspect or pool of suspects until the laboratory report is prepared. The software achieves greater resolution in deconvolution of mixture profiles than current standard practices. Most importantly, the software offers increased statistical strength.

Bottleneck, Mixture Deconvolution, Expert System

A80 Measure for Measure: A Decade of the Impact of CODIS in Criminal Cases in New York City and Beyond

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After attending this presentation, attendees will have a greater appreciation of the CODIS database. Almost a decade ago, the New York City Office of the Chief Medical Examiner joined CODIS as a local LDIS laboratory. Since then CODIS has been used to serve the people of New York as well as those around the world. This is done through the identification of donors of evidentiary DNA profiles which may aid in investigations. This presentation measures the impact of CODIS on criminal cases in New York City and selected cases presented will demonstrate the direct effects that the database has had in aiding or solving these cases.

This presentation will impact the forensic science community by demonstrating the potential for more cases aided and solved as more DNA profiles from individuals are entered into the databases.

The Combined DNA Index System (CODIS) originated as a software project created by the FBI in 1990. In 1994, The DNA Identification Act gave the FBI authority to establish a National DNA Index System (NDIS) for law enforcement purposes. To this database, labs from around the country upload forensic and offender profiles in an attempt to identify the source of evidentiary samples and connect related cases. In 2000, the New York City Office of Chief Medical Examiner was made a local CODIS laboratory and began uploading evidentiary profiles. As of May 2009, NDIS contained over 7,000,000 offender profiles and 260,000 forensic profiles with CODIS producing over 90,900 hits assisting in more than 89,600 investigations. Of these profiles, New York State has uploaded over 308,000 offender profiles, 26,000 forensic profiles, and has helped to assist in over 7,900 investigations, with over 18,500 forensic profiles and 3,400 investigations aided being produced by the New York City OCME. By the end of 2009, the New York City OCME expects to have contributed 20,000 DNA profiles to the New York City LDIS database.

A correlation can be shown between the number of offender profiles in the New York State database and the number of matches per samples

uploaded from the OCME. For example, from 2002 to 2006, as the number of offender profiles uploaded by the state increased by 72%, the number of OCME matches per profile uploaded increased by 75%. This association has continued as New York has increased the number of offender profiles uploaded since becoming an "all felon" state. Although a majority of the matches obtained by the OCME are profiles with 12 to 14 loci, 8% of matches have been obtained with partial profiles (<12 loci). This means that for New Yorkers, almost 400 investigations have been aided even when only a partial DNA profile could be determined.

Most of the CODIS "hits" to New York City cases have been matches within its own borders and the state of New York, but criminals don't operate in New York alone. A significant number of matches (12%) have come from areas outside of the state, often south along I-95, which runs along the east coast of the U.S. from Maine to Miami. Though many matches come from neighboring states, matches have also come from 34 additional states, Puerto Rico, Canada, and most interestingly, Geneva, Switzerland.

DNA, CODIS, Database

A81 Integration of DNA Authentication Into the Forensic Procedure

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After attending this presentation, attendees will get acquainted with authentication of DNA, an emerging field in forensic science. DNA authentication is a new test that verifies that a DNA sample is genuine, rather than artificially-synthesized, as could be the case as the result of deliberate falsification or inadvertent contamination.

This presentation will impact the forensic science community and the general public by demonstrating that the current standard forensic procedure is incomplete without DNA authentication, and that adopting such an assay for casework samples is necessary for maintaining the high credibility of DNA evidence in the judiciary system.

Over the past twenty years, DNA analysis has revolutionized forensic science, and has become a dominant tool in law enforcement. Today, DNA evidence is key to the conviction or exoneration of suspects of various types of crime, from theft to rape and murder. However, the disturbing possibility that DNA evidence can be faked has been overlooked. It turns out that standard molecular biology techniques such as PCR, molecular cloning, and recently-developed whole genome amplification (WGA), enable anyone with basic equipment and know-how to produce practically unlimited amounts of *in vitro* synthesized (artificial) DNA with any desired genetic profile. This artificial DNA can then be applied to surfaces of objects or incorporated into genuine human tissues and planted in crime scenes.

This presentation will demonstrate that the current forensic procedure fails to distinguish between such samples of blood, saliva, and touched surfaces with artificial DNA, and corresponding samples with *in vivo* generated (natural) DNA. Furthermore, genotyping of both artificial and natural samples with Profiler Plus® yields full profiles with no anomalies.

An authentication assay developed will be presented, which distinguishes between natural and artificial DNA based on methylation analysis of a set of genomic loci: in natural DNA, some loci are methylated and others are unmethylated, while in artificial DNA all loci are unmethylated. Data will be presented from testing of the assay on natural and artificial samples of blood, saliva, and touched surfaces, all with complete success.

Artificial DNA, Methylation Analysis, DNA Authentication

A82 Evaluation of Quantitation Methods for Implementation in Forensic Casework

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After attending this presentation, attendees will be familiarized with the use of Quantifiler® Duo and Plexor® HY and how they compare with each other in performance capabilities and salient features.

This presentation will impact the forensic science community by providing validation data and practical guidance to support use of a robust multiplex DNA quantitation kit.

The quantity of DNA added to an amplification impacts the ability to obtain a usable genetic profile. In forensic biological evidence, the total DNA recovered from a sample can be comprised of human and non-human DNA (e.g., comprised of human and bacterial DNA) and/or can be mixtures of human male and female contributors. The amount of female DNA can be present in excess in mixed samples such that no male DNA profile can be obtained. Therefore, determining the amount of total human and male DNA derived from a sample will enable an analyst to make an informed decision regarding autosomal and Y-STR amplifications. The amount of DNA is important for STR assays because there is a narrow optimal template range for DNA typing.

Quantifiler® Duo is a commercially available kit designed to quantify the concentration of total human DNA and human male DNA simultaneously. The system makes use of three 5' nuclease assays simultaneously in a real time PCR format: a target-specific human DNA assay (ribonuclease P RNA component H1, located on chromosome 14), a target-specific human male DNA assay (sex-determining region Y), and an internal PCR control assay (a synthetic sequence not found in nature). The internal PCR control can be used to assess the presence of inhibitors. The ability to determine optimal template addition and inhibition will enable greater success, potentially reduce labor, cost of supplies, and minimize consumption of evidentiary DNA samples.

Commercially available Plexor® HY is also designed to quantify the concentration of total human DNA and human male DNA simultaneously. The system measures the decrease in fluorescence by utilizing specific interactions between two modified nucleotides, isoC and isoG. The human autosomal DNA target is a multicopy, 99 base pair segment on chromosome 17, while the human male target is a 133 base pair Y-chromosome region. The internal PCR control is a novel 150 base pair sequence. A passive reference is added to each sample, which is used to normalize the data from the other three dyes to this signal.

Human male DNA (from the Quantifiler® Human kit) and K562 DNA (female) were used to assess the sensitivity of detection of the assay and of total human and human male mixtures. In addition, concordance studies were performed. For the sensitivity study concentrations of 50, 12.5, 3.13, 0.78, 0.2, 0.05, 0.012, and 0.003 ng/µl were prepared and analyzed. Duplicate samples were run on separate plates. Mixtures of male:female ratios included 1:1, 1:2, 1:4, 1:8, 1:16, 1:32, 1:64, 1:32, 1:64, 1:128, 1:256, 1:512, and 1:1024. Duplicate samples were run for the

mixture study as well. For the concordance study, selected casework samples from UNTCHI casework that had been quantified previously using Quantifiler® Human were compared with data from Quantifiler® Duo and Plexor® HY.

The results to be presented, in concert with current casework experience, form part of the validation foundation for properly implementing a robust methodology to quantify the amount of total human and male DNA derived from forensic samples.

Quantifiler® Duo, Validation, Casework

A83 Forensic Analysis of *Salvia divinorum* and Related Salvia Species Using Chemometric Procedures

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After attending this presentation, attendees will be familiar with the analysis of the hallucinogen, Salvia divinorum. This will be accomplished by presenting a standardized method to extract salvinorin A, the active constituent, from *S. divinorum*; demonstrating the ability to differentiate *S. divinorum* from other Salvia species based on the presence of salvinorin A; and, demonstrating the use of Pearson product moment correlation (PPMC) coefficients and principal component analysis (PCA) to objectively associate plant materials spiked with *S. divinorum* or pure salvinorin A to *S. divinorum*.

This presentation will impact the forensic science community by enhancing the community's knowledge by demonstrating objective methods for the analysis of this potent hallucinogen.

S. divinorum is a perennial herb whose active constituent, salvinorin A, is considered to be the most potent naturally occurring hallucinogen known. Although the U.S. Drug Enforcement Administration has listed *S. divinorum* under Drugs and Chemicals of Concern, the herb has not yet been federally regulated. Currently, fourteen individual states have regulated either the plant or salvinorin A and fourteen others have pending legislation against its possession. Dried *S. divinorum* leaves are generally smoked; however, spiking *S. divinorum* onto other plant materials, such as marijuana, is also known to occur. In forensic laboratories in states where the plant or its active component are regulated, extraction methods for salvinorin A are widely varied.

Four solvents of varying polarity (methanol, acetone, dichloromethane, and hexane) were evaluated to extract salvinorin A from *S. divinorum*. Gas chromatography-mass spectrometry (GC-MS) was used to analyze the extracts for salvinorin A content. The extraction solvent with the highest extraction efficiency, precision, and stability of the extract was then used to extract salvinorin A from *S. divinorum* for 1, 3, 5, 10, 30, 1,000 minutes, allowing for determination of the optimal extraction time. The optimized extraction method was then used to extract additional *Salvia* species (*S. splendens*, *S. nemerosa*, *S. guaranitica* and *S. officinalis)*. The extracts were analyzed by GC-MS and the chromatograms compared to *S. divinorum*. As salvinorin A is only known to exist in *S. divinorum,* visual differentiation of the *Salvia* species from *S. divinorum* was possible through identification of salvinorin A.

S. divinorum and pure salvinorin A were then spiked, in varying concentrations, onto different plant materials (marijuana, tobacco, and other *Salvia* species). Spiked samples were then analyzed by GC-MS. Data pretreatment, including background subtraction, retention time alignment, and normalization, were performed on the total ion chromatograms to minimize experimental sources of variance that are unrelated to the chemical composition of the spiked extract. Principal component analysis (PCA) was performed and the resulting scores plots (plot of principal component 1 versus principal component 2) were used to associate the spiked extracts to *S. divinorum*. Pearson product moment correlation (PPMC) coefficients were calculated to statistically determine the association of the spiked extracts to *S. divinorum*. Replicates of each plant material were closely associated with each other and the spiked plant materials were closely associated with the replicates of *S. divinorum.* Results of the research will be presented and implications for the forensic analysis of *S. divinorum* will be discussed.

***Salvia divinorum*, GC-MS, Chemometrics**

A84 Validation of Thin Layer Chromatography With AccuTOF-DART™ Detection for Forensic Drug Analysis

Susanne E. Howlett, BA, Fredericksburg, VA 22407*

After attending this presentation, attendees will be familiar with the results of validation for the identification of several pharmaceutical preparations on Thin Layer Chromatography (TLC) plates using the Direct Analysis in Real Time (DART™) ion source and an exact mass, time-of-flight mass spectrometer in conjunction with physical examination.

This presentation will impact the forensic science community by offering the potential benefits of this identification method relative to current pharmaceutical identification methods using TLC and Gas Chromatography-Mass Spectrometry (GC-MS).

At the conclusion of this presentation, attendees will be familiar with the results of validation for the identification of several pharmaceutical preparations on Thin Layer Chromatography (TLC) plates using the Direct Analysis in Real Time (DART™) ion source and an exact mass, time-of-flight mass spectrometer in conjunction with physical examination. The potential benefits of this identification method relative to current pharmaceutical identification methods using TLC and Gas Chromatography-Mass Spectrometry (GC-MS) will also be offered.

Thin Layer Chromatography (TLC) is a technique that is commonly employed in forensic drug analysis. Detection is typically accomplished using various spray reagents – forming visible chromophores indicative of the compounds analyzed. Direct Analysis in Real Time (DART™) is an ionization source, coupled to an accurate mass time-of-flight, mass spectrometer that has the capability to ionize materials in ambient conditions. The AccuTOF-DART™ system is currently used at the Virginia Department of Forensic Science to screen drug samples with identification being made only after the use of other confirmatory techniques.

Analysis of pharmaceutical preparations in Virginia's Department of Forensic Science laboratories begins with the comparison of physical identifiers of the tablet based on the size, color, shape and markings compared with the expected characteristics detailed in the published pharmaceutical libraries. TLC is then employed to separate the components of the preparation and compare the relative retention factor of the sample against the relative retention factor of the standards, with spray reagents used for detection. Once TLC is successfully completed, the sample is then analyzed with GC-MS against the expected standards. Three common pharmaceutical preparations, tablets of codeine,

hydrocodone, and oxycodone mixed with acetaminophen, were chosen for this study.

This study consisted of four main steps: (1) determination of the lower limit of detection (LLOD) of codeine, hydrocodone, and oxycodone standards spotted on TLC plates with detection by DART™; (2) determination of the selectivity of TLC-DART™; (3) DART™ detection of codeine, hydrocodone and oxycodone when dissolved from tablets containing acetaminophen after TLC;, and, (4) reproducibility of the results. In the LLOD portion of the experiment, serial dilutions were made of each standard and spotted onto TLC plates. The plates were then vertically incised, sprayed with 1:25 glycerol in methanol (to enhance detection) and analyzed with the DART™ to determine the best gas heater temperature. The ideal temperature was determined to be 325° C for all three preparations. Additional TLC plates were spotted, incised, sprayed with the glycerol solution and analyzed to determine the LLOD. The LLOD was determined to be 0.3 mg/mL for codeine and 0.5 mg/mL for hydrocodone and oxycodone. For the selectivity determination, standards were obtained for drugs with similar empirical formulae to determine the ability to differentiate them using the TLC-DART™ method. Orifice 1 voltages of 30 V and 90 V were used to give both molecular weight and fragmentation data. While there was some overlap in retention factors for TLC and peaks seen with the DART™, there were enough differences in both the chromatography and the DART™ mass spectra that the combination allowed for specific identification. The detection of codeine, hydrocodone and oxycodone tablets containing acetaminophen was determined by crushing a portion of the tablet and dissolving in an appropriate solvent. TLC plates were spotted, chromatographed, incised, sprayed with the glycerol solution and analyzed to determine if the separation achieved by the TLC baths allowed for the identification of the components of the preparations. Ten replicates were run to test reproducibility. The reproducibility study was repeated twice more on separate days.

The combination of TLC with DART™, after physical examination, streamlines the analytical scheme used to screen and identify pharmaceutical preparations while still meeting the requirements of SWGDRUG guidelines for drug identification. This study validates the use of TLC-DART™ in the forensic identification of the components of several pharmaceutical preparations.

Thin Layer Chromatography, Direct Analysis in Real Time, Mass Spectrometry

A85 Synthesis of Fluoromethcathinones

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After attending this presentation, attendees will have learned how to synthesize fluoromethcathinones and will be familiar with the supporting analytical data for all three structural isomers of the fluoromethcathinones.

This presentation will impact the forensic science community by providing information on the synthesis of 2'-, 3'- and 4'-fluoromethcathinone along with analytical data by GC/MS, ATR-FTIR, 1H-NMR, LC-MS/MS, solubility, and other physical chemical data.

Fluoromethcathinone is an amphetamine-like drug of abuse surfacing in the world of illicit drugs. This emerging cathinone derivative has been seen in both pill and powder form. It is being advertised as a "legal alternative to ecstasy" in online marketplaces in the United Kingdom. Fluoromethcathinone, methcathinone, 4'-methylmethcathinone and 3, 4-methlenedioxymethcathinone are analogs of cathinone that are being used as recreational drugs.[1] These analogs of cathinone have been popularized by their ease of synthesis. Cathinone is the primary central nervous system stimulating component of *Catha edulis,* better known as the khat plant. When the plant matures, cathinone is converted into cathine and norephedrine, which also have stimulating effects. The khat plant is grown mainly in Yemen, Somalia and Kenya and its roots and buds are commonly chewed to obtain euphoric effects.[2] When the leaves dry, they can be used in a tea called Arabian or Abyssinian tea. The khat plant is believed to be brought to the United States by immigrants to help cope with being away from their homelands and families. Internationally, cathinone is a schedule I drug under the Convention of Psycotropic Subtanaces and it is also a schedule I drug under the DEA Controlled Substances Act of 1993.

The fluorine in fluoromethcathinone can be arranged in the 2'-, 3'- or 4'- position of the methcathinone structure. The 4'-fluoromethcathinone is also called "flephedrone". Synthesis of fluoromethcathinones has been done previously with the following yields: 27% of 4'-fluoromethcathinone, 20% of 2'-fluoromethcathinone and 8% of 3'-fluoromethcathinone.[1] In an attempt to increase yields of fluoromethcathinone, sodium carbonate, lithium carbonate or cesium hydroxide were added in equimolar amounts before addition of the methylamine. Sodium carbonate proved to be most beneficial in the synthesis of 4'-fluoromethcathinone with a yield of 73.9%. Yields of 17.4% and 11.6% were obtained with the addition of sodium carbonate for 3'-fluoromethcathinone and 2'-fluoromethcathinone respectively. Lithium carbonate was used in the synthesis of 2'-fluoromethcathinone and produced yields of only 4.5%. Since lithium carbonate was not advantageous in the 2'-fluoromethcathinone synthesis, it was no longer used in further synthesis of fluormethcathinones.

Confirmation of the presence of the fluoromethcathinones was done by ATR-FTIR and gas chromatography/mass spectroscopy and compared to previous results.[1] A 30 meter methylsilicone (0.25 mm x 0.025 um) capillary column was used which yielded retention times of the compounds as follows: 10.123 minutes – 4'-fluoromethcathinone; 10.197 minutes – 3'-fluoromethcathinone; 10.264 minutes – 2'-fluoromethcathinone. Major fragmentation of fluoromethcathinone includes the ions *m/z* 58, *m/z, 95* and *m/z* 123. In 2'-fluoromethcathinone *m/z* 56 is present instead of *m/z* 58 which correlates with previous data from R.P. Archer.[1]

H-NMR, LC-MS/MS, solubility, and other physical chemical data will be presented.

References:

1 Archer RP. Fluoromethcahinone, a new substance of abuse. Forensic Sci Int 2009;185:10-20.

2 Feyissa AM, Kelly JP. A review of the neuropharmacological properties of khat. Progress in Neuro-Psychopharmacology and Biological Psychiatry 2008;32:1147-1166.

Fluoromethcathinone, Cathinone, Gas Chromatography/Mass Spectroscopy

A86 Microcrystal Analysis of Cocaine Hydrochloride and Added Adulterants

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After attending this presentation, attendees will have a basic understanding of microcrystal tests, the effect of adulterants on cocaine microcrystal morphology, and general trends to observe when performing microcrystal tests on cocaine.

This presentation will impact the forensic science community by shedding new light on an old technique by showing trends in crystal behavior of cocaine when diluted with common adulterants. It will demonstrate that microcrystal tests are specific enough to be used in drug analysis. The techniques developed in this project have potential application in drug profiling to track both local and international trafficking patterns.

Microcrystal analysis of drugs, once used as a confirmatory test, has gradually been replaced with more sophisticated technology; however, these tests still have a place in forensic labs. The objective of this project was to investigate the changes in the crystal morphology of cocaine in the presence of the common adulterants, caffeine and lidocaine.

The observed changes in the morphology of the cocaine crystals were unique to both the specific adulterant and the concentration of that adulterant. Similar trends were seen for aqueous and powder samples. Cocaine/caffeine mixtures can be identified by the appearance of curved short axes. The degree of curvature increases with caffeine concentration, until at fifty percent caffeine, sphere shaped branched crystals appear. The crystal formation was also delayed in the presence of caffeine.

Unlike caffeine, the changes in crystal morphology of cocaine in the presence of lidocaine were seen immediately. Lidocaine adulterant can be identified by longer, thinner crystals with an X-shaped short axis. As the lidocaine concentration increases, the crystals become x-shaped and at fifty percent lidocaine, the crystal form an X with the presence of few non-branched spherical crystals.

The results show that the cocaine crystal morphology does change in the presence of an adulterant. Distinct trends were observed with each adulterant at each concentration.

Current work on this project includes examining the crystal habit of cocaine mixtures of procaine, benzocaine, table sugar, baking soda, and levamisole.

Microcrystal, Cocaine, Adulterants

A87 Exploration of Cocaine Contamination of United States Currency – Continuing Studies

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The goals of this presentation are to continue the development of the understanding of the contamination of U.S. currency resulting from illicit cocaine trafficking, as well as to introduce a survey of several foreign currencies for similar contamination; and to offer a mathematical model which seeks to assign a numerical probability of drawing from currency in general circulation bills contaminated at the levels quantitated in evidence submissions to the FBI Laboratory associated with forty criminal investigations involving drug trafficking and money laundering.

This presentation will impact the forensic science community by providing information on an analytical protocol developed for quantitation of loosely-bound cocaine residue levels on currency, and a mathematical model offered regarding the interpretation of the resulting values for U.S currency.

This study, early results of which have been reported to the Academy (1997 and 2003), had its beginnings in response to a 1994 decision by the 9th Circuit Court of Appeals in the case of U.S. v. U.S. Currency (Alexander), 39 F.3d 1039, in which the court(s) acknowledged the wide-spread contamination of the U.S. currency supply by the illicit cocaine importation trade. The argument has been put forth and a former FBI Laboratory forensic examiner, successfully so during expert witness testimony in federal court on several occasions, that the absolute amount of the drug on currency, and not its mere presence, is probative.

The ink on U.S. currency never really dries. In effect, one can conceptualize currency as in a microscopic sense a “sticky” surface on to which, as it is circulated, various oils (e.g., human sebaceous) and miscellaneous environmental dirt and grime (including residue amounts of drugs of abuse) become attached. In the case of cocaine, a person who has handled the drug the then handles currency transfers residue in the low hundreds of nanograms range to the bill(s), and that this amount over the course of subsequent circulation and manipulation is reduced to a steady state “background” level.

A study has recently been completed of the currency in general circulation in the U.S. Quantifiable levels of cocaine have been encountered on more than ninety percent of the bills thus far examined. Because it is unlikely that members of the illicit drug trade have actually physically handled this volume of bills, it was presented during a 1997 presentation to the Academy that some other agent is responsible for the extent of the distribution of the drug on currency in general circulation, in particular submitting that this agent is the mechanical currency counters which are universally employed in financial institutions have had a “homogenizing” effect on the currency supply.

The sampling aliquot for this study is $1,860, which translates to ten bills of each common U.S. currency denomination ($1, … $5, … , $100). Thus results are reported by location and by denomination. The initial screening is performed with a Barringer Instruments IONSCAN ion mobility spectrometer (IMS), an instrument with nanogram sensitivity for a number of the commonly encountered drugs of abuse, and cocaine in particular. Confirmation and quantitation is accomplished using liquid chromatography-mass spectrometry- mass spectrometry (LC/MS/MS) on

an Applied Biosystems API4000Q instrument with Shimadzu LC. A deuterated internal standard is introduced in the extraction solvent in the initial step of the quantitation process so as to eliminate potential errors associated with subsequent manipulations. Currency aliquots from some 70 locations in 42 states have been surveyed (quantitated). In addition, currency from on the order of ten foreign countries has been similarly surveyed.

Following plotting of the background currency data (frequency as a function of contamination level in ng/bill) the equation of the resulting curve has been established and the function then normalized. Integration from zero to a particular contamination level, i.e., one from a given criminal case, with subsequent subtraction from 1.00, estimates the probability of drawing a bill from general circulation contaminated to that particular extent or higher.

Cocaine Residue Recovery, Quantitation of Cocaine on Currency, Interpretation of Cocaine Currency Contamination

A88 The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG)

Scott R. Oulton, BS, Southwest Laboratory, 2815 Scott Street, Vista, CA 92081*

After attending this presentation, attendees will discuss the current status of SWGDRUG's work products. Representatives from the SWGDRUG Core Committee will answer questions and address the concerns of the attendees.

This presentation will impact the forensic science community by providing the current work products by SWGDRUG as it relates to the analysis of seized drugs.

The objective of this presentation is to update forensic drug analysts on recent work products from the Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG). Currently, SWGDRUG is working on the following topics:

- Examples for the estimation of uncertainty of measurement in weight determinations;
- Revising/updating current SWGDRUG Recommendations;
- Developing standard training competencies.

These topics have been widely discussed in the forensic science community. During this presentation, the current status of SWGDRUG's work products will be discussed. Representatives from the SWGDRUG Core Committee will answer questions and address the concerns of attendees.

In past presentations to the American Academy of Forensic Sciences, a synopsis of the history of SWGDRUG and goals of the core committee have been presented. This year's presentation will focus on the specifics described above. However, the following information is presented here for those unfamiliar with the SWGDRUG process. SWGDRUG has been in existence since 1997. The mission of SWGDRUG is to recommend minimum standards for the forensic examination of seized drugs and to seek their international acceptance.

The objectives of SWGDRUG are the following:

- Specifying requirements for forensic drug practitioners' knowledge, skill and abilities;
- Promoting professional development;
- Providing a means of information exchange within the forensic science community;
- Promoting ethical standards of practitioners;
- Providing minimum standards for drug examinations and reporting;
- Establishing quality assurance requirements;
- Considering relevant international standards; and,
- Seeking international acceptance of SWGDRUG recommendations.

The SWGDRUG core committee is comprised of representatives from federal, state and local law enforcement agencies in the United States, Canada, Great Britain, Germany, Japan, Australia, the European Network of Forensic Science Institutes (ENFSI), the United Nations Drug Control Program (UNDCP), forensic science educators, the American Society of Crime Laboratory Directors (ASCLD), ASTM, and the National Institute of Standards and Technology (NIST). Published recommendations are available on the SWGDRUG website located at: www.swgdrug.org.

Analysis of Drugs, SWGDRUG, Seized Drugs

A89 PCR Optimization of a Highly Polymorphic Marijuana STR Locus on Collection Cards for High-Throughput Screening

Heather M. Coyle, PhD, University of New Haven, Forensic Science Department, 300 Boston Post Road, West Haven, CT 06516*

After attending this presentation, attendees will have a better understanding of evidence archival for plant DNA and how plant DNA can be useful as forensic evidence.

This presentation will impact the forensic science community being that this is the first time collection cards and automation for plant data basing has been presented in a useful forensic context that could be implemented in all forensic laboratories and for crime scene personnel for marijuana typing.

The genetics of marijuana has long been undefined and a better understanding of the different relationships of *Cannabis* cultivars would be useful in trying to understand different grow operations and for tracing drug distribution patterns. As such, a DNA-based bioinformatics classification program using a variety of genetic markers and methodologies is being initiated. A series of different markers have been identified and published in the scientific literature in recent years; however, evaluating which markers would be ultimately the best to use (based on power of sample discrimination) is challenging at the population level. A polymorphic hexanucleotide repeat STR locus (NMI01) was selected as a genetic marker to screen our samples for initial classification by DNA. As our samples are sorted into groups, we will add more markers to determine if further individualization of the samples can be accomplished as deemed necessary from the data.

As an initial step, one goal was to define a convenient, long-term archival system for plant DNA typing of marijuana (*Cannabis sativa* L.). Forensic evidence collection and archival of plant evidence is typically performed by collecting leaf samples in coin envelopes and air drying the sample for later trace evidence analysis. Collection cards, however, are utilized for human DNA database archival of blood and saliva fluids and are considered valuable for long-term preservation of DNA evidence and for high through-put processing by PCR. Samples on these cards are stable for several years at room temperature storage. These cards are also pre-treated with chemicals that lyse cells, denature proteins and protect nucleic acids from nucleases, oxidation and ultra violet irradiation damage as well as preventing mold and bacterial growth.

Collection cards were selected and utilized the manufacturer protocol for preparation of a 3 mm diameter punch removed from the card after the plant leaf had been applied to the card. This preparation procedure took approximately 30 - 60 minutes to perform for sample batches of ten samples at a time, processed by hand. As long as green material from the fresh leaf was visibly transferred, a DNA profile was obtained from the card punch. Further parameters such as size of card punch, number of reagent washes and time between drying the punch and performing PCR will be assessed to determine if processing time can be shortened.

For the PCR reaction, a PCR kit was utilized and supplemented with custom-labeled PCR primers and PCR conditions as specified in Hsieh et al., 2003.[1] In order to conserve reagents, the PCR reaction volume for the kit was reduced in-scale from 50 to 25 microliter reaction volumes without any effect on profile quality. As a positive control, fresh bud marijuana material was used that genotyped consistently as a 22/26. Ivy (*Hedera helix L.*) and catnip (*Nepeta cataria*) were used as negative card controls. Results show that collection cards are a simple and effective means for capturing plant nucleic acids and for simplifying marijuana genotyping for high throughput processing by PCR. Further steps to stream-line processing with collection cards will be reviewed. In addition, the level of genetic diversity that we identify within our sample database with the NMI01 locus will be discussed and compared against other published data sets.

Reference:

[1] Hsieh et al. 2003. A highly polymorphic STR Locus in *Cannabis sativa*. Forensic Science International. 131: 53-58.

Cannabis, Plant, DNA

A90 Development of PAH-SPME Phases for the Forensic Science Application of Selective Absorption of Nitroaromatic Explosives

Jana A. James, BS, The Pennsylvania State University, 107 Whitmore Laboratory, University Park, PA 16802; and Dan G. Sykes, PhD, The Pennsylvania State University, 330 Whitmore Laboratory, University Park, PA 16802*

After attending this presentation, attendees will have a better understanding of solid phase microextraction (SPME) and the unique selectivity that polyaromatic hydrocarbons (PAH) have for nitroaromatic explosives. This presentation will also discuss the development of homemade SPME fibers, sampling and analysis techniques. Lastly, the presentation will project the future integration and impact this technique will have on the forensic science community.

This presentation will impact the forensic science community by demonstrating the there is an increasing need for a cost efficient, environmentally friendly technique that can detect a broad range of explosive compounds effectively to ensure the future safety of the American people. With the events of September 11 and the increase of national threats, the homeland security agency has developed a series of scientific devices to hinder and absolve these types of events in the future. The current security explosive detection methods, such as ion mobility spectrometry and canine detection units, are tuned to only a small band of compounds.

Solid-phase micro-extraction (SPME) has found widespread use in the extraction of volatile and semi-volatile compounds from environmental matrices. SPME is a rapid, re-usable, environmentally-benign and a cost-effective, field sampling technique when compared to liquid-liquid extraction and solid phase extraction. The basis for SPME is the use of a small- diameter, fused silica fiber coated with a polymer that has strong affinity of the target analytes. Commercially-available polymers include polydimethylsiloxane (PDMS), polyacrylate, and carbowax among others. Once the analytes are adsorbed onto the surface of the coating, removal requires chemical or thermal desorption. As such, SPME is typically coupled with either gas chromatography or high-pressure liquid chromatography for the separation, identification and quantitation of adsorbed analytes. The development of efficient and sensitive analytical methods to detect and quantify trace amounts of explosives and explosive residues is significant both for environmental protection and public security agencies.

Phase I: Explosives Selectivity – The initial work of this project focuses on developing new pyrene-, phenyl- and phenoxy- based stationary phases bonded to silica substrates. The commercial Supelco phase, Ascentis Butylphenyl, synthesized for high pressure liquid chromatography columns is particularly selective toward aromatic analytes that have electron withdrawing groups attached to the aromatic ring. This is believed to be caused by strong p-p interactions between the phenyl phase and the analytes. The enhanced selectivity of the phenyl phase may provide unique applicability for HPLC as well as SPME applications for components of explosive mixtures that contain nitro aromatics. Extending the stationary phase chemistry to include poly aromatics will potentially yield the same selectivity advantage, or better, but with the added benefit that poly aromatic compounds are fluorescent.

Phase II: SPME Extraction – The fiber coating process begins with the addition of a platinum catalyst to a linear polymer, PDMS. This will then start a reaction that will crosslink the PDMS with the PAH phase that has been added simultaneously. This process creates a three dimensional polymer with a high molecular weight. Also, the platinum catalyst induces a hydrosilation reaction to remove any double bonds within the polymer chain and increase the dimensions. The poly-aromatic phases are covalently bonded to the oxygen group on the surface of the fused silica fibers through a coating process. Once the fiber is evenly coated with the PDMS/PAH phase, the high molecular weight of the polymer will give the coating the ability to withstand the degradation of the organic solvents that the fiber may be subjected to during sampling or analysis. This characteristic will allow the fiber to have an indefinite lifetime and increase the recycling aspect of the fiber after complete chemical or thermal desorption.

Phase III: Explosives Detection – It is a well known verity that nitro aromatics quench the fluorescence of poly aromatic compounds. However, the mechanism for fluorescence quenching is not completely understood. The high degree of selectivity of the synthesized poly aromatic silanes towards nitro aromatic compounds translates into a corresponding unique fluorescence (or fluorescence quenching) signature. This study will collect the emission spectra of the synthesized poly aromatic silanes in the absence, and in the presence, of nitro aromatic compounds.

The PAH silane-based SPME fibers serve a dual purpose: (1) fluorescence quenching of the PAH silane by nitro-aromatics can be monitored by attaching the fiber to a field-portable fluorimeter allowing real-time quantitative detection of nitro aromatics in ambient air; and, (2) the analytes can be thermally or chemically desorbed from the fiber upon return to the laboratory and undergo “normal” chromatographic analysis.

The principal goal of the research is to develop a suite of silane coatings with a high-degree of selectivity towards specific nitro aromatics and/or develop a mixed-mode phase (PDMS/PAH) with broad selectivity

and use multiple component analysis to recover individual analyte species. The forensic application of these PAH fibers could lead to future validation studies confirming accelerant canine detection alerts and aid in the screening process by airport security agencies.

Nitroaromatic Explosive Compounds, Solid Phase Microextraction, Public Security

A91 Competitive Adsorption of Ignitable Liquids on Charred Wood

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After attending this presentation, attendees will have learned about the complications that may arise in the analysis of ignitable liquids extracted from charred wood in fire debris (arson) cases. An understanding of the complications that result from this problem may assist an analyst to more thoroughly understand the results obtained from the analysis of certain fire debris samples.

This presentation is from results of a study that qualitatively examined the complications associated with the extraction of ignitable liquids onto carbon strips from heavily charred wood. The charred wood has a potential to retain ignitable liquid residues resulting in skewed chromatographic patterns of the liquids, or compete for vapors in the headspace above the debris, either of which can prevent an analyst's from properly classifying the residue per ASTM criteria. This presentation will impact the forensic science community by examining these effects and documented the skewed patterns, which in practice, can be used to explain unexpected variations of peak ratios of compounds of ignitable liquids adsorbed onto carbon strips from heavily charred wood. It is desirable for the fire debris chemist to be familiar with the criteria necessary for the proper identification of ignitable liquids as well as understand the factors which may cause variations from the expected norms.

Fire debris is most often analyzed for ignitable liquids in the forensic laboratory using an ASTM extraction method which utilizes a heated passive adsorption onto activated charcoal strips. Identification of the extracted ignitable liquid residues is accomplished by ASTM E-1618 test method which employs gas-chromatographic-mass spectrometry as a separation, detection, and classification technique for ignitable liquids. A fairly strict set of data interpretation guidelines are used in the reporting and classification of ignitable liquids. Data interpretation is often complicated by the presence of background hydrocarbons, combustion products, and pyrolysis products making it difficult to distinguish even common products, such as gasoline, from the complicated chemical profile of the fire debris. Typically these interfering compounds are the same compounds that comprise the ignitable liquid. The problem presented by charred wood in fire debris is that the ASTM extraction technique is using charcoal, essentially the same material as charred wood, as the receptor or absorbent medium to capture the vapors of the ignitable liquid as it heats during extraction. The process is further complicated because charred wood seems to also selectively retained compounds of ignitable liquids. This study qualitatively looked at the competitive adsorption and retention of volatile compounds on charred wood and the variation of compound ratios typically used by the fire debris analysts in the interpretation, classification, and reporting of ignitable liquids. Various types of wood and varying degrees of charring were variables studied in the project. Some attention was also given to the affects of temperature and length of extraction on the recovery of the ignitable liquid. Additional work was performed using different classes of ignitable liquid products (such as distillates) to see if or how the presence of charred wood affects these products.

Fire Debris, Competitive Adsorption, Ignitable Liquids

A92 Chemical Agents for Use in Preserving Fire Debris Evidence Against Microbial Degradation

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After attending this presentation, attendees will understand the concept of microbial degradation and what chemicals can stop this process and help preserve fire debris evidence.

This presentation will impact the forensic community and the justice system by suggesting means for stopping microbial degradation, which will allow forensic chemists to determine that an ignitable liquid is present and what type of ignitable liquid it is.

The analysis of ignitable liquids, like gasoline, is an important part of the investigation into arson cases. Even after a fire, there can be ignitable liquids still present on materials, including on the surrounding soil. Samples collected at the crime scene usually sit for some time until they can be analyzed. Over time, microorganisms in the soil have been thought to degrade the ignitable liquids to the point where they can no longer be identified. This is problematic for forensic scientists as evidence often times will be allowed to sit for days or weeks before it is analyzed.

Suggested methods for preserving evidence include freezing at -5°C, autoclaving, and using acidic slurry with sodium bisulfate. However, these methods are not practical in a forensic science laboratory. Cold storage would require too much space, autoclaving samples containing ignitable liquids could result in the loss of that ignitable liquid, and creating an acidic slurry would require a large amount of sodium bisulfate. Furthermore, microbial degradation has already begun by the time the samples reach the laboratory, so a method for inhibiting microbial degradation should be applied in the field. The suggested methods are not applicable on site, which also makes these methods unfavorable for use in stopping microbial degradation. However, other chemical agents that are readily available to fire investigators could provide a solution to the microbial degradation.

Bleach, Lysol®, and 3% hydrogen peroxide have been tested in minimal media with soils gathered in winter and summer. An assay using 0.2, 0.4, 0.6, 0.8, and 1mL (3% H_2O_2 only) of each chemical in 10 mL of minimal media inoculated with 10µL of bacteria from the soil. These experiments were also repeated but instead of adding the chemical at the same time as the bacteria, the cultures were allowed to grow for 72hr before the chemical agent was added. 2% bleach was enough to prevent growth in both the cultures from summer and winter soil, whereas 4% was required in order to kill the microbes in both cultures from summer and winter soil. For Lysol, growth was prevented in winter soil cultures with 8% Lysol® for 72hrs. However, after a week growth was present in all cultures. For 3% hydrogen peroxide, 0.06% was enough to prevent

growth, but even the 0.3% was not enough to kill the microbes.

Headspace GC/MS was also used to analyze cultures with gasoline and gasoline, bacteria, and the chemical agent in minimal media to determine if the chemical agent was successful in preventing microbial degradation of the gasoline. Other household chemicals will also be tested.

Chemical Agent, Fire Debris, Ignitable Liquid

A93 Prediction and Standardization of Fire Debris Evaporation Patterns With the Advanced Distillation Curve

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After attending this presentation, attendees will have an understanding of the importance of evaporation patterns, the capabilities of the Advanced Distillation Curve (ADC) technique, the huge variation in accelerants, and the use of equations of state to predict such variations.

This presentation will impact the forensic science community because it is impossible on a practical level to know a priori the evaporation patterns of all potential accelerants, but the ADC and its link to fluid theory can provide such information in a validated database (i.e., math is cheaper than chemistry).

As pointed out by the recent National Academy of Sciences report on forensic sciences, the study of fire patterns and debris in arson fires is in need of additional study and standardization. Part of the difficulty is in determining the appropriate suite of analytes for which to focus fire debris analyses. This has been done with time consuming accelerant weathering or evaporation studies.

In this presentation, a recently introduced method will be discussed that has the potential of providing predicted evaporation patterns for accelerants. The method is complex fluid analysis protocol called the advanced distillation curve (ADC) approach, which features: (1) a composition explicit data channel for each distillate fraction (for both qualitative and quantitative analysis); (2) temperature measurements that are true thermodynamic state points that can be modeled with an equation of state; (3) temperature, volume and pressure measurements of low uncertainty suitable for equation of state development; (4) consistency with a century of historical data; (5) an assessment of the energy content of each distillate fraction; (6) trace chemical analysis of each distillate fraction, and, (7) a corrosivity and stability assessment of each distillate fraction.

As applied to accelerants, the method allows the rapid prediction of the evaporation or weathering pattern as a function of temperature. This is done by measuring the boiling curve and along with it a composition explicit data channel. It is this channel, provided by any analytical technique that one cares to apply, that furnished the predicted evaporation pattern. Access to the qualitative and quantitative composition data can also provide an enthalpic analysis of the accelerant, as well as trace analysis of constituents that can serve as taggents. The application will be discussed of the method to kerosenes and gasolines, and outline how expansion of the scope of fluids to other accelerants can benefit the criminalist in the analysis of fire debris for arson. We also describe the existing database of accelerants that has been measured, and the potential for additional measurement parameters that can be added to the protocol.

Accelerants, Evaporation Patterns, Fire Debris

A94 Detection and Forensic Analysis of Triacetone Triperoxide (TATP) in Uninitiated and Initiated Samples

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After attending this presentation, attendees will have learned about current analytical methods used for the analysis of triacetone triperoxide.

The presentation will impact the forensic science community by teaching new methodology in explosives analysis.

Triacetone triperoxide (TATP) is a cyclic organic peroxide that is extremely unstable and is classified as a primary explosive. TATP has been used frequently by Palestinian extremists in improvised explosive devices (IEDs) against Israeli military and civilian targets for over twenty five years. TATP use in terrorist attacks has not been limited to just the Middle East. Over that past ten years TATP has been linked to bombing attacks, and attempted attacks, in Asia, Europe, and the United States. Research at the National Center for Forensic Science (NCFS) has focused on both the detection and the forensic analysis of uninitiated and initiated TATP samples, as well as the characterization of precursor chemicals used in the synthesis of TATP.

Optimized methods have been developed for the detection of TATP using gas chromatography mass spectrometry (GC-MS), electrospray ionization mass spectrometry (ESI-MS), atmospheric pressure chemical ionization mass spectrometry (APCI-MS), and ion mobility spectrometry (IMS). Our optimized GC-MS method, utilizing a lower source temperature and injection port temperature, has yielded picogram levels of detection for TATP using both electron ionization and chemical ionization. Analysis of TATP by GC-MS using chemical ionization with ammonia as the reagent gas is the preferred method as it not only gives detection at the picogram level, but also provides a diagnostic $[TATP+NH_4]^+$ ion. This method has also been successful in identifying diacetone diperoxide (DADP) and the cyclic tetramer tetraacetone tetraperoxide (TrATrP) via their ammonium adduct ions. Detection of TATP by ESI-MS and APCI-MS gave higher limits of detection, but these methods proved to be more sensitive in the detection of linear oligoperoxides that are formed in the TATP synthesis reaction and often present in the final “crude” product.

Rapid detection of TATP, both solid and vapor samples, has been achieved using ion mobility spectrometry (IMS). Though detection of TATP in the negative ion mode is possible, detection in the positive ion mode gave better limits of detection by at least one order of magnitude. Field detection of TATP was performed on post-blast samples by directly swabbing the debris, and by sampling the headspace over the debris.

Forensic analysis of TATP samples to obtain information about the precursor chemicals used in its synthesis was also investigated. Acetone obtained from twenty seven different commercial sources was used to synthesize TATP. Many of the acetones contained organic additives and impurities that were found to carry through the synthesis reaction and could be detected in the final TATP product by GC-MS analysis using electron ionization. In some cases the additives could be detected in post-blast samples.

The influence of the acid used to catalyze the TATP reaction was also investigated. TATP was synthesized using H_2SO_4, HCl, HNO_3, H_3PO_4, CH_3CO_2H, and $SnCl_5$ as the acid catalyst. In some cases samples could be discriminated based on the acid used to catalyze the synthesis reaction.

To confirm results obtained from microscale syntheses, large scale

syntheses (2g-88g) of TATP were also performed. Detonation of these large scale synthesis samples were conducted in the field at a test range, and post-blast samples were collected and analyzed both in the field and later in the laboratory.

Views presented do not reflect the position of the government or infer endorsement.

Triacetone Triperoxide, Analytical Chemistry, Trace Evidence

A95 Analysis and Potential Differentiation of Soot From Different Fuels Using Laser-Induced Thermal Desorption Fourier Transform Mass Spectrometry (LITD-FTMS)

Katherine Hutches, MSFS, Donald P. Land, PhD, and Diana Wang, University of California at Davis, One Shields Avenue, Davis, CA 95616*

After attending this presentation, attendees will have been familiarized with laser-induced thermal desorption (LITD) coupled with FT-MS, pyrolysis products of common fuels, soot formation mechanisms, and the application of LITD-FTMS for the analysis of soot deposited onto glass surfaces.

This presentation will impact the forensic science community by introducing its members to a new analytical technique and the potential applications of this technique to surface and soot analysis.

This study seeks to determine whether LITD-FTMS can be used as a tool for the analysis of soot deposited onto glass surfaces during compartment fires. Fire debris chemists have long recognized the presence of varying pyrolysis products from different fuels, such as styrene from polystyrene and nitrogen-containing compounds from polyurethane. If the soot and soot-adsorbed species that deposited onto glass surfaces were likewise different from one fuel to another, then it might be possible to differentiate between fuel sources, and possibly determine the order of deposition (and first fuel), using this surface-analyzing technique.

The deposits from polystyrene, flexible polyurethane foam, and gasoline have been analyzed and compared for visible "marker" peaks. Polyurethane is easily distinguished by peaks at *m/z* 122 and 148, which correspond to toluene diamine (TDA) and toluene aminoisocyanate (TAI) respectively. These are known pyrolysis products of flexible polyurethane foam, which is typically based on toluene diisocyanate (TDI). The polystyrene and gasoline deposits share many peaks in their mass spectra, which vary greatly with incident laser power density. High power densities yield mainly low-*m/z* peaks that may be attributed to the $C_{2n}H_{2m}??^{+}$ ions predicted by the hydrogen-abstraction C_2H_2-addition (HACA) theory of soot formation. At low incident laser power densities, both fuels yield spectra dominated by aromatic compounds such as benzene, naphthalene, and other conjugated ring systems. At these low incident power densities, the spectra for gasoline deposits are dominated by a large peak at *m/z* 202, which may be attributed to several isomers of $C_{16}H_{10}$. This peak is typically significantly smaller for the polystyrene deposits. The relative abundance of other peaks, such as *m/z* 91 and 128, is also a potential indicator of the identity of the initial fuel. The first laser shot in a given location typically yields the greatest relative abundance of high-*m/z* peaks, with later laser shots yielding a range of compounds.

Simple two-layer samples are also prepared and likewise analyzed. Where one layer contains polyurethane deposits, this layer is easily distinguishable by the TAI and TDA peaks. The gasoline and polystyrene layers are more difficult to distinguish, in some cases being inseparable using only the markers noted in earlier portions of the study. It is noted that as successive laser shots are fired in the same location, the peaks from the topmost layer are often visible in spectra from later laser shots.

While the single-component samples are separable using this method, further method development will be required before this method can become a viable tool for the analysis of more complicated layered samples, which would be necessary for fire investigation. Towards this end, some initial analyses of single-component samples using principle component analysis will be presented.

Soot, Fourier Transform Mass Spectrometry, Laser

A96 Analysis and Detection Limits of Smokeless Powder Components by Capillary Electrochromatography – Time-of-Flight Mass Spectrometry

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After attending this presentation, attendees will have learned how the components of commercial smokeless gunpowder can be detected and identified using capillary electrochromatography – mass spectrometry (CEC-TOF-MS).

This presentation will impact the forensic science community by providing the details of a fast and robust analytical method requiring minimal sample preparation that avoids the sample instability and degradation that can occur with methods such as gas chromatography. In this process, unburned particles of smokeless powder such as those that might be found at a bombing scene are analyzed in an attempt to associate evidence found at the crime scene to a particular brand or lot of powder. Using the data obtained from this analysis, investigators may be able to generate leads or narrow the number of potential sources of the smokeless powder used in the bombing.

A mixed standard of commonly found smokeless powder additives was prepared by dissolving 1.0 mg of each standard in 1.0 ml of methylene chloride. A standard calibration curve was prepared by measuring an aliquot of each standard, evaporating the methylene chloride, and reconstituting the sample in a run buffer. Samples were run by capillary electrochromatography on a hexyl acrylate-based monolith. All standards were analyzed with an Agilent capillary electrophoresis unit run in CEC mode, connected to an Agilent time-of-flight mass spectrometer (TOF-MS). Detection limits were determined for eleven compounds found in smokeless powders: nitroglycerin, diphenylamine, dimethylphthalate, diethylphthalate, dibutylphthalate, methyl centralite, ethyl centralite, 2-nitro- and 4-nitrodiphenylamine, and 2-nitroso- and 4-nitrosodiphenylamine.

The use of CEC-TOF-MS represents a promising analytical scheme for the detection, identification, and quantitation of smokeless powder components. It is a fast, reproducible technique for the discrimination of smokeless gunpowder that avoids the problems presented by the breakdown of thermally labile components of smokeless powder during GC-MS analysis. Resolution in the CEC mode is high and sample preparation requirements are minimal.

Smokeless Powder, CEC-TOF, Improvised Explosive Device

A97 A Proposed Mechanism for the Trichloro Triazine Trione/Isopropanol Reaction with Regards to Its Use in the Construction of Chemical Reaction Bombs

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After attending this presentation, attendees will have a better understanding of the mechanism involved in the reaction between trichlor triazine trione based chlorine tables and isopropyl alcohol with regards to their use in the construction of chemical reaction bombs.

This presentation will impact the forensic science community by providing data related to the analysis and detection of residues from chlorine tablet/isopropyl alcohol based chemical reaction bombs.

Also known as pop bombs and bottle bombs, chemical reaction bombs are not all that new to the forensic laboratory. These devices and their remnants have been encountered for numerous years. Within recent memory however, the number of submissions involving these devices has been steadily on the rise. Reasons for this may be attributable to the presence of numerous recipes on the internet with available video documentation on their construction, the overall ease of construction, and the fact that they can be manufactured with materials that are either on hand already or can be obtained at just about any local store.

At first glance, such devices would appear to be relatively harmless. Since they consist of nothing more than either a single compound or a mixture that can produce large volumes of gas and a sealable container (typically a soda bottle), one might be led to believe that these devices are nothing more than a simple nuisance. To the contrary, these devices can present a significant danger to anyone in their immediate vicinity when they explode. The forces involved can have surprising effects and the substances that are either used in their construction or evolved during the reactions that take place can be highly acidic, strongly basic, or toxic. Combine these features with an inherent unpredictability and it should become obvious why such devices should be treated as dangerous.

Some of the more common components of these devices include dry ice, which acts simply through sublimation, hydrochloric acid and aluminum foil, which produces large volumes of hydrogen gas, and sodium hydroxide and aluminum foil, which also produces large volumes of hydrogen gas. Another popular mixture that is often encountered is the addition of isopropyl alcohol to pool chlorine tablets, the primary ingredient of which is trichloro triazine trione (also known as symclosene and trichloro isocyanuric acid). When mixed together, these two compounds rapidly react in an exothermic fashion to produce a large volume of gaseous product. If confined in a vessel such as a soda bottle, pressure will build rapidly until the confinement capacity is reach at which point the vessel will rupture with forceful consequence.

The goal of this research was to attempt to elucidate the mechanism involved in the exothermic chemical reaction between trichloro triazine trione and isopropyl alcohol. By mapping out this mechanism it is thought that a better understanding of the types of by-products produced could be obtained. If armed with such knowledge it might be possible to devise better methods for the detection and identification of the residues involved. Preliminary research indicated that an oxidation reaction was taking place in which the isopropyl alcohol was being converted to acetone. In order to test this hypothesis, carefully controlled quantities of reactants were mixed together and the reactions that took place were carefully monitored. The reaction products were then characterized using a combination of gas chromatography/mass spectrometry, scanning electron microscopy-energy dispersive spectrometry, Fourier transform infrared analysis, and X-ray diffraction. Based on the results obtained using these analytical techniques and observations of the reactions themselves, a possible reaction mechanism was thus constructed.

This presentation will discuss the methods that were employed to achieve this goal and the results that were obtained. In addition to the information pertaining to the mechanism, a brief discussion on the products obtained and their analysis will also be provided.

Chemical Reaction Bomb (CRB), Chlorine Tablet/Isopropyl Alcohol, Reaction Mechanism

A98 An Evaluation of the Stability of Seminal Fluid in Condoms

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After attending this presentation, attendees will have a better understanding of the underlying mechanisms of the stability of semen stored in condoms.

This presentation will impact the forensic science community because the ability to recover spermatozoa from the seminal fluid in condoms holds significant implications to forensic investigations. The identification of spermatozoa serves to confirm the presence of semen while the genotyping of the spermatozoa serves to identify the semen donor.

Used condoms are routinely found at crime scenes. The ability to recover spermatozoa from the seminal fluid in condoms holds significant implications to forensic investigations. First, the identification of the spermatozoa by microscopic examination serves to confirm the presence of semen. Second, the genotyping of the spermatozoa serves to identify the semen donor, which may then implicate the guilty and exonerate the innocent. However, the analysis of semen in condoms can be problematic as demonstrated in casework. Even spermatozoa recovered from recently used condoms can be in poor condition, suggesting that condoms possess physical and/or chemical properties that can compromise the semen samples.

To better understand the underlying mechanisms of this phenomenon, a controlled study was conducted on the stability of semen stored in condoms. The two independent variables tested were condom type and duration of storage. The three condom types selected for this study were Trojan lubricated, Trojan non-lubricated, and Trojan spermicidal. One milliliter of semen was stored in each of the condoms for a period of 1, 3, 5, 7, and 14 days (short-term study) and 7-9 months (long-term study). The hypotheses of the study presented here is that the components of semen are expected to degrade over time when stored in a condom. In addition, spermicidal condoms were expected to compromise the morphology of the spermatozoa relative to lubricated and non-lubricated condoms. In order to test these hypotheses, the samples were evaluated for seminal acid phosphatase activity, spermatozoa morphology and spermatozoa concentration. The first and tenth swabs of selected samples were evaluated based on the ability to obtain mitochondrial DNA profiles and for total nuclear DNA recovery.

The results of the present study demonstrate that the type of condom and duration of storage are important factors that contribute to the

instability of semen. Specifically, acid phosphatase activity was detected in all condom types for semen stored up to two weeks; only two lubricated condoms gave negative results. In comparison, acid phosphatase activity was detected in a majority of the non-lubricated condoms and some of the spermicidal condoms stored between 7-9 months. However, acid phosphatase activity was not detected in any of the lubricated condoms stored over a comparable time period. No major spermatozoa morphological changes or concentration decreases were observed for the samples stored in the short-term study. However, for samples stored in the long-term study, both non-lubricated and lubricated condoms primarily exhibited head and tail separation. The morphology of the heads associated with the lubricated samples appeared grainy suggesting compromised membrane structure. In contrast, spermatozoa were difficult to locate in samples stored in the spermicidal condoms. The heads that were identified appeared to have a grainy and tulip-shaped silhouette, again suggesting a compromised cellular membrane. Full mtDNA profiles were recovered from all samples tested, regardless of the type of condom used to store the semen. There was a noticeable decrease in the intensity of the profile for the long-term study samples. NuDNA was recovered for all samples; however, there was a decrease in the amount recovered as the duration of storage increased.

The results of the present study suggest that condoms have a negative affect on the stability of seminal fluid; however, nuDNA and mtDNA was recovered from all the samples. This suggests that there may be other factors (besides nuclease activity) contributing to the degradation of seminal fluid in condoms.

Semen Identification, Condoms, Genotyping

A99 Comparative Analysis of Condom Lubricants in Pre- and Post- Coital Swabs by Accurate Time-of-Flight – Direct Analysis in Real Time

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After attending this presentation, attendees will understand how a commercially available time-of-flight instrument, a very sensitive and accurate state-of the-art mass spectrometer, may be used to analyze vaginal swab and condom residues obtained by volunteers before and after intercourse. In particular, this study uses *in vivo* samples for the analysis (vaginal swabs after intercourse) in order to mime a rape situation.

This presentation will impact the forensic science community because this analysis put the basis for the application of this instrumentation to analyze biological samples obtained in rape cases. The implementation of this technique in forensic analysis is also a key point of this work.

In the last several years the number of sexual assaults in which the perpetrator used a condom has dramatically increased. Condom lubricants can be polyethylene glycol (PEG)-based or silicone-based. Polyethylene glycol is a non-ionic water-soluble polymer of ethylene oxide whose viscosity depends on the chain length. The compound is water-soluble and can therefore easily pass across mucous membranes, limiting its forensic detection. Silicone-based lubricants are found on most lubricated condoms, they are not absorbed into the skin or across membranes, thus staying on the surface to provide lasting slipperiness. It is this characteristic that makes it of great forensic value. Its major ingredient is PDMS (polydimethylsiloxane), a silicone-based organic polymer, which is a mixture of oligomeres ranging in molecular weights up to 20,000 amu. The oligomeres have a limited number of monomer units while polymers can have an unlimited number of monomer units. The spermicide most commonly found in condom lubricants is the detergent nonoxynol-9. It is a non-ionic surfactant and is typically a harsh detergent, but is found in condom lubricants at concentrations ranging from 5% to 10%. In sexual assault cases, lubricants and polymers recovered from the crime scene may provide useful information for the investigation, particularly when DNA evidence is not available. Individuals, generally, use condoms to be protected by sexually transmitted diseases and to prevent identification from the deposited semen. Several techniques have been used in the past to analyze traces left by condoms: Raman spectroscopy,[1] gas chromatography – mass spectrometry,[2] infrared spectroscopy,[3] nuclear magnetic resonance,[4] and capillary electrophoresis.[5] In this research, the instrument has been used to determine differences between commercially available condoms. The lubricant from condoms sold in the United States were collected using a specially designed glass apparatus and analyzed directly, without any manipulation, with the instrument in order to obtain pre-coital data and to differentiate between the condoms. Data obtained from vaginal swabs obtained before sexual activity will be presented: these data were used in the study as a blank. The traces obtained from vaginal swabs in post-coital conditions were also analyzed by means of the same technique. Due to interference from the background in the post-coital vaginal swabs and an overall low sample yield, the vaginal swab samples were also extracted using different polar and non-polar solvents in an attempt to increase signal power. Data derived from the extraction step will be also presented. Volunteers have been recruited to obtain the vaginal swabs before and after intercourse and several brands of condoms were used in the analysis. The overall goal of the project was to be able to individualize the condoms and consequently be able to discriminate between the brands and consequently collect useful information that could be used in sexual assault cases.

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Time-of-Flight, Vaginal Swab, Condom's Residue

A100 The Collection of Forensic Evidence From Prepubescent Victims of Sexual Assault

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After attending this presentation, attendees will become familiar with the types of evidence collected from sexually assaulted victims under the age of thirteen. In addition, attendees will be exposed to the most valuable types of evidence that yield positive DNA results linking a suspect to the crime as well as where this type of evidence can be found. Attendees will learn about how a child's developmental stage and activities following the assault impacts the amount of recoverable evidence found.

This presentation will impact the forensic science community by creating new guidelines and protocols for health care professionals, law enforcement personnel, and research personnel regarding collection of evidence from juvenile sexual assault victims. It will create an understanding of the differences between adult and juvenile sexual assault victims as well as highlight the major differences between sex kit protocols for both adults and children.

National data for 2006 show that among an estimated 905,000 child maltreatment victims, nearly nine percent were sexually abused with just over half of sexually abused children being under twelve years of age (U.S. Department of Health and Human Services). National figures for child maltreatment include only children reported to Children's Protective Services agencies, and therefore likely underestimate actual numbers of child sexual abuse victims.

The "72 hour" rule for evidence collection from sexual assault victims has been recommended by the American Academy of Pediatrics (AAP) and is supported by laboratory research and studies of adult victims. However, minimal research has been performed to support this rule regarding prepubescent and juvenile sexual assault victims. Research has shown that evidence collection kits obtained from both children and adult victims after twenty four hours following a sexual assault yields minimal to no evidence when using non-DNA methods of analysis. Some reasons proposed for such a low yield of evidence in children likely include the lack of genital development, such as the lack of mucus and folds in prepubescent tissues, the smaller size of vaginal and anal canals when compared to adults, and the nature of violence being decreased in some child sexual assaults compared to adult assaults.

The goal of this research is to create a database regarding child assault cases analyzed by the Houston Police Department crime laboratory from January 1, 2007 to December 31, 2008. One goal of the study is to determine what pieces of evidence collected from sexually assaulted children are the most valuable in identifying a suspect or perpetrator using DNA-based methods of analysis. Several factors are thought to influence the value of evidence collected from victims of sexual assault.

The first factor is the effect of post-assault activities performed by the victim, such as bathing, washing, wiping, eating and drinking, urinating and defecating, vomiting, and brushing teeth or using mouthwash. It is expected that the amount of evidence that will yield a positive DNA result decreases as post-assault activities increase. The reason for this is because activities such as bathing, washing and wiping, and urinating and defecating potentially remove any evidence left on the body and in the genital cavities following an assault.

A second factor is where the evidence is found, such as the vaginal cavity, the anus, the mouth, or bedding and clothing. It is expected that evidence found on undergarments, clothing, and bedding might yield more positive DNA results when compared to swabs from the vaginal cavity or anus because of the developmental stage of children less than thirteen years of age. For example, evidence is less likely to remain in the vaginal cavity because of the lack of mucus and folds in prepubescent children.

A third factor is the difference in evidentiary value from older versus younger children and how genital development can influence the value of recovered evidence. It is expected that older children will provide evidence that will test positive for DNA at a higher rate than younger children because of the stage of genital development.

The ultimate goal of this research is to provide a database that can serve as the foundation of a protocol or set of guidelines for health care professionals, law enforcement personnel, and laboratory researchers. This database will be consulted and utilized to determine what kind of evidence is the most valuable when dealing with sexual assault victims less than thirteen years of age. In addition, the database will outline the best place to find such evidence and whether or not it is useful to conduct a rape kit examination on a child rather than simply collecting bedding and clothing, where positive DNA evidence is likely most prominent.

Sexual Assault, Prepubescent, DNA

A101 Internal Validation a Florescent Labeling System: A New Spermatozoa Identification Method

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After attending this presentation, attendees will have gained an understanding of how a new spermatozoa identification method works and a sample validation process.

This presentation will impact the forensic science community by providing an example of an internal validation for the new spermatozoa identification method and showing some of the expected results.

Common sources of evidence for DNA analysis come from sexual assaults. These samples often require identification of semen stains and the presence of spermatozoa. The current method for spermatozoa identification is Kernechtrot Picoindigocarmine (KPIC) staining. While this method is effective, the time required to search slides is considerable, particularly, when the slide contains a significant amount of cellular debris. A kit utilizing florescent labeling of spermatozoa allows for faster and more accurate slide screening. This internal validation included studies in cell type specificity, substrate, sensitivity, and previously KPIC

stained slides. In each of these studies the florescent labeling system was shown to be specific and sensitive to sperm heads without incorrect labeling.

Florescent Labeling, Internal Validation, Sperm Identification

A102 Effect of Pulsed Pressure Injection on the Analysis of Gasoline Using Gas Chromatography-Mass Spectrometry and Chemometric Procedures

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After attending this presentation, attendees will understand the importance of a pulsed pressure injection on the precision of gas chromatography-mass spectrometry (GC-MS) data, as well as, the effect on subsequent chemometric procedures used in data analysis.

This presentation will impact the forensic science community by identifying parameters that can affect the precision of injection and by illustrating the subsequent effect on data analysis procedures. Optimizing injection parameters is essential in order to minimize non-chemical sources of variation prior to applying chemometric procedures and, hence, to ensure meaningful results. The effect of injection mode on the association of gasoline replicates with discrimination from other gasolines will be demonstrated using principal components analysis (PCA).

Chemometric procedures such as principal component analysis (PCA) are widely used in the analysis of samples of forensic interest. These chemometric tools can facilitate the rapid and reliable identification and differentiation of complex samples based on the chemical composition. However, it is necessary to minimize any sources of variance that are not inherent to the samples, to ensure that meaningful results are obtained. The purpose of this research is to investigate the effect of a pulsed pressure injection on the precision of chromatographic data and the resulting effect on data analysis using PCA.

For optimization studies, a standard mixture of five alkanes, ranging from C_8 to C_{16} was prepared. The alkane standard was analyzed by GC-MS with an automatic liquid sampler, using a standard oven temperature program. The pulsed pressure injection was firstly optimized, investigating pulse pressures up to 40 psi and up to one minute in duration. For each combination of pressure and duration, the alkane standard was analyzed in triplicate and relative standard deviations (RSDs) of peak height, peak area, and retention time were calculated for each alkane, from the total ion chromatograms. The optimal pulsed pressure method was chosen based on the combination that offered the lowest RSDs and, hence, the best precision. The alkane standard was then analyzed by the optimal pulsed pressure injection in both split and splitless modes, as well as by an unpulsed injection in both modes. Relative standard deviations of the peak height, peak area, and retention time for the alkane components were compared among all combinations of injection parameters to determine the most precise injection mode.

To demonstrate the effect of injection mode on PCA, five gasoline samples were collected from different brand service stations. Each sample was diluted 1:200 in dichloromethane and analyzed in triplicate by GC-MS, using both the optimized pulsed injection as well as a non-optimized injection. The resulting 30 chromatograms were retention time aligned using a commercially available alignment algorithm and normalized. Principal components analysis was then applied to assess the effect of injection mode on the precision of the analysis, which has consequences for the association of replicates and discrimination of different gasoline samples. Results of these studies will be presented and discussed along with the implications for forensic analyses using chromatographic data and chemometric procedures.

GC-MS, Gasoline, Principal Components Analysis

A103 The Differentiation of Kerosene Samples by Target Compound Ratio Analysis

Alexandria M. Bondra, BS, Carolyn E. Trader, MSFS, and J. Graham Rankin, PhD, Marshall University, Forensic Science Program, 1401 Forensic Science Drive, Huntington, WV 25701*

The goal of this presentation is to present initial results of a method developed to differentiate kerosene samples and residues from fire debris by Gas Chromatography/Mass Spectrometry (GC/MS) using target compound ratio analysis. This method is an extension of a method developed for the differentiation of gasoline samples as neat liquids and fire debris residues. The ultimate goal of both projects is the development of a uniform statistical method to establish the degree of similarity between any two ignitable liquid residues in fire debris analysis.

This presentation will impact the forensic science community by providing methodology and a statistical basis for declaring a similarity between any two kerosene samples as required by the courts and the recent National Academy of Sciences report.

Although gasoline is the number one ignitable liquid used as an accelerant in arson cases, kerosene is number two in much of the United States. Similar products classified as middle petroleum distillates (MPD) by the American Society for Testing and Materials (ASTM) E1618 method are also common due to their availability as charcoal lighters, paint thinners, and solvents. Classification of ignitable liquids according to the E1618 classification scheme can readily identify the ignitable liquid residue as a gasoline, MPD, or kerosene; however, comparing two samples (i.e. residue from fire debris to residue from a suspect's clothing) to determine if they are from the same source is much more problematic. This research was undertaken to provide the analytical and statistical basis for making such a determination.

Target compound ratio analysis is applied to high resolution GC/MS data utilizing the peak area ratio of sequentially eluting key compounds. Compounds eluting from a non-polar polydimethylsiloxane column elute primarily in boiling point order. Therefore, two compounds eluting with similar retention times will have similar boiling points and thus similar evaporation rates during a fire. Although the two compounds may decrease in overall concentration with increasing evaporation, their peak ratio will see little change. This allows comparison between samples with different amounts of evaporation. Kerosene, unlike gasoline, is a simple distillation product from crude oil and should be strongly related to the petroleum from which it was distilled. The relative concentrations of the key components in kerosene from a refinery will often change daily because of the variety of sources that distribute crude oil. This variation in concentration can provide sufficient variability for comparison between individual kerosenes. A number of compounds have been identified by the petroleum industry for crude oil typing and for matching a given crude oil source with environmental contamination from a tanker

spill or pipeline release. The preliminary work completed has identified thirty possible ratios for the comparison between kerosene samples. The target compounds selected have adequate concentrations in the kerosene samples, which allows for reproducible ratios between injections, as well as significant variation between kerosene samples from different sources.

Two commonly used metrics for crude oil typing are odd/even predominance of normal hydrocarbons and the pristine/phytane ratio. Pristine and phytane are both in low amounts in kerosene (near the upper boiling point limit); therefore, this ratio was found to be too variable within a given sample to be useful. Odd/even predominance showed good reproducibility within samples, but showed little statistical difference between the first set of kerosene samples, thus making the ratio not applicable for this purpose. The relative amount of normal hydrocarbons to iso- and cyclo-paraffins does show both reproducibility and statistical difference between kerosene samples as neat liquids. Burn tests and evaporated samples will be presented to show the robustness of these compound ratios under a variety of conditions and substrates.

Comparison of MPD will be presented with a similar set of target compounds for comparison and differentiation of this ignitable liquid class. A database of gasoline, MPD, and kerosene analyses is being developed from a large number of samples from a variety of sources. This database will be necessary to establish the statistical criteria for declaring two samples similar with a probability of error.

Kerosene, Target Compound Ratios, Fire Debris Analysis

A104 Effects of Matrix Interferences on the Identification of Mixed Ignitable Liquids in Fire Debris Using Chemometric Procedures

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After attending this presentation, attendees will have an understanding of an objective method for the association of mixtures of ignitable liquids to the corresponding neat liquids despite the presence of matrix interferences, using principal components analysis (PCA) and Pearson product moment correlation (PPMC) coefficients.

This presentation will impact the forensic science community by providing a more objective method for the identification of an ignitable liquid residue in fire debris, even in the presence of mixed ignitable liquids and matrix interferences.

In fire debris analysis, ignitable liquid residues (ILRs) are extracted from the collected fire debris and analyzed by gas chromatography-mass spectrometry (GC-MS). Chromatograms are compared visually to a reference collection of ignitable liquids analyzed on the same instrument to confirm the presence, or absence, of an ignitable liquid. However, visual examination is highly subjective and increases in difficulty due to weathering of the ignitable liquid, the presence of mixed ignitable liquids, and the formation of pyrolysis and thermal degradation products, as well as matrix interferences from the debris. Thus, in order to reduce the subjectivity of visual comparisons of chromatograms, an objective method must be developed for identification of ILRs in fire debris.

The purpose of this research is to investigate association of ignitable liquid mixtures to the corresponding neat liquids, even in the presence of matrix interferences. In the first study, the potential of principal components analysis (PCA) and Pearson product moment correlation (PPMC) coefficients to associate the mixed liquids to the corresponding neat liquids with discrimination from other liquids was investigated. In the second study, the effect of matrix interferences on the association and discrimination was assessed.

Six ignitable liquids, one from each of six classes defined by the American Society for Testing and Materials (ASTM), were chosen for this initial study. Each ignitable liquid was spiked onto a Kimwipe™ and extracted using passive headspace extraction with activated carbon strips. Extracts were then analyzed in triplicate by GC-MS under standard conditions. Two of the liquids, gasoline and kerosene, were then evaporated to two different levels (50% and 90%), and a set of mixed ignitable liquids was prepared using all combinations of the evaporated gasoline and kerosene (1:1 v/v), as well as the neat gasoline and kerosene. The mixed liquids were extracted and analyzed as described previously. Total ion chromatograms (TIC) and extracted ion profiles (EIP) of the aromatic (m/z 91+105+119+133) and alkane (m/z 57+71+85+99) components were generated for each liquid and three data sets were compiled: one containing TICs of the neat and evaporated liquids, one containing the aromatic EIPs of the neat and evaporated liquids, and the last containing the alkane EIPs of the neat and evaporated liquids. Each data set was subjected to retention time alignment using a commercially available algorithm to account for slight variation in retention time between analyses. Each data set was then peak area normalized to account for variation in injection volume and instrument sensitivity between analyses.

Principal components analysis was used to identify the natural clusters among the neat ignitable liquids and the mixed ignitable liquids based on the TICs as well as the EIPs. In the PCA scores plot, replicates of the neat liquids and replicates of the mixed liquids were closely clustered, while liquids of different classes were distinct. The mixed liquids were more closely associated with the corresponding neat liquids than the other liquids in the sample set. Loadings plots were generated to identify the chemical components that were most variable among the liquids. PPMC coefficients were calculated to further confirm the association and discrimination afforded by PCA.

To assess the effect of matrix interferences on association, each mixed liquid was spiked onto a carpet matrix, which was then burned and extinguished through covering with a petri dish. The ILR and matrix interferences were extracted and analyzed in the same manner, generating TICs and EIPs as described previously. Then, PCA was used to assess the association of the mixed ignitable liquids to the neat ignitable liquids in the presence of matrix interferences based on the TIC and each EIP. PPMC coefficients were also calculated and were used to aid in associations that were not clearly determined from the scores plots alone.

Ignitable Liquids, Chemometrics, Matrix Interferences

A105 Qualitative and Quantitative X-Ray Diffraction in Forensic Analysis of Duct Tapes

Rebecca E. Bucht, BSc, John Jay College of Criminal Justice, John Jay College, 899 Tenth Avenue, 636T, New York, NY 10019*

After attending this presentation, attendees will understand in which ways Qualitative and Quantitative XRD analysis can be used in the forensic analysis of duct tapes.

This presentation will impact the forensic science community by discussing how XRD analysis has the potential to offer a convenient, cost effective, and non-destructive method for further characterization of the tape backing layer. This research project investigates the usefulness of XRD analysis of duct tapes in distinguishing between tapes from different manufacturers and between tapes from different batches from the same manufacturer.

Duct tapes fall under the umbrella of pressure sensitive tapes (PST), which are an increasingly important class of forensic evidence. This study proposes the use of x-ray diffraction (XRD) technology to extend the ability of evidence examiners to gain additional information about a duct tape specimen. XRD data will support the commonly used microscopy, elemental, and spectral analyses for greater discrimination. XRD analysis has the potential to offer a convenient, cost effective, and non-destructive method for further characterization of the tape layers.

Forensic analysis of duct tapes has two main goals. Comparing physical and chemical characteristics can help determine how likely it is that two or more tape samples have the same origin. This can help in proving or disproving links between suspects and crimes or crimes to each other. In addition, comparing the characteristics of an unknown tape sample to a database of known tape samples can provide additional information for the investigative process.

A variety of physical investigations and instrumental analyses are used to gather information for discrimination of tapes. Efforts to further individualize tapes have centered on elemental analysis of the adhesive layer. The adhesive layers have more variation in composition than the backing layers, but they are also more sensitive to contamination and weathering effects. Many of the methods providing information about elemental composition involve analyses that destroy the sample, which is undesirable as the size of forensic tape samples is often very limited.

XRD analysis has the potential to offer a convenient, cost effective, and non-destructive method for further characterization of the tape layers. Although the composition of the polymer in the backing may not vary much between duct tapes, the different production methods and manufacturing machinery could result in different patterns of orientation of the components. The polymer used in the backing layer of duct tapes is polyethylene which is a semi-crystalline material. The crystalline component is influenced by many factors including microstructure, thermal history, processing, and average molecular weight. As a result, slight variations in the manufacturing process may produce significant and detectable differences in the crystallinity of the product.

This research project investigates the usefulness of XRD analysis of duct tapes in distinguishing between tapes from different manufacturers and between tapes from different batches from the same manufacturer. Limitations of specimen size will also be explored.

Duct Tape, X-Ray Diffraction, Multivariate Statistics

A106 Developing and Validating a Method to Analyze Components of Bank Dye Packs With HPLC and GC-MS

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After attending this presentation, attendees will see the importance of having both a presumptive and confirmatory test for detecting bank dye pack components. It will be demonstrated that the presumptive test developed in this study, utilizing HPLC, successfully separates and detects all three bank dye pack components. Additionally, the GC-MS method that was developed is a successful confirmatory test for all three components. Incorporating these two methods together provides an efficient and easy protocol for analyzing bank dye pack evidence.

This presentation will impact the forensic science community by providing a presumptive test for detecting bank dye pack components that has the potential to replace the previously used technique. TLC has been previously used to screen for bank dye pack components. However, TLC testing often has limitations. Some of these include solvent expense, solvent waste, operator time, and analysis time. HPLC is an efficient technique that can be used instead. Additionally, HPLC has the potential to be automated, which makes it even more appealing than TLC.

A common type of evidence encountered with bank robberies is exploding bank dye packs. These are used to aid in the investigation process and sometimes deter the criminal from completing the crime. The dye pack not only contains a red dye, 1-(methylamino) anthraquinone (MAAQ), but two tear gases as well, ortho-chlorobenzylidene malononitrile (CS), and chloroacetophenone (CN). The packs are often submitted to the local crime laboratory with subsequent pieces of evidence (i.e., a suspects clothing) that may have encountered the dye pack. It is the job of a trace chemist to determine whether or not the dye pack came in contact with the submitted evidence. In this project, an extraction method was developed for evidence exposed to bank dye components. The best solvent for extraction was determined to be a 50:50 mixture of ethanol and isopropanol and the extraction was performed at room temperature using an ultrasonic tank. A presumptive test was also developed using reverse phase High Performance Liquid Chromatography (HPLC) that incorporates a UV detector. The HPLC instrument used was an Agilent 1120 LC with EZChrom Software version 3.3 and the column was a Zorbax Eclipse Plus C18, 4.6 x 150 mm, 5-Micron. The mobile phase incorporated methanol as the organic phase and 0.1% trifluoroacetic acid in deionized water as the aqueous phase. All three of the components present in bank dye packs are successfully separated by gradient elution. Ibuprofen was used as an internal standard because its retention time falls among the bank dye components. The linear range for MAAQ, CS, and CN was found to be 0.001 mg/ml – 0.1 mg/ml, with r^2 values of 0.9999 for all components. The robustness, specificity, accuracy, and precision of this method were also tested and found to be acceptable. A confirmatory test was developed using Gas Chromatography-Mass Spectrometry (GC-MS). The GC-MS instrument used was an Agilent 6890 GC and 5973N MS with Chemstation Software 1701DA. The injection mode was splitless at an initial temperature of 250˚C. The method incorporates an initial oven temperature of 125˚C which then ramps at 35˚C/min up to 265˚C. The method provides good separation and resolution of all three bank dye components as well as the internal standard. A full internal validation was completed for this method.

High Performance Liquid Chromatography, Gas Chromatography - Mass Spectrometry, Bank Dye Packs

A107 Raman Spectroscopy of Pigmented Fibers

Shay M. Smith, BS, John Jay College of Criminal Justice, 445 West 59th Street, New York, NY 10019; and John A. Reffner, PhD, 97 Ocean Drive, East, Stamford, CT 06902*

After attending this presentation, attendees will understand where pigmented fibers are encountered, the importance of differentiating

between dyed and pigmented fibers, and the usefulness of Raman spectroscopy in identifying pigments found in fibers.

This presentation will impact the forensic science community by showing that Raman spectroscopy is a useful technique for the analysis of pigmented fibers.

Fibers are a type of trace evidence sometimes found at crime scenes. Analysis and characterization of these fibers may be pertinent to an investigation. Dyed fibers have been successfully analyzed using techniques such as microspectrophotometry and thin-layer chromatography. However, a successful technique for analyzing pigmented fibers has not been established. This study will show that Raman spectroscopy can be used to identify the pigments in such fibers.

Standard pigment samples will be obtained from manufacturers and used to verify the methods as well as for comparison purposes. Pigmented fiber samples will be obtained and subsequently analyzed using Raman spectroscopy. From this analysis, the specific pigments in the fibers will be compared to standards and identified. This will show that Raman spectroscopy is a useful technique for analysis of pigmented fibers.

Raman Spectroscopy, Pigment, Fibers

A108 Surface-Enhanced Raman Analysis of 1,2-Triazolo-Benzodiazepines Using Gold and Silver Colloidal Dispersions

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The goal of this presentation is to show the applicability of surface-enhanced Raman spectroscopy to the analysis and detection of trace quantities of benzodiazepines. The limits of this technique will also be discussed

This presentation will impact the forensic science community by providing a quick and easy method, surface-enhanced Raman spectroscpoy, for the analysis of trace quantites of benzodiazepines.

Forensic science drug laboratories are reporting a significant increase in the prevalence of benzodiazepines in submissions from drug-facilitated sexual assault cases. Due to the pharmacological properties of these drugs and their availability by prescription, their potential for abuse is high. Their physiological effects on the central nervous system, such as confusion, drowsiness, amnesia, and impaired coordination, are ideal for their use in the commission of these crimes.

Raman spectroscopy is a relatively new method to the field of forensic science. Due to major advances in the technique, analysis can be performed on trace quantities of materials in different mediums. Surfaced-enhanced Raman spectroscopy (SERS) overcomes the low sensitivity and quenches unwanted fluorescence effects that are seen with conventional Raman spectroscopy. SERS spectra are obtained by applying the analyte of interest onto a SERS-active metal substrate such as colloidal particles or metal films and then obtaining the Raman spectra.

Surface-enhanced Raman spectroscopy (SERS) is proposed as a technique for the analysis of trace quantities of 1,2-triazolo-benzodiazepines in aqueous samples. SERS provides a spectral "fingerprint" of small, Raman active molecules at trace concentrations. This technique is simple to use, utilizes easily prepared substrates and simple instrumentation, and has the ability to distinguish analytes which are structurally very similar due to the spectral information provided.

Aqueous colloidal dispersions of gold and silver nanoparticles were synthesized using a modified Lee Meisel method. Diluted benzodiazepine samples were added to the colloidal dispersions and SERS spectra were obtained. A comparison of the enhancement of the spectral characteristics observed using gold and silver colloidal dispersions as the SERS active substrate was performed. Detection limits for the various colloidal dispersions were also characterized.

Benzodiazepine, Surface-Enhanced Raman Spectroscopy, Drug Chemistry

A109 Soil Discrimination and Provenancing by Laser Induced Breakdown Spectroscopy (LIBS) as Compared to Other Elemental Analysis Methods

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After attending this presentation, attendees will understand how the application of Laser-Induced Breakdown Spectroscopy (LIBS) for the elemental analysis of soil can provide for the discrimination and/or association of soil samples. Attendees will also learn the advantages of LIBS over other analytical methods.

This presentation will impact the forensic science community by introducing a strategy for the differentiation of soils incorporating LIBS as an analytical tool for elemental analysis. The presentation will also compare the LIBS results to other more accepted analytical techniques such as Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES), Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS), and micro X-Ray Fluorescence (μXRF).

The goals of this study were to develop a method for the qualitative and quantitative elemental analysis of soil samples using LIBS and to apply the method to the analysis of environmental soil sample sets for discrimination and provenancing. Soil contains a mixture of mineral, organic and anthropogenic material, which varies greatly from region to region, resulting in a large variation of the major, minor, and trace components. The elemental profile can be used to discriminate soil samples originating from different geographic regions and associate samples originating from the same source. For example, the provenance of soil transferred to objects such as shoes, tires, or instruments would provide valuable information in a criminal investigation. In addition to the discrimination of soil samples themselves, an optimized soil analysis method could also be used in the future as a tool to examine the effects of soil diagenesis in bone, and possibly in field analysis applications. Many techniques have been used to determine the elemental profile of soil samples, including those mentioned above. LIBS is an emerging technique that provides many advantages over these techniques. For example, LIBS is relatively inexpensive, fast, and easy to use. Additionally, field-portable instruments have recently become available. The LIBS spectrum provides a richness of information on all the elements present without the requirement for prior knowledge of the element menu. In addition, LIBS has good sensitivity in the low atomic mass range, which is often an issue for both LA-ICP-MS and μXRF. For the LIBS analysis, a pulsed Nd:YAG laser is used as the excitation source to create a very small plasma. The light emitted from the plasma is focused into a

high resolution Mechelle spectrometer coupled to an intensified CCD camera detector. The emission lines collected are characteristic of the elemental composition of the sample. The initial sample set includes ten contaminated soil samples, taken at various locations and distances around an automotive battery manufacturing facility. These samples were initially analyzed for environmental contaminants (lead, tin, and antimony) using ICP-MS and also by ICP-OES.[1] These results are now compared to the results obtained using LIBS, as well as LA-ICP-MS and μXRF. A second, larger, sample set taken from a broader geographical area is used to further test the method. Two soil standard reference materials were used for method optimization and as control standards during the elemental analysis of the samples. The element menu was chosen to maximize precision, signal to background ratio, and linearity of response. All samples, blanks, and standard reference materials were spiked with internal standards, homogenized using a high speed ball mill mixer, and pressed into pellets without the need for the addition of a binder. An external calibration curve was constructed using blank sand spiked with various levels of the elements of interest. A convenient ratio comparison tool has been developed by the Almirall group that facilitates the forensic comparison of soils. Discrimination was performed using multivariate statistical analysis, such as pairwise comparison by analysis of variance (ANOVA) and correlation/discrimination trends are also reported using principal component analysis (PCA) and partial least squares discriminant analysis (PLS-DA). An analytical method was successfully developed for the elemental analysis of soil by LIBS. Good correlation was observed between the different methods making LIBS a viable alternative to the more expensive and complicated techniques.

Reference:

[1] Arroyo, L., Trejos, T., Gardinali, P.R., Almirall, J.R., *Spectrochim. Acta Part B* 64 (2009) 16-25.

Soil, Elemental Analysis, Discrimination

A110 Errors Associated With Pipetting Warm and Cold Liquids

Wendy Vaccaro, BA, Bjoern Carle, PhD, and Keith J. Albert, PhD, Artel, 25 Bradley Drive, Westbrook, ME 04092*

After attending this presentation, attendees will have a greater understanding of how warm and cold reagents can unknowingly be under- or over-pipetted, respectively, with more error coming with smaller volumes.

The presentation will impact the forensic science community by shedding more light on how error can creep into a process, even at the pipetting stages.

The material presented herein discusses errors associated with pipetting warm or cold liquids when using typical, air displacement-based pipettes. Many common laboratory procedures require the handling and quantitative dispensing of reagents at various temperatures. Mechanical action micropipettes are most often used for this routine task. The construction of these pipettes, however, makes their performance susceptible to variations in temperatures of the samples dispensed. This susceptibility to thermal effects is reflected in pipette calibration standards (i.e., ISO 8655-6 and ASTM E1154), stipulating stringent control of temperatures (20 ± 0.5°C) during pipette calibration, and also requiring that all materials, including the liquids, be thermally equilibrated prior to the calibration. However, many common assay protocols require the dispensing of reagents that are not in the specified temperature equilibrium.

Two common examples are tissue culture applications, which employ reagents and buffers at 37°C, and assays with nucleic acid-based reagents at 4°C or lower. The work presented herein investigates the accuracy of micropipettes from three different manufacturers, in the most commonly used range of 2 μL to 1000 μL, when used to pipette aqueous samples at various temperatures. The data showed that pipetting errors were more pronounced at the low volume ranges where the cold reagents were over-pipetted and the warm reagents were under-pipetted.

Pipetting Errors, Assay Errors, Confidence in Pipetting

A111 A Comparison of Fingerprint Screening Ability Between a Computerized Search Program and Human Examiners

Gary H. Naisbitt, PhD, Utah Valley University, Criminal Justice Department, Mail Stop 286, 800 West University Parkway, Orem, UT 84058*

The goal of this presentation is to compare the screening ability of fingerprint examiners using the same data and experimental design that were used in the computer based companion study.

This presentation will impact the forensic science community by comparing *Daubert* considerations of error rate, statstical confidence, and examiner subjectivity.

In the companion paper, a Fingerprint Search Program Validation Study, the optimal search settings and latent fingerprint screening capability of a finger print search program are reported. A parallel study is presented here. The goals of this project were to compare the screening ability of fingerprint examiners using the same data and experimental design that were used in the computer based companion study. Both the results obtained by fingerprint examiners and a comparison of the two studies are reported here.

Using rolled and plain (slapped) fingerprints of high quality, several fingerprint examinations were performed and the results were compared to known theoretical outcomes. In place of a database of extracted prints, examiners were provided with the prints found in the search program's database in hard copy format. Examiners used conventional optical/hand methods to compare the database prints to the test latent print. The experimental design is described below:

1. Can the fingerprint examiner find an exact copy of the full latent in the database? This is a self-matches-self experiment with the expected outcome of a match on every attempt.
2. Can the fingerprint examiner match the full print by searching portions of an exact copy of the full print? This is a form of a self-matches-self experiment that simulates searching the database with an ideal partial print. To mimic a partial print, the full latent print was divided into quarters or quadrants and each was searched as a separate latent print. Fifteen minutiae were arbitrarily chosen for all experiments as it is generally accepted that a full latent can be identified from twelve to sixteen minutiae, even if only a partial print is present. The expected outcome is 100 percent.
3. Can the fingerprint examiner match the full print by searching a series of plain prints of the same finger that have varying quality and spacial orientation? In this case the database contained only prints made with the same finger as the full latent and is another version of a self-matches-self test. Because each plain print contained at least fifteen minutiae, the theoretical outcome should be 100 percent.

4. This experiment was the same as experiment number three above, except non-matching prints were included in the database to better simulate a real life search. The same setting and number of minutiae were used as before, except the theoretical outcome changes to include non-matching candidates for examination.

In some cases fifteen minutiae were not sufficient to identify the full print in the database resulting in true candidates not being omitted from the list of candidates for consideration by the examiner. Even when the selectivity setting was reduced to allow more lenient comparisons, not all the true candidate prints in the database were identified. Although this deficiency does not lead to false identifications it does increase the examiner's work and in the case where only a single true print exists in the database, it may not be selected as a candidate for consideration

The inability of a partial print with fifteen minutiae to match a full print in the database casts a shadow on both the software and the prevailing fingerprint comparison protocol. Basing an identification on twelve to sixteen minutiae (prevailing standard) might be too low.

Daubert considerations of error rate, statstical confidence, and examiner subjectivity will be discussed. Graphs and tables of the data will be presented.

Fingerprint, *Daubert*, Validation

A112 Is Your Automated Liquid Handler Working for Your Assays? – Uncovering Errors, Understanding Device Behavior, and Optimizing Methods

Keith J. Albert, PhD, Artel, 25 Bradley Drive, Westbrook, ME 04092*

After attending this presentation, the attendees will appreciate the need to check, calibrate, and/or verify the volume transfer performance ("device behavior") of automated liquid handlers employed for important laboratory tasks.

This presentation will impact the forensic community by focusing attention on assays that are performed with automated liqid handlers. Without checking these systems for performance metrics, the assay results could, in some cases, be unknowingly flawed where the results cannot be trusted - or hold up in court.

The focus of this presentation is to highlight the need of ensuring quality in important assays performed with automated liquid handlers. Nearly all assays performed within a laboratory are volume-dependent. In turn, all concentrations of biological and chemical components in these assays, as well as the associated dilution protocols, are volume-dependent. Because analyte concentration is volume-dependent, an assay's results might be falsely interpreted *if* liquid handler variability and inaccuracies are unknown *or* if the system(s) go unchecked for a long period. No one wants to perform assays that could essentially produce meaningless results. If liquid handlers are properly employed (with the right methods/materials for the specific assay) *and* they are regularly assessed for performance, they can be powerful systems for lowering costs, increasing throughput, and avoiding errors associated with manually-pipetted methods. It is imperative, therefore, to quantify the volumes transferred with an automated liquid handler, especially for the specific automated methods that are used to perform the assays. Measuring and knowing the exact volumes transferred, for specific and/or routine methods, will inherently lead to confidence in the experiment, *i.e.*, the results can be trusted.

As presented herein, a case-study is shared where a real time polymerase chain reaction (RT-PCR) assay was being transferred from the bench (using a manually pipetted method) to an automated liquid handler. Many assays, such as RT-PCR assays, depend on accurate volume delivery. The technician was observing acceptable results with the manual assay, but as the assay was transferred to the automated pipettor, the results could not be repeated and were deemed unacceptable, *i.e.*, the liquid handler was producing errant results for the same assay that worked with a handheld pipette. In brief, the automated liquid handler was delivering a different volume compared to the manual method and ultimately, it was blamed for performing poorly. It is often the case that assays are initially performed on the benchtop using handheld pipettes before they graduate, or transfer, to an automated liquid handler. During the transfer process; however, the manual assay should be directly compared to the automated assay for consistencies in pipetting performance. As discussed, this RT-PCR assay transfer was finally successful after simply comparing the volume transfer performance of the handheld pipette vs. the automated liquid handler.

This presentation focuses on the importance of understanding liquid handler behavior for forensic assays. To understand and assess the liquid handler performance, the MVS® Multichannel Verification System was employed. The MVS measurement results are traceable to NIST and the measurement methodology follows international guidelines (ISO 8655, Part 7). By using this system, the RT-PCR assay method was successfully transferred from the bench to the automation. Additionally, the measurement system was used in numerous forensics laboratories to assess liquid handling behavior when running specific methods. For instance, it will be presented how the liquid handling steps were measured, understood, and/or optimized for numerous assay experiments, including: (1) on-board mixing efficiency; (2) tip-to-tip reproducibility; (3) finding a bad "tip-in-the-box" in a newly opened tip box; (4) highlighting the differences between accuracy and precision; (5) comparing individual volume transfers over multi-sequential dispenses; (6) optimizing an automated method for a specific target volume; and, (7) directly comparing performance between liquid handlers from multiple locations.

Liquid Handling Error, RT-PCR Assay Transfer, Liquid Handler Behavior

A113 Forensic Identification of Fluorescent Brighteners on Trace Evidence Fibers by Capillary Electrophoresis

Oscar G. Cabrices, BS, Stephen L. Morgan, PhD, James E. Hendrix, PhD, Pakritsadang Kaewsuya, BS, and Micheline Goulart, University of South Carolina, Department of Chemistry and Biochemistry, 631 Sumter Street, Columbia, SC 29208*

The goal of this presentation is to present the development of trace analytical methods for the analysis of fluorescent brighteners extracted from white fibers through capillary electrophoresis and followed by identification by UV/visible spectrophotometry and/or mass spectrometry.

This presentation will impact the forensic community by demonstrating that the characterization of white fibers with respect to fluorescent brighteners provides significant chemical marker information that is useful in identifying the origin and past history of such a fiber.

Textile fibers have become an important aspect of forensic science due to their abundance at crime scenes. Fibers are fundamental evidence as they could offer supportive evidence involving personal contact, whether between suspect and victim, or victim and inanimate objects such

as cars, windows, and screen doors. Fibers fluoresce either because the colored dyes on them, the fiber polymer itself or the fluorescent brighteners (FBs) that have been added to the fiber. Due to the fact that FBs are the only dyes present on white fibers in most cases and the high number of compounds that can be used as FBs makes the probability of a matching combination of two or more apparently unrelated fibers highly improbable by coincidence alone. Although ultraviolet(UV)/visible and fluorescence microspectrophotometry allows direct and nondestructive analysis of a fiber of few mm in length, a more selective and sensitive technique such as capillary electrophoresis, is required to analyze diminutive amounts of dye (2-200 ng) present on forensically relevant analytes.

Neat white cotton, nylon and acrylic fabrics available at our lab were subject to simulated laundering by actual FBs industrially used on fibers. Suitable solvent conditions for the microextractions of optical brighteners from fibers were determined by screening experiments on small scale threads (2-5cm) following progress millimeter size threads were subject to extractions followed by reconstitution of the FBs with deionized water (ddH_2O). Individual and mixed standards of different types of FB's (e.g., coumarin, distyrylbiphenyls, heterocycle, pyrazolines, stilbenes and thiophene oxazole) used on white fibers were prepared by dissolving 1.0 mg of each standard in 1.0 mL of deionized water followed by a pre-cleaning stage using disposable pipette extraction (DPX) for the removal of surfactants. The FB analysis were performed with an Agilent 3D-CE system equipped with a diode array detector; the dyes were identified by matching migration times, UV/visible and fluorescence spectra. Optical brightener analysis through CE/MS will be performed after initial runs of FBs standard solutions performed with an Agilent 1100 Series LC/MS-TOF system due to technical difficulties with the CE/MS instrumentation available at the laboratory. The FBs present in the fibers were qualitatively identified and their relative quantitative composition was estimated. In addition the number of false positive and false negative matches, whether the FBs were correctly recognized, and the report of estimated proportions of multiple FBs was recorded.

The ability to discriminate white fibers from one another will add a new dimension to current fiber characterization technology. The successful use of CE/MS represents a promising analytical scheme for the detection and identification of fluorescent brighteners and dramatically increases the evidential value of white fibers.

Capillary Electrophoresis, Textile Fibers, Fluorescent Brighteners

A114 Elemental Analysis of Unprocessed Cotton by LIBS, LA-ICP-MS, and µ-XRF: A Comparison of Methods

Emily R. Schenk, BSc, Florida International University, 11200 Southwest 8th Street CP 194, Miami, FL 33199; and Jose R. Almirall, PhD, Department of Chemistry, Florida International University, University Park, Miami, FL 33199*

After attending this presentation, attendees will: gain an insight into the need to verify the source of cotton commodities; learn how provenancing can be accomplished using analytical tools; be shown a comparison between three different analytical methods used in this study; and, better understand the chemometrics approach used for data interpretation and validation of the methods.

This presentation will impact the forensic science community, as well as the trade and commerce community in that the work described provides a means for the elemental analysis of cotton, which can be used for provenancing in forensic and fraud detection applications. Yarn fraud affects the multi-billion dollar cotton imports industry, resulting in serious consequences for fair competition of U.S. produced goods with fraudulent imported cotton material.

Cotton is the most abundant natural fiber in the world. Many countries are involved in the importation and exportation of this commodity. Because customs documentation can be easily falsified it is a necessity to develop an irrefutable method for corroborating the source of the cotton commodities. Elemental analysis of natural fiber evidence provides a means to increase the discrimination power beyond the physical and morphological examinations normally performed. Cotton exhibits an elemental signature that is characteristic of the attributes from the plant skeleton, nutrients absorbed in the plant, and environmental contributions that can either be absorbed through the plant system or collect on the outer fibers of the cotton boll. Previous work[1] has demonstrated that elemental analysis by laser ablation inductively coupled mass spectrometry (LA-ICP-MS) can provide a means for differentiating between different processed cotton samples. Also reported recently is a correlation between the composition and the geographic origin of unprocessed cotton.

This presentation will impact both the forensic science discipline and the trade and commerce community in that the work described provides a means for the elemental analysis of cotton, which can be used for provenancing in forensic and fraud detection applications. Yarn fraud affects the multi-billion dollar cotton imports industry, resulting in serious consequences for fair competition of U.S. produced goods with fraudulent imported cotton material. The goal of this work is to more thoroughly evaluate the correlation between growing region and other environmental factors to the elemental composition of the cotton using a larger sample set – incorporating samples from the U.S. and from international origins.

The analytical methods of laser-induced breakdown spectroscopy (LIBS), LA-ICP-MS and micro X-ray fluorescence (µ-XRF) were used for comparison of the analytical figures of merit between all three techniques.

LA-ICP-MS is an accepted analytical instrument that is commonly used in forensic laboratories. However, this technique is expensive to purchase and maintain, which can be beyond the budget allotted to some laboratories. LIBS is a less expensive alternative to LA-ICP-MS that offers many advantages including simplicity of instrumentation, the quickness of acquisition, and the ability to provide the user with a spectrum rich in information with no prior knowledge of the sample matrix. In addition, many forensic laboratories are already equipped with µ-XRF instrumentation and therefore, this method was also incorporated as a possible technique for elemental analysis of raw cotton.

LA-ICP-MS and LIBS data showed good analytical correlation suggesting that LIBS is a viable alternative for elemental analysis of cotton commodity samples. Grouping trends based on geographic regions were observed using principal component analysis (PCA) and partial least squares – discriminant analysis (PLS-DA) for the samples in this study. This study suggests that LIBS could, in the future, prove to be a beneficial tool to associate cotton evidence that has the same source of origin and in the field for prevention of cotton fraud at U.S. ports.

Reference:

1 J.M. Gallo and J.R. Almirall, Elemental Analysis of Cotton Fiber Evidence using Solution ICP-MS and LA-ICP-MS, *Forensic Sci. Int.*, 2009, 190(1), 52-57.

Cotton, Elemental Analysis, Provenancing

A115 The Microscopic, Spectrophotometric, Chromatographic, Chemical Characterization, and Discrimination of Eco-Fibers

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After attending this presentation, attendees will obtain knowledge of the microscopic, spectrophotometric, chromatographic, and chemical properties of eco-fibers as well as the optimal method for their discrimination.

This presentation will impact the forensic science community by providing the complete characterization of eco-fibers and the best method for their discrimination.

The general population has become increasingly aware of their impact on the environment which has created a market for environmentally friendly, or "green," products. This is seen in the fabric and textile industry via the re-emergence and introduction of eco-fibers. There are three fundamental types of eco-fibers that are commercially available: organic natural fibers, regenerated man-made fibers, and recycled synthetic fibers. Organic fibers are grown, cultivated and processed without pesticides, harmful chemicals, or synthetic fertilizers, and include organic cotton, organic linen, and organic wool. Regenerated fibers are made from natural resources and processed using green chemistry and clean state-of-the-art technology. These fibers consist of bamboo rayon, lyocell from seaweed, and azlons (regenerated proteins) made from corn, milk and soybeans. Synthetic materials, such as plastics, can be recycled into fibers, such as recycled polyethylene terephthalic acid (PET).

Eco-fibers are being used in all areas of the fashion industry, from retail stores such as the GAP to haute couture by Oscar de la Renta. Clothing is not the only use for these fibers, as they are also used in the manufacturing of footwear, handbags, toys, pillows, towels, beddings, carpets, and furnishings. As eco-fibers become more prevalent in society, they will undoubtedly make their way into crime scenes and require analysis by trace evidence examiners. Consequently, forensic scientists need to be equipped with appropriate analytical techniques and references to support their comparisons and conclusions, as well as the ability to identify counterfeit products (i.e., regular cotton marketed as organic cotton). Although the forensic characterization of eco-fibers has begun, there is no large scale collection of microscopical, spectrophotometric, chromatographic or chemical data of eco-materials.

This research focuses on the collection, analysis and characterization of several different eco-fibers. The characterization of these eco-fibers will be completed by polarized light microscopy, micro-melting point analysis, chemical staining, solubility, microscopical IR spectrophotometric analysis, micro-attenuated total reflection Fourier Transform (FT) IR spectroscopy, FT Raman spectrometry, dispersive Raman microspectroscopy, and pyrolysis-gas chromatography-mass spectrometry. The best discriminatory method and combination of methods for the characterization and differentiation of eco-fibers will be determined.

Fibers, Spectroscopy, Microscopy

A116 Classification of Organic Pigments by Raman Spectroscopy

Christopher S. Palenik, PhD, Bryn M. Wilke, AS, and Skip Palenik, BS, Microtrace, 790 Fletcher Drive, Suite 106, Elgin, IL 60123-4755*

The goal of this presentation is to follow up on previous seminars regarding the study of pigments by Raman micro spectroscopy with an emphasis on forensic applications.

This presentation will impact the forensic science community by presenting the first general classification of organic pigments.

Pigments are encountered in a variety of trace evidence, including automotive paints, architectural paints, inks, fibers, and other polymers of many varieties. Traditionally, pigments have been studied by polarized light microscopy, microchemistry, infrared spectroscopy, pyrolysis GC/MS, SEM/EDS and X-ray diffraction. Limitations inherent to each of these techniques have limited the practicality of pigment identification in the analysis of trace evidence. Raman spectroscopy, which is slowly becoming a more common instrument in forensic laboratories, provides the spatial resolution and sensitivity to pigments (over binders and other fillers) necessary for their effective and reliable characterization and identification.

Over the past three years, the utility of Raman spectroscopy as a technique for identifying both pigments in their free form and *in situ* in architectural and automotive paints has been demonstrated (Palenik et al., 2007, Palenik et al., 2008). During this period, a Raman spectral library of approximately 200 different pigments has been established. This includes most major automotive and architectural pigments.

With the development of this Raman database and evidence supporting the ability to identify pigments *in situ*, several higher level questions begin to arise. This presentation addresses several of these questions, which include:

Are the Raman spectra from a given pigment reproducible? Given the difficulty of obtaining pigment samples, how reliable are the samples in a given collection? Are pigments produced under the same chemical index number by different manufacturers consistent with each other or can they be differentiated. Finally, and most significantly, to what extent can a given pigment be specifically identified by Raman spectroscopy (to chemical class or to the actual pigment name)?

Results to date show multiple spectra collected on different days from the same pigment and from different pigment particles in the same sample are reproducible. More specifically, the wavenumber shift of major, medium and minor intensity peaks (peaks >5% intensity relative to the maximum peak) is reproducible.

In regards to the question of manufacturer to manufacturer variability, analysis of modern pigments purported to be of the same chemical index produced by different manufacturers have each been found to be spectroscopically consistent with each other, even when produced under different trade names (to date). The only exception identified to date is a historic artist's pigment with a questionable chemistry that has been produced in different (and disputable) ways over the years (Indian yellow pigment).

With the above supporting background, the ultimate question regarding pigment characterization can be addressed: the extent to which various pigments can be differentiated by Raman spectroscopy. Just as animals can be grouped by genus and species, pigments can be grouped into a general chemical class (e.g., diarylide yellow, diazo, phthalocyanine, etc.) and then more specifically identified by specific R-groups. By characterizing multiple pigments in the major general pigment classes, the extent to which specific pigments can be

differentiated will be discussed. For example, the study of multiple pigments from a single class has shown that pigment classes can generally be identified on the presence of certain groups of bands. This is somewhat analogous to the ways in which functional groups can be recognized in the infrared by characteristic peak positions and shapes. More specific pigment identification can, in most cases, be made be examining the finer details of the Raman spectrum. In some cases; however, it was not possible to differentiate between certain pigments by Raman spectroscopy alone. The result of this work is the first iteration of a pigment identification scheme that relies upon grouping of pigments by chemical class rather than being reliant upon a spectral library search to identify pigments. The advantage of this development is the potential to obtain useful chemical information from the Raman spectrum of a pigment that has not been previously characterized or included a spectral database.

Pigment, Raman, Microscopy

A117 Characterization of Selected Solid and Liquid Products From the Pyrolysis of Cotton Fabrics

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After attending this presentation, the attendee will learn to recognize and characterize particulate and liquid residues that result from cotton pyrolysis and apply this information to casework situations involving burnt cotton and cellulosic clothing.

An amber viscous liquid and microscopic spheroids produced during combustion of cotton fabrics can be used as markers of a burn event when observed microscopically and characterized by elemental and organic analysis. This provides a tool for linking a person or object with a fire event if such residues are found on the person's clothing.

When cotton fabrics are burnt or exposed to high heat, the non-gaseous reaction products include char, ash, mineral residues, and an amber-to-brown viscous material. The ash progresses from black to brown to white, each stage exhibiting greater loss of mass. The amber-brown material appears as a viscous residue. When the residues are examined microscopically, tiny viscous amber beads are observed adhering to individual fibers, and microscopic hollow black spheroids shaped like the amber beads are observed on the burnt fabric and in loose debris from the burn. The amber beads appear to be a condensate; they are found on less damaged portions of fabric protected by folds, yet appear after the fabric is heated past the initial charring stage. This corresponds with descriptions in the cellulose pyrolysis literature describing cotton "tar" resulting from the breakdown of cellulose during combustion above 300°C and reported to comprise levoglucosan, its isomers and condensation products.

This interest in microscopically observed burn residues is twofold: (1) the types and ratios of the several types of residues vary with burn conditions and may be able to provide information about burn conditions such as rapid high heat versus slow smoldering char. The question is complicated by the effect of fire retardants on the pyrolysis product ratios (inhibition of levoglucosan formation) and will be the subject of further study; and, (2) a finding of readily observed residues such as amber viscous deposits and microscopic black spheroids on the clothing or artifacts of a person who was exposed to a fire or other high heat may provide a link between the person and an event such as an arson fire. To be used as markers of proximate exposure to the pyrolysis of cotton or other cellulosic fabrics, the microscopic spheroids must be distinguishable from microscopic spheres found as residues from pyrotechnics, from the discharge of black powder weapons, from incinerator residues, and from the thermal decomposition of non-fabric cellulosic materials such as wood. The viscous amber residue must be distinguishable from tree sap, mastics, and other sticky residues. The focus of this paper is the chemical characterization of the amber residue and the spheroids via elemental analysis and organic analysis, optical characterization via light microscopy, and their production during exposure to high heat and flame.

The black spheroids, analyzed using a scanning electron microscope equipped with energy-dispersive X-ray (SEM-EDX), can be characterized by trace elements, that despite a range of variation between samples are readily distinguishable from trace elements from spheres produced in black powder discharge and pyrotechnic residues (the latter as reported by Kosanke, et. al.). A smaller number of white spheres were also observed in burn residues and appear to be mostly carbonate. The amber viscous residue from several samples were analyzed using Fourier transform infrared spectroscopy (FTIR), gas chromatography-mass spectrometry (GC-MS) of aqueous extracts and polarized light microscopy (PLM) and SEM-EDX of particulates. The particulates include tiny carbonate crystals that form in the viscous residue and may form from dissolved carbonates. These crystals have not been observed in samples of tree sap examined to date and if the environment does not account for other sources of carbonate crystals, may suggest combustion.

Summary: A finding of amber viscous residues, microscopic amber viscous beads and microscopic black spheroids that result from the burning or heat exposure of cotton fabrics can be considered markers of burn events and can be distinguished from materials of similar appearance that result from different processes or different materials. Such residues are forensically significant materials that can be used to link an object found elsewhere with a fire event.

Burn Debris, Pyrolysis, Trace Evidence

A118 Estimating the Uncertainty of Purity Measurements in the Forensic Chemistry Laboratory: Application of the Horwitz Model

Sandra E. Rodriguez-Cruz, PhD, Drug Enforcement Administration, Southwest Laboratory, 2815 Scott Street, Vista, CA 92081*

The goal of this presentation is to illustrate the application of the Horwitz model for the estimation of the uncertainty associated with purity measurements.

This presentation will impact the forensic science community by creating the interest to other forensic chemistry analysts and laboratory personnel involved in the evaluation of measurement uncertainty, as required for accreditation under the ISO 17025:2005 standard.

Accreditation under the ISO/IEC 17025:2005 standard requires testing and calibration laboratories to have established procedures for estimating the uncertainty of their measurements. In order to meet this requirement and those of the American Society of Crime Laboratory Directors/Laboratory Accreditation Board (ASCLD/LAB)-*International* Program, the Drug Enforcement Administration (DEA) Office of Forensic Sciences has established procedures for reporting uncertainty of

measurement estimates associated with both weight and purity determinations. This presentation will describe the top-down approach used for the estimation of the uncertainty of measurement associated with the quantitation of controlled substances.

Evaluation of six years (2003-2008) of proficiency testing program (PTP) samples and laboratory data from collaborative studies indicates that the relative standard deviation (RSD) of quantitative measurement among DEA laboratories is a function of analyte concentration, with higher RSD values observed as the concentration of the analyte decreases. This behavior has been previously characterized and documented by Horwitz and collaborators.[1,2] During the evaluation of numerous inter-laboratory studies in the early 1980's, Horwitz observed that an approximately 2-fold increase in RSD occurred for each 100-fold decrease in analyte concentration. Notably, Horwitz's studies also demonstrated that the RSD associated with purity determinations is independent of analyte, matrix, or analytical technique used. Horwitz's empirically-derived equation (equation 1) summarizes the experimental findings and defines the mathematical relationship between RSD and purity, where C is the analyte concentration expressed as a decimal fraction, i.e., 100 % = 1.00.

$$\%RSD_H = 2^{1-0.5\log_{10}C}$$ Equation 1 (Horwitz curve)

RSD values obtained from DEA PTP samples and collaborative studies performed during 2003-2008 are found to be consistent with the curve defined by the Horwitz model. Furthermore, analysis of the data also indicates that an upper limit for RSD values can be established, regardless of controlled substance, matrix, or analytical technique used, as predicted by Horwitz. This upper limit is defined by equation 2.

$$\%RSD_{1H} = 2^{2-0.5\log_{10}C}$$ Equation 2 (2x the Horwitz curve)

Therefore, the Horwitz model provides a reasonable basis for the estimation of the uncertainty of measurement associated with purity analyses performed by DEA laboratories. Uncertainty values reported are concentration dependent, and are calculated using equation 3.

$$U = x \cdot RSD_{2H} \cdot k_{95\%}$$ Equation 3

Where, x is the purity of the analyte, RSD_{2H} is the relative standard deviation (or coefficient of variation) defined by 2 times the Horwitz curve, and k is the coverage factor for a 95% confidence level ($k = 2$).

Results from the historical data evaluated will be presented and the validity of using the Horwitz model as the basis for the uncertainty of purity determinations will be demonstrated. This presentation is expected to be of interest to other forensic chemistry analysts and laboratory personnel involved in the evaluation of measurement uncertainty, as required for accreditation under the ISO 17025:2005 standard.

References:

1 Horwitz W. Evaluation of Methods Used for Regulation of Foods and Drugs. Anal Chem 1982;54(1):67A-76A.

2 Boyer KW, Horwitz W, Albert R. Interlaboratory Variability in Trace Element Analysis. Anal Chem 1985;57:454-459.

Uncertainty, Controlled Substances, Purity

A119 Comparison of Frequentist Methods for Estimating the Total Weight of Consignments of Drugs

Ivo Alberink, PhD, Annabel Bolck, PhD, and Reinoud D. Stoel, PhD, Netherlands Forensic Institute, Laan van Ypenburg 6, Den Haag, 2497 GB, NETHERLANDS*

After attending this presentation, attendees will understand the problematic behavior of some ways that have been suggested to estimate total drug weight of consignments based on a subsample.

This presentation will impact the forensic science community by showing that suggested confidence intervals of total drug weight of consignments based on a subsample are basically unreliable.

Suppose a consignment of n packages suspected of containing illicit drugs is seized, of which it is considered too time-consuming to individually determine the individual drug bearing weights $x_1,\ldots,x_n$. Instead, a sub-sample of m packages is taken, without replacement. Given the sample, several authors have commented on how to obtain confidence bounds for the total drug weight $w = x_1+\ldots+x_n$ of the whole consignment. These bounds turn out to be problematic from a practical point of view.

The analyses are usually based on the assumption that the consignment is interpreted as a population with a fraction p of the packages containing drugs, and if so, the drug weights are normally distributed.

Complicating factors in the statistical analysis of the set-up are that:

1. Sampling takes place without replacement, whereas m/n may be relatively large, which reduces uncertainty, and
2. The probability distribution of total drug weights per package is a mixture of a point-mass at zero and a normal distribution.

The first of these leads to the introduction of the so-called finite population correction in limits of confidence intervals, and the second leads to separate estimating procedures for the "success rate" (fraction of non-zeroes) and the normal weight distribution of drug bearing packages.

Indeed, let the mean and standard deviation of the whole subsample, including zeroes, be defined as $\overline{X}_m$ and S_m. Moreover, let the fraction of observed *non-zero* elements in the sub-sample be $P_m = K_m/m$, and sample mean and standard deviation of the non-zero elements $\overline{X}^*_m$ and S^*_m. The obvious point estimator of the total drug weight is $n\overline{X}_m = nP_m\overline{X}^*_m$. In [Tzidony, Ravreby, 1992], the statistical behavior of $\overline{X}^*_m$ is studied, assuming that the fraction of non-zeros P_m in the subsample is equal to that over the whole consignment (p). On this basis, confidence intervals for the total drug weight of the consignment are obtained of the form

(*) $|n\overline{X}_m - w| \leq t_{m-1,1-\alpha}$ x Fpc x $(n/\sqrt{m})$ x S^*_m

where the constant $t_{m-1,1-\alpha}$ depends on the degrees of freedom $m-1$ and the desired percentage of confidence $(1-\alpha)\times 100\%$.

It was recently observed in [Stoel, Bolck, 2009] that the standard deviation used was only over the (non-zero) drug containing units, so that in (*), the terms $t_{m-1,1-\alpha}$ and $(n/\sqrt{m})$ should be replaced by $t_{Km-1,1-\alpha}$ and $(n/\sqrt{K_m})$. They give new intervals. The above is an improvement but adds the conceptual problem that degrees of freedom appear which are random, next to the fact that the random behavior of P_m is still not taken into account. An alternative is to ignore the possible zeroes, and use the canonical inequality of the form

(**) $| n\bar{X}_m - w| \leq t_{m-1,1-\alpha}$ x Fpc x $(n/\sqrt{m})$ x S^*_m

This certainly has the advantage of simplicity. Knowledge about the statistical model, which separates success rate, mean drug weight and standard deviation, is thus ignored. However, the estimation of two parameters, each with its own measurement error, is avoided. Moreover, this approach does not use the assumption that $P_m = p$, which leads to underestimation of the variance involved. The current study shows that the classical confidence intervals are basically unreliable, since they are based on an underestimation of the variation of the random variables involved. In a simulation experiment where 90% of the scores were non-zero, the 95% confidence interval based on (*) turned out to be correct in 35% of the cases.

Two alternatives to (*) are presented that do yield asymptotically correct results, among which the canonical one described in (**). These alternative intervals are still not reliable for small subsamples though. The reason for this is the inherent multimodal behavior of the sample mean. There seems to be no obvious way to fix this.

Drug Sampling, Forensic Statistics, Finite Population

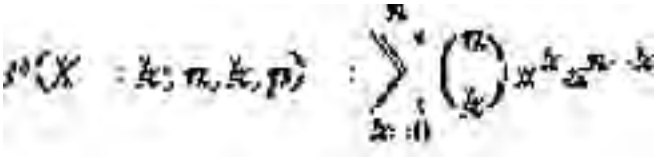
A120 Statistical Methods for Determination of Sample Sizes: The Binomial Distribution

Shannon L. Crock, BS, University of Alabama at Birmingham, 1201 University Boulevard, Birmingham, AL 35205; and Elizabeth A. Gardner, PhD, University of Alabama at Birmingham, Department of Justice Sciences, UBOB 210, 1530 3rd Avenue South, Birmingham, AL 35294-4562*

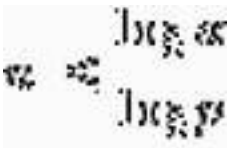
After attending this presentation, attendees will be able to explain each of the variables in the binomial distribution, calculate the sample size required for a given confidence level and percent of samples positive, and relate the sample size calculated with the binomial distribution to that calculated with the hypergeometric distribution.

This presentation will impact the forensic science community by presenting an explanation of the binomial distribution at a level appropriate for expert witness testimony in court, providing an understanding that will make it more easily accessible for use in laboratories.

Statistical methods for choosing sample sizes from large populations of items currently are rarely used in forensic laboratories, largely because they are difficult to explain to juries. One such method, the binomial distribution, is explained from the derivation of the basic form through its use in contexts where the sample size is the unknown. The equation for the binomial distribution is presented below.



This equation reduces down to:



Where n is the is the sample size, α is the confidence, and p is the fraction of positives in the population. When calculating the sample size with the binomial distribution, the sample size is not a factor in the calculation.

Unlike the commonly used statistical examples such as a jar of marbles containing known proportions of red and blue marbles, the proportion of drugs (say, cocaine) in a seizure is not known for certain. However, it is possible to make guesses as to the proportion of cocaine in the seizure and confirm or deny that guess with a previously-decided degree of certainty. For example, common choices when the binomial method is used are being 95% certain that 90% of the seizure is cocaine.

The binomial distribution method is also compared with another statistical method, the hypergeometric distribution. The sample sizes are plotted for the two methods. The binomial distribution is found to sometimes result in larger sample sizes, but to have other advantages that may counterbalance this difference, depending on laboratory needs.

Sampling, Statistics, Binomial

A121 The Use of Inkjet Printing Technology for Producing Trace Narcotics Standard Test Materials

Jessica L. Staymates, MFS, Jennifer R. Verkouteren, MS, Michael Verkouteren, PhD, and Julie Ott, BS, National Institute of Standards and Technology, 100 Bureau Drive Mailstop 8371, Gaithersburg, MD 20899; and Rona Nishikawa, MS, PO Box 148, Hanapepe, HI 96716*

After attending this presentation, attendees will be aware of the efforts made by NIST for developing a method to produce standard test materials for swipe-based ion mobility spectrometers. Attendees will understand the benefits of using inkjet printing technology for precise analyte deposition.

This presentation will impact the forensic science community by providing information about the standard test materials that will be available for use to verify the working conditions of ion mobility spectrometry screening instruments.

Ion Mobility Spectrometry (IMS) is a widely used screening tool for both explosives and narcotics trace detection. These IMS instruments are versatile and can be used in many settings because they operate at atmospheric pressure, are field deployable, and are convenient for laboratory use. In a typical implementation of IMS technology, a fabric swipe or trap is used to sample trace residues on a surface. The trap is then introduced into the IMS where it is rapidly heated to desorb the analyte for chemical analysis. The analysis is based on the gas phase mobility of analyte ions in a weak electric field. In order to ensure these instruments are functioning properly, well controlled test materials are needed. There is a major focus at the National Institute of Standards and Technology to make such standards containing either explosives or narcotics. Historically, quality-assurance verification samples are made by solution deposition onto the instruments collection trap via pipette or dropper bottle. However, this method is often unrepeatable and leads to erroneous results that can mislead instrument operators.

An ideal collection trap and a precise deposition method are needed to make standards that are accurate and repeatable, and a quick production method is desirable. In this work, the feasibility is evaluated of piezo-electric drop on demand inkjet printing for production of standard test materials. One benefit of utilizing inkjet printing technology for making standards includes the ability to deposit extremely small volumes of solution at a specific location on a surface. When similar

solutions are pipetted, the volumes dispensed need to be relatively large, causing the liquid to wick-out over the surface. This can cause problems with IMS analysis since most thermal desorption units in these instruments have a "sweet spot" that is generally in the center of the swipe. The larger pipetted volumes soak through the entire swab, distributing the analyte throughout the thickness of the collection trap. This leads to decreased detection levels when a sample is analyzed because the analyte may not be completely vaporized during the thermal desorption process. Piezo-electric inkjet printing offers the ability to dispense smaller, more precise volumes on the top surface of the swipe to ensure that the analyte gets fully desorbed.

Manufacturers of IMS provide a variety of collection swabs for their instruments. For simplicity of this study, one type of material was chosen for all samples. Nomex was the chosen material because of its high resistance to heat and its ability to be easily cut into any shape for use in different IMS desorber configurations. Illicit drugs including cocaine, methamphetamine, and oxycodone were weighed out and dissolved in isobutanol. Piezo-electric print heads have a narrow range of viscosities that they can print, therefore isobutanol was chosen because of its rheological properties and stability during the jetting process. Serial dilutions were made in quartz cuvettes to create a calibration curve using UV-Vis spectrphotometry in order to confirm the solution concentration initially and throughout the printing process. Narcotic solutions were printed on the nomex swipes and stored in metal cans with lids.

Studies were performed in our laboratory to confirm the repeatability of mass printed on the swipe substrates. For further testing, a pilot study was conducted by sending printed samples to various agencies that perform regular drug screening with IMS. The results of the pilot studies will be presented, as well as the studies that have been continually performed in our laboratory with various IMS instruments.

Ion Mobility Spectrometry, Inkjet Printing, Piezo-Electric

A122 Application of the Raman Microscope to Forensic Science: From Trace Elements Analysis to Drug Identification

Sergey Mamedov, PhD, Eunah Lee, PhD, Fran Adar, PhD, Horiba; Andrew Whitley, PhD, and Jon Goldey, MS, Horiba Jobin Yvon Inc., 3880 Park Avenue, Edison, NJ 08820*

After attending this presentation, attendees will have learned about Raman Microscopy in Forensics Applications.

This presentation will impact the forensic science community by providing information about using Raman microscopy in trace element analysis, fibers, and drug identification.

Raman microscopy was developed in the early to mid 1970s for chemical analysis with 1 micron spatial resolution. Early motivation was to identify substances/contaminants that appeared in crime scene evidence and manufactured products. However it was quickly applied to all types of materials analysis. Raman analysis has been recognized to have potential for solving an entire variety of problems of forensic science. However, one of the barriers to exploiting this potential has been the overhead of the technology – the cost of the equipment, its footprint, and the level of skill required for successful use. New Raman microscopes have been introduced at about quarter the cost of larger research systems, and they take up no more lab table space than an ordinary optical microscope. During this presentation, this new equipment will be described, as well as forensic applications including identification of illicit drugs in their containers, counterfeit currency, fibers, and glitters. In particular, the difference in Raman spectra of Cocaine HCl and Crack (free base) will be shown as well as possibility to identify cocaine in plastic bag or vial will be shown. In an effort to aid law enforcement personnel and the public at large, the ability of Raman spectroscopy to identify a variety of polymers used in fibers has been investigated. "Fingerprints" of nylon 6, Kevlar, poly-styrene, PET, poly-propylene, and some others along with different types of Nylon (nylon 6, nylon 66, nylon 12 and others) will be shown. Using Confocal Raman Microprobe fiber(s) embedded in epoxy were identified. Because of the different fillers, a counterfeit $20 bill was differentiated from legitimate ones. The entire Raman analysis can be performed in less than five minutes Raman spectra will be presented and method development will be described. It will be shown that commercial software is available that can provide quick identification of materials whose spectra have been collected in a library, or just matched to suspect material samples.

Raman Spectroscopy and Microscopy, Fiber Identification, Drug Identification

A123 Confirmatory Analysis of Selected Controlled Substances by DART-TOF Mass Spectrometry

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After attending this presentation, attendees will understand the advantages of utilizing Direct Analysis in Real Time – Time of Flight Mass Spectrometry (DART-TOF) in the context of a forensic drug analysis laboratory, as well as validated parameters for ensuring proper daily instrument performance. Attendees will understand the feasibility of using DART-TOF as a confirmatory test for the selected controlled substances alprazolam and cocaine.

This presentation will impact the forensic science community by providing validation parameters and data for the first known drug confirmatory methods utilizing DART-TOF. Forensic laboratories will be able to better understand the benefits of DART-TOF confirmation leading towards decreased turn-around-time and backlog reduction, a significant concern among controlled substance laboratories.

DART-TOF is a novel and powerful technique providing near real-time mass spectrometry data. It allows for the rapid identification of target analytes with minimal sample preparation through an open atmospheric sampling interface. The selectivity of DART-TOF is based upon the high degree of mass accuracy, various fragment ions at different voltages, and the presence of characteristic isotopic ion ratios. The Controlled Substances Laboratory has successfully validated this instrument for use in forensic casework and it has been in operation since 2007. Herein, criteria are presented to insure proper instrument performance, as well as validated methods for confirmatory analysis of alprazolam and cocaine currently utilized in the Controlled Substances Laboratory.

Confirmation of alprazolam in a pharmaceutical tablet matrix was performed without sample preparation and was based on analyte fragmentation at both 40V and 120V. Thirty previously confirmed alprazolam tablet case samples were analyzed and tested positive for the presence of the protonated molecular ion (309.09070 m/z) at 40V as well

as the presence of two fragment ions (281.07197, 205.07657 m/z) at 120V within a range of ±5 mmu. Neither sample preparation (whole tablet, partial tablet, or crushed tablet dissolved in methanol) nor tablet orientation upon introduction was found to significantly affect the exact mass outside of the specified range. A survey of similar compounds revealed nine potential structures which fall ±10 mmu of the protonated molecular ion. The presence of chlorine in the alprazolam structure and the subsequent observable isotopic ratio excluded all but four of these compounds, with none of them being commercially available. Phenylbutazone was studied as an interfering compound as its protonated molecular ion is within 0.0696 amu from alprazolam. All fragments were distinct from those characteristic of alprazolam.

Suspected cocaine samples for confirmation were prepared by dissolving several milligrams of solid (or a cotton swab of residue) in minimal methanol and were introduced into the DART source by the use of a borosilicate glass capillary tube. Thirty previously confirmed case samples (comprised of either cocaine salt, base, residue or no controlled substance) were analyzed by DART-TOF and fragmented at both 40V and 100V. All previously confirmed cocaine samples tested positive for the presence of the protonated molecular ion (304.15488 m/z) at 40V and the presence of two fragment ions (82.06567 and 182.11810 m/z) at 100V within a range of ±5 mmu. A survey of similar compounds in three scientific databases revealed multiple potential structures which fall ±10 mmu of the protonated cocaine molecular ion. However, most of those compounds are in the research stage, and only two of them are commercially available. Those two compounds, scopolamine and phenoxybenzamine, were studied as interfering compounds. They were distinguished from cocaine by lacking the fragment ions specific to cocaine. In addition, phenoxybenzamine exhibited the typical chlorine isotopic ion ratio of 3:1, which is absent in cocaine samples. It was also determined that up to ten case samples could be easily analyzed in one acquisition with acceptable mass accuracy, with baseline blanks analyzed in between each sample to ensure no carryover between introductions. Grouping samples in this manner significantly reduced acquisition and data analysis time, furthering the efficiency of this technique.

DART-TOF, Controlled Substances, Method Validation

A124 Development of a Forensically Integrated Microfluidic DNA Analysis System

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After attending this presentation, attendees will be informed of the progress made by this group on the development of a fully integrated device for the analysis of multiplex short tandem repeat DNA profiles from control buccal samples. Furthermore, attendees will understand the strategy of implementation of such a device within a forensic environment such as a police custody suite/booking office.

This presentation will impact the forensic science community by demonstrating a method for the delivery of a step change in the DNA analysis process: By the integration of an instrument and microfluidic cartridge with the forensic process, it will be possible to process a DNA sample taken from an individual in police custody and compare the profile with over five million United Kingdom samples held on The National DNA Database® in under two hours.

In urgent cases, control samples such as buccal swabs for DNA analysis can be processed in the laboratory in as little as six hours; more typically; however, processes allow for the routine analysis of DNA samples from control buccal swabs in 24-72 hours and require that the sample taken from a suspect is transported to a laboratory for processing, adding additional time to the overall process. Hence the suspect is very likely to have been released from police custody while the sample is processed. Frequently, where the suspect believes they will be subsequently charged with an offence, additional crimes are committed between release from custody and re-arrest following DNA database intelligence reports. The implementation of a rapid system whereby a control sample can be processed within the police custody area would be of value to the law enforcement community: a suspect's DNA sample could be processed and compared to a database of crime sample DNA profiles whilst the individual remains in custody. Rapid elimination of an individual from an investigation can also be achieved, reducing cost and releasing resources to focus on the investigation of alternative leads in a case.

The microfluidic cartridge-based system has been designed to operate in a non-laboratory environment. Contamination is minimized by implementation of a closed cartridge system which performs DNA extraction, DNA amplification using an 11 or 16 locus multiplex STR system, resolution of the STR alleles by microchip CE and detection using laser induced fluorescence. The disposable plastic cartridge is supplied prefilled with reagents required for the entire process and simply clips into the instrument which provides simple integration using embedded actuators and sensors. This avoids the need for complex fittings and fixings, reducing the complexity of integration and facilitating the goal of single push button processing. Data collected from the CE-LIF is processed using FSS software and the DNA profile is recorded in a format compatible with the data requirement for submission to the UK National DNA Database.

The whole system is designed to allow simple loading of a suspect's control DNA sample to the cartridge, and robust walk-away processing of the sample in under two hours.

Data will be presented describing the development process, the issues encountered and the solutions that were produced to develop a robust integrated prototype.

Forensic DNA, STR, Microfluidic

A125 Optimization of Automation Strategies Through Improved User Interfaces

Cristopher A. Cowan, PhD, Joseph Bessetti, MS, Melissa R. Schwandt, PhD, and Benjamin Krenke, MS, Promega Corporation, 2800 Woods Hollow Road, Madison, WI 53711-5399*

After attending this presentation, attendees will understand the opportunities for increased automation adoption through improved user interfaces.

This presentation will impact the forensic science community by showing the capabilities of well integrated automation strategies.

Many forensic laboratories are turning to automation not only to increase sample throughput, but also to improve reliability and reproducibility across the entire laboratory workflow. The use of automated DNA extraction and analysis can be an effective means of addressing these needs. Currently, only a portion of forensic DNA laboratories in the U.S. have successfully implemented automated sample analysis. A number of factors are responsible for the limited use of such systems, including (1) general lack of familiarity with automated liquid handlers; (2) difficulty of integrating information handling between steps in the DNA workflow; (3) complexity of software interfaces which reduce accessibility; and, (4) lack of flexibility required to integrate automated liquid handling with laboratory practices for handling of samples and controls. The development of flexible forensic-specific workflow automation and simplified user interfaces, compatible with multiple robotic platforms, can significantly increase the ease of implementing automation in the forensic laboratory. Examples of full automation strategies will be presented employing forensic-specific interfaces for sample extraction, quantitation, normalization and STR analysis. In addition the potential impact of these measures in reducing adoption and validation times for automated instrumentation will be highlighted.

Automation, User Interface, STR Analysis

A126 A Novel Platform for the Modular Integration of Forensic Assay Setup and Medium- to High-Throughput Purification of Nucleic Acids

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The goal of this presentation is to share validation and customer evaluation data on a new platform for automated medium- to high-throughput extraction of genomic DNA from trace material. A modular concept for integration of nucleic acid extraction and automated assay reaction setup will be presented.

This presentation will impact the forensic science community by enabling forensic investigators to process case evidence with higher accuracy in a standardized manner and to integrate extraction and setup of downstream assays in a single automated workflow.

There is increasing demand for optimized forensic laboratory processes. Requirements include minimization of manual interactions, scalable throughput formats, and comprehensive audit trail logging and process documentation,

A novel, modular system has been developed that integrates medium- to high-throughput purification of DNA, RNA, or proteins with forensic downstream assay setup. An extraction module (SP module) and an assay setup module (AS module) each are equipped with independent robotic work-heads allowing multitasking and both, independent or connected processing of samples. Sample extraction and assay setup areas are individually contained with external touch screen controls. An eluate transfer "tunnel"` facilitates full interoperability between modules. The fully air pipetting system allows processing of any number of samples between 1 and 96 in multiple, scalable batches. Reagents and plastic consumables are administered through a novel drawer concept. Barcode reading of samples, reagents, eluates and assay components provides comprehensive tracking throughout the process. The SP module facilitates extraction of molecular targets from a range of reference and casework sample types, using standardized protocols to ensure optimized processing of samples. The platform utilizes proven magnetic-particle technology. Buffers required for nucleic acid extractions are contained in a sealed ready-to-run reagent cartridge. This cartridge is opened automatically by the instrument when used for the first time. Dedicated protocols were designed to provide maximal DNA yield from casework samples. Sample input volumes ranging from 200 µl to 1 ml lysate for casework samples can be combined with a relatively broad range of elution volumes down to 30 µl for sample input and output flexibility. The AS module integrates reaction setup of commonly used assays for forensic DNA quantification and STR analysis, facilitating multi-channel precision pipetting and Peltiers based active cooling. Two workflows are supported by the SP and AS module – integrated or independent. For integrated operation eluates from extractions are directly transferred to the assay setup module, reducing manual steps and documentation.

The extraction module has been evaluated for sensitivity processing a range of typical casework samples, like surface swabs, hairs, stains, cigarette butts or chewing gum. Success rates obtained in profiling of those samples during the evaluation were compared to statistic records of the corresponding sample category and found to be at least equivalent or better. Exclusion of sample carry-over was tested for the casework protocols using saliva samples of different donors arranged in a checkerboard pattern alternating with negative extraction controls. No mixed profiles were observed, and none of the negative controls showed a profile.

The AS module was tested for setup of a commonly used forensic quantification assay. Preliminary validation results will be shown.

Conclusion: The integrated system of extraction and assay setup modules provides a highly flexible solution for processing casework or reference samples in a medium- to high-throughput scale. It minimizes manual interactions and thereby increases efficiency and process safety of a laboratory workflow.

Automation, Nucleic Acid Extraction, PCR Reaction Setup

A127 Automated Extraction of High Quality Genomic DNA From Forensic Evidence Samples Using a Cartridge-Based System

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After attending this presentation, attendees will have learned about a new and unique method for automated extraction of genomic DNA from forensic evidence samples. The extraction method enables recovery of genomic DNA from forensic samples.

This presentation will impact the forensic science community by demonstrating a novel automated method developed specifically for extraction of genomic DNA from forensic evidence samples.

DNA analysis plays an important role in human identification (HID).

The past two decades have witnessed advancements in the development of new technologies for short tandem repeat (STR) analysis. However, isolation of DNA from forensic evidence samples is still a challenging process that creates bottlenecks in the sample processing workflow. This is due to the large variation in sample types and substrates, possible exposure of the samples to environmental insults, presence of PCR inhibitors and limited starting material. Therefore, it is important that the procedure used to isolate genomic DNA is efficient and delivers DNA in a highly purified form. It is also desirable to have an extraction methodology that enables quantitative recovery of DNA from small quantities of starting material.

In this presentation, we describe an automated DNA purification system that enables the isolation of genomic DNA from forensic samples. This DNA is ready for downstream applications including real-time qPCR and genotyping. We have also designed and implemented a novel apparatus for lysis and the separation of the lysate from the substrate. This novel apparatus minimizes sample handling and maximizes lysate recovery. This automated extraction method employs multi-component surface chemistry to isolate genomic DNA from forensic evidence samples. All reagents required for purification of DNA from the lysate of one forensic sample are packaged into a single cartridge, resulting in consistent recovery and minimizing cross contamination risks. A total of thirteen sample lysates can be processed for isolation of DNA simultaneously. Walk-away operation increases both the efficiency of trained forensic analysts and the throughput of forensic labs. The automated protocols are optimized for extraction of DNA from a variety of sample types including blood stains on denim, cotton cloth, and FTA® paper, samples spiked with PCR inhibitors, saliva on swabs, semen on cotton fabric, bones, teeth, chewing gum, cigarette butts, tape lifts, and touch evidence samples. DNA yields for all samples tested were equal to or greater than other automated DNA extraction methodologies. DNA obtained from these samples was free of detectable PCR inhibitors.

High quality of isolated genomic DNA is demonstrated by the successful amplification of STR profiles obtained. Performance and ease of use of the automated benchtop DNA extraction system is better than or comparable to similar benchtop extraction systems for extraction of DNA from forensic samples.

DNA Extraction, Automation, DNA Analysis

A128 Sample Collection System for DNA Analysis of Forensic Evidence

Eugene Tan, PhD, Network Biosystems, 1B Gill Street, Woburn, MA 01801*

After attending this presentation, attendees will be familiar with recent advances in buccal swab and crime scene evidence collection devices compatible with microfluidic DNA purification protocols that enable forensic sample analysis to be performed rapidly and with minimal user intervention.

This presentation will impact the forensic science community by demonstrating a sample collection system that allows evidence collected on a swab to be processed microfluidically to yield purified DNA, a major step towards the development of a fully integrated, samples-in to results-out STR analysis system for both laboratory use and field forward operation. Such a system has the potential to reduce the time, labor, and cost of performing STR analysis.

A major challenge in bringing biochip-based DNA analysis tools to the forensic community has been in developing a robust, easy to operate commercial instrument that offers reliable and reproducible performance. A fully integrated STR analysis system based on microfluidic biochip technology for forensic laboratory and field-forward operation would comprise modules to perfor: (1) DNA purification and, for casework samples, human specific DNA quantification; (2) multiplexed STR amplification; and, (3) separation and detection of the resulting amplicons.

The development of a sample collection system consisting of a sample collection device and a sample processing cartridge, referred to as the Smart Cartridge will be reported. The sample collection system is the critical interface between the user, real world samples, and microfluidics biochips for rapid automated DNA processing. Development tasks included the evaluation and selection of various evidence collection matrices, evaluation and selection of an evidence collection device, design and fabrication of the Smart Cartridge, and development of the computer controlled pneumatic drive system.

Data will show that mock casework and database samples can be extracted and purified with high efficiency and that the resulting DNA is compatible with subsequent microfluidic PCR amplification and separation and detection. The sample collection system is well-suited for incorporation into a fully-integrated microfluidic forensic DNA analysis system will be demonstrated.

STR Analysis, DNA Extraction and Purification, Biochip

A129 Rapid Microfluidic Human Specific DNA Quantitation

Eugene Tan, PhD, Network Biosystems, 1B Gill Street, Woburn, MA 01801*

The goal of this presentation is to familiarize the forensic scientist with recent advances in biochip based DNA analysis systems and, in particular, with a biochip-based rapid human-specific DNA quantitation system for fully integrated microfluidic STR analysis.

This presentation will impact the forensic science community by demonstrating biochip-based human specific quantitation, a major step towards the development of a fully integrated, samples-in to results-out STR analysis system.

The rationale for developing biochip-based DNA analysis tools is that a fully integrated system has the potential to reduce the time, labor, and cost of performing STR analysis. These advances may increase the capacity of forensic laboratories as well as reduce the current backlog of casework and database samples. Furthermore, a fully-integrated system that can be operated in the field offers the potential to expand the use of STR analysis beyond an evidentiary role at trial to an investigative role at the crime scene. A fully integrated STR analysis system based on microfluidic biochip technology for forensic laboratory and field-forward operation of casework samples would comprise modules to perform: (1) DNA purification and human specific DNA quantification; (2) multiplexed STR amplification; and, (3) separation and detection of the resulting amplicons.

The development of a rapid microfluidic human specific DNA quantitation system that is able to perform human specific DNA quantitation in seventeen minutes will be reported. Quantitation is based on end-point detection of PCR product using human specific primers and fluorescent intercalating dyes. The system uses the same rapid biochip-thermal cycler required to perform rapid STR amplification. Similarly, excitation and detection of the reaction solutions is accomplished with the same laser and optical train as used in the separation and detection

module. This multipurposing of critical components is important to minimize the dimensions, cost, and complexity of the instrument.

Data will show generated with demonstrate the accuracy, repeatability, and specificity of the system. Mock casework and buccal swab samples will also be used to show that microfluidic biochip DNA quantitation is well-suited for incorporation into a fully-integrated microfluidic forensic DNA analysis system.

STR Analysis, Human Specific DNA Quantitation, Biochip

A130 Integration of RNA Purification and Reverse Transcription Amplification (RT-PCR) in a Single Microfluidic Device for Biowarfare Agent and Pathogen Detection

Carmen R. Reedy, BS, Kristin A. Hagan, BS, Whitney L. Meier, BS, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

After attending this presentation, attendees will have learned the advantages of utilizing a microdevice for RNA purification and amplification for application to various biological samples associated with biowarfare providing a completely closed environment reducing contamination and sample degradation.

This presentation will impact the forensic science community by demonstrating the use of a microfluidic device capable of both RNA purification and reverse-transcription amplification (RT-PCR). The integration of these sample processing steps provides the next step towards a micro total analysis system (μTAS) which would reduce overall analysis time and provide imperative information to the forensic and defense communities in a timely manner.

The identification of genes encoded for by RNA is a technique commonly used within the defense community for detection of biowarfare agents, such as pandemic diseases like influenza A. In order to detect the presence of biowarfare agents in a biological sample, the RNA must first be purified from cellular and extracellular material and then undergo RT-PCR amplification of a specific region of the genome to identify the threat at hand. These processes can be completed conventionally using solid phase extraction (SPE) and RT-PCR amplification performed on a thermal cycler, however, they often require multiple sample transfer steps, exposing highly unstable samples to potential contamination or degradation as well as exposing the individual processing the sample to the infectious agent. Conventional extraction and amplification methods also require lengthy analysis times. In contrast, the use of a microfluidic purification and amplification system would benefit the defense community by providing a closed environment to reduce contamination of the sample and exposure of the individual processing the sample to the infectious disease. A microfluidic system for RNA analysis also provides reduced sample consumption, reagent consumption, and analysis time, and provides portability for on-site analysis while allowing for seamless integration of multiple sample processing steps.[1]

The implementation of SPE on a microfluidic device for the purification of RNA has been well characterized, and shown to be reproducible and widely applicable to multiple sample types using both a silica-based chaotropic method and a completely aqueous method using an alternative solid phase, chitosan.[2,3] This aqueous methodology involving the reversible binding of DNA to chitosan-coated silica based upon a buffer pH change was first demonstrated Cao et al.[4] The chitosan phase, also employed by Hagan et al.[3], was later found to perform superior to silica for RNA purification. The use of this phase allows for nucleic acid purification to be completed in a completely aqueous environment, eliminating the need for reagents commonly used in chaotropic extraction methods involving a silica solid phase that can inhibit downstream PCR analysis such as guanidine hydrochloride or isopropyl alcohol. Using completely aqueous buffers also allows elution of RNA in PCR buffer, ensuring compatibility with downstream PCR analysis. Additionally, the low-molecular weight chitosan used has been proven a RNase inhibitor, providing an ideal environment for extraction of RNA.[5] The implementation of PCR on microfluidic devices has also been well established using small sample volumes (nL).[6] One example of PCR on a microfluidic device involves the use of infrared (IR)-mediated heating, which results in increased speed of temperature transitions and, therefore, a decrease in analysis time. This was used by Legendre et al.[7] for the integration of SPE with PCR for DNA analysis, however, the integration of SPE and RT-PCR has not before been demonstrated.

This work provides the first demonstration of a microfluidic system for purification of RNA integrated with RT-PCR utilizing IR-mediated heating for more rapid thermal cycling. The use of an integrated microdevice provides a completely closed environment and decreases sample handling steps, with less opportunity for the introduction of contaminants and RNases and exposure of the individual processing the sample to an infectious disease. The decreased analysis time achieved with this method would assist the forensic and defense communities by providing information faster in situations where response time may be critical as well as provide vital information to first-responders. An integrated device design will be shown in addition to characterization of the SPE domain using purified human RNA as a simulant for cells infected with influenza A virus. Method development employing separate microdevices for SPE and RT-PCR will be demonstrated. This will entail determining the optimal SPE elution fraction containing the maximum mass of purified RNA for RT-PCR. The reduction from a two-step RT-PCR method to a one-step method on a microfluidic device will also be shown. Lastly, integration of SPE and RT-PCR on a single microfluidic device will be demonstrated.

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Solid Phase Extraction, RT-PCR, RNA

A131 Advanced Integrated and Portable Microfluidic Systems for Fully-Automated STR Analysis

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After attending this presentation, attendees will have a complete understanding of the current state of development of automated, microfluidic systems for human identification. It will also highlight the advantages of microscale analytical systems for rapid generation of STR profiles from buccal swab samples.

This presentation will impact the forensic science community by illustrating next-generation DNA typing technology that will revolutionize how genetic analysis is performed both in the field and in the laboratory.

STR typing has become the accepted gold standard for human identification over the past two decades, and is now successfully employed in paternity testing, criminal casework, and missing person cases, as well as for databasing efforts. Although highly successful and reliable, current methodologies require 8-10 hours to complete under routine conditions, use large sample volumes, costly reagents, and are labor-intensive. Additionally, samples are open to the environment at multiple points during processing, making them susceptible to contamination. A translation of these sample processing and analytical methods to the microscale format will permit automation, miniaturization, and integration that will provide the end user with a system that provides expedited, cost-effective analysis in a closed system that reduces sample handling and possible contamination.

A variety of fully-integrated microfluidic biochemical analysis systems have been demonstrated recently for a variety of applications (e.g., Easley *et al.*).[1] Although integrating purification, PCR amplification, and electrophoretic separation/detection has been successfully demonstrated for pathogen detection, human identification using STR typing poses a number of new challenges for integrated systems, including: efficient miniaturized DNA purification, PCR amplification of the required thirteen core STR targets with commercial multiplexed kits, fine-tuning the use of commercial kits optimized for large volume amplification (25 µL) to function effectively at the microscale and, finally, rapidly separating the amplified target fragments with single base resolution and detection of 5-color fluorescence.

A system capable of the simultaneous and fully-automated processing and analysis of STR loci directly from buccal swab samples will be presented. Utilizing a single, integrated and disposable microfluidic chip, the multi-step sample processing and analysis that consumes 8-10 hours for conventional forensic STR analysis, can be carried out in less than forty five minutes. Exploiting novel DNA purification technology, DNA is purified from crude sample in less than fifteen minutes and guided into a chamber for a complex, STR PCR amplification using IR-mediated thermocycling. The PCR process, alone requiring ~3 hrs with conventional thermocycling, can be completed in less than twenty five minutes due to the excellent thermal properties of the microchip and the use of IR as a heat source, with efficient amplification of all 16 STR loci in sub-microliter volumes. Separation is carried out using electrophoresis in a short channel (6 cm), using an optimized polymer, with baseline resolution and with 5-color detection based on acousto-optic filtering. Seamless integration of these methods on a single disposable microdevice provide a means long sought after in the forensic community for performing sample processing and fluidic manipulation entirely in sub-microliter volumes regime. This presentation will provide a glimpse at the role that microfluidics will play in the future of forensic DNA analysis. The design and function of the integrated instrument capable of accepting the microfluidic device will be detailed, with data supporting the capability of the microfluidic system for rapid, automated, end-to-end genetic analysis for human identification.

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DNA, Microfluidics, STR

A132 A Review of the Changing Use of Mitochondrial DNA in Identifications by the Central Identification Laboratory

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After attending this presentation, attendees will understand how the Central Identification Laboratory and Armed Forces DNA Identification Laboratory use mtDNA to identify United States service members lost in historic conflicts, and how mtDNA can be used in different ways as the evidence and reference database sizes increase.

This presentation will impact the forensic science community by showing the power of large mtDNA evidence and reference databases for directly making identifications and for constructing hypotheses that may lead to identifications.

In 1991, the U.S. Army Central Identification Laboratory—Hawaii (CILHI) made its first identification that used mitochondrial DNA (mtDNA), followed by three more in 1994 (Holland et al. 1993).[1] After questions were raised about the reliability of mtDNA-based identifications, the Defense Science Board Task Force on the Use of DNA Technology for the Identification of Ancient Remains conducted its own review. Their 1995 final report recommended that mtDNA could indeed be used for the identification of the remains of U.S. service members lost in prior conflicts. Over the following four years, mtDNA reports issued by the Armed Forces DNA Identification Laboratory (AFDIL) supported 36% of the identifications made by the CILHI. In 2000, for the first time, mtDNA reports supported a majority of identifications, and since then 79% of identifications by the CILHI and its successor organization the Joint POW/MIA Accounting Command—Central Identification Laboratory (CIL) have been supported by mtDNA.

The manner in which the CIL uses mtDNA results has developed and expanded over time. The earliest identifications resulted from comparisons of a single evidence sequence with a maternal family

reference sample (FRS) obtained for a single casualty by that casualty's respective military service. These were followed by comparisons between one or more evidence sequences and a small, closed population of casualties. In the late 1990s, as CILHI began analyzing remains recovered from North Korean battlefields, potential casualty populations became more open. As a result, the services were asked to obtain maternal references for much longer lists of casualties. In 2003, the CIL began submitting megacomparison requests to AFDIL, asking for a long list of potential casualties to be compared to a list of cases recovered from a given region. At the same time, it became clear from mtDNA results that the remains of single individuals might be spread across multiple accessions from North Korea. To address the question of commingling, AFDIL began generating spreadsheets that charted the occurrence of each individual sequence across all of the different cases received from North Korea. In 2008, this spreadsheet was extended to include all those remains recovered by the CIL in North Korea. Most recently, the same tabulation has been done for all remains associated with the Vietnam War. At the same time, the proportion of casualties for whom FRS are available has increased to 68% for Korea and 69% for Vietnam. Given the completeness of this reference set, it now makes sense to run each distinct evidence sequence against all the FRS available for that conflict.

At the same time that the FRS database has grown, so has the reference population database. The first mtDNA comparisons by AFDIL relied upon a reference population of 715 individuals reported in the literature. In 1998, AFDIL began using what is currently the SWGDAM database, which by 2002 contained 4839 individuals. In 2007, AFDIL began using its own Casework Population Database (CPD) of 10,428 individuals, including samples from each racial and continental grouping. Even when an evidence sequence does not match any FRS, if it is present within the CPD, hypotheses can be generated about the ancestry of the individual. This has allowed the CIL to focus attention on these remains exhibiting sequences consistent with individuals of probable American ancestry (whether European, African, or Native American), as opposed to those indigenous to Korea, Southeast Asia, or elsewhere in Asia or the Pacific. In cases from Europe, such determinations are clearly of less value; however, in at least one case, greater credence could be given to a claim that a unilaterally turned over bone derived from an American aircraft loss because the mtDNA sequence obtained was only found in the CPD among U.S. Hispanics.

MtDNA is, in theory, an exclusionary method of identification: If an evidence sequence does not match an FRS, then the sequence does not represent that casualty. If a sequence does match an FRS, then it is possible, but not certain, that the sequence represents that casualty. In small, closed populations, all individuals generally have different sequences, so this is not a problem. In large scale comparisons, such as that between hundreds of evidence sequences and thousands of FRS, many sequences may represent multiple skeletal individuals and match multiple casualties. In these comparisons, mtDNA is a source of hypotheses, which can then be tested using other methodologies. If, for instance, a sequence from Korea or Southeast Asia matches only one casualty from that conflict, then the identitity of that sequence with that casualty is a fairly strong hypothesis. If circumstances of recovery are consistent with those of loss, and dental and anthropological comparisons are also consistent, identification may be possible. The first such IDs were made in 2004 and 2005, when skeletons turned over by the Vietnamese and North Koreans, respectively, were identified based on unique blind mtDNA matches combined with biological profiles of the skeletal remains and odontological analysis of the dental remains. If a sequence matches multiple casualties, or has been obtained from multiple sets of remains, anthropology and odontology may be insufficient to support an identification. AFDIL is now developing the capability to use Y-DNA and autosomal STR comparisons to support mtDNA matches, and both methods have been used in recent identifications (Irwin et al. 2007).[2]

The views expressed herein are those of the authors and not necessarily those of the Joint POW/MIA Accounting Command, the Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the U.S. Department of Defense.

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2 Irwin J, Edson S, Loreille O, Just R, Barritt S, Lee D, et al. The intersection of genetic identity: the application of multiple marker systems and new technologies to establish identity 50 years after death. J Forensic Sci 2007;52:1115-8.

mtDNA, Population Databases, Military Casualties

A133 Making a "Dentin" – The Use of Teeth for Human Identification: Modifications in Extraction Protocol Allow for Vast Improvements in Mitochondrial DNA Results

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After attending this presentation, attendees will have step by step knowledge on the implementation of a new protocol for the extraction of mitochondrial DNA from highly degraded tooth samples, a greater understanding of handling difficult dental samples for DNA processing, and knowledge of the improvement in the success rate of samples processed at AFDIL.

This presentation will impact the forensic science community by explaining how the modifications to this protocol have radically changed how tooth samples from highly degraded cases are processed, and will illustrate how laboratories can implement this protocol. The AFDIL has documented an increase in reported tooth samples from a historic success rate of 78% to a rate of greater than 96% with the implementation of this simple protocol.

The primary mission of the mitochondrial DNA (mtDNA) section of the Armed Forces DNA Identification Laboratory (AFDIL) is to aid the Joint POW/MIA Accounting Command (JPAC) in the identification of United States service members lost in previous military conflicts. Mitochondrial DNA testing is frequently used to obtain genetic information in cases where nuclear DNA or direct reference material is limited. Obtaining DNA from skeletal remains exposed to harsh environmental conditions such as acidic soils, extreme heat or severe fragmentation is commonly a challenge. Often, a single tooth is the only element remaining after decades of degradation. Fortunately, tooth enamel offers a greater level of protection against environmental conditions than that provided to other osseous elements. A modified extraction protocol that yields reproducible results from a smaller sample with improved reliability while preserving the tooth for comparison to dental records is the goal of this study. The protocol utilizes increased

cleaning stringency, along with a previously published demineralization extraction buffer (Loreille et al FSI:Genetics 2007) which dissolves a majority of the tooth powder. Dentin masses as low as 0.01 grams have been used to obtain fully reproducible HV1/HV2 mtDNA sequences, depending on the level of degradation. The implementation of this protocol has enabled the mtDNA Section at AFDIL to regularly generate multiple extracts from one tooth achieving our requirement for reproducibility. This protocol also improved the mtDNA testing success rate from a historical average of 78% to a current average of over 96%. Since less material is required for this protocol, it is not necessary to pulverize a complete tooth, allowing the odontologist to conduct subsequent comparisons to antemortem dental records that may become available at a later date. This protocol will benefit the forensic community in DNA identification of skeletal remains using bone and tooth material in a wide variety of circumstances including missing persons and mass graves.

mtDNA, Tooth, Extraction

A134 Resolving Extremely Commingled Skeletal Remains From the Sinking of the *USS Oklahoma* at Pearl Harbor on 7 December 1941 Through Mitochondrial DNA (mtDNA) Testing

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After attending this presentation, attendees will learn of different DNA methods being employed in the resolution of the highly commingled remains from the sinking of the *USS Oklahoma*.

The presentation will impact the forensic science community by presenting a discussion of current status of the USS Oklahoma identifications, a look at instances of bone-leaching occurring between skeletal elements, the potential application of improved DNA typing methods (i.e., LCN STR, YSTR, XSTR), and a glimpse into several future directions for this case as it represents only one casket among approximately 65 containing those service members unaccounted for from the *USS Oklahoma*.

One of the primary missions of the Armed Forces DNA Identification Laboratory (AFDIL) is to aid the Joint POW/MIA Accounting Command – Central Identification Laboratory (JPAC-CIL) in the identification of missing service members from past U.S. military conflicts, including World War II, the Korean War, and the conflict in Southeast Asia. While it is common for JPAC-CIL to encounter commingled remains recovered from the field, a recent investigation of skeletal remains believed to have originated from the battleship *USS Oklahoma* has proven particularly difficult to identify due to the circumstances surrounding their burial.

On December 7, 1941, the United states was preemptively struck in Pearl Harbor, HI, by Japanese forces, effectively drawing the U.S. into WWII. The *USS Oklahoma* (BB-37) was one of eight battleships anchored in the area of Pearl Harbor known as "Battleship Row." Due to damage sustained from torpedoes during the attack, she capsized quickly. Several sets of remains were recovered in the following days; the remains of the rest of the crew were recovered during salvage operations spanning the next two years. A total of 429 Sailors and Marines were lost aboard the *USS Oklahoma*, including one pair of twins and one set of three brothers; 35 of these casualties were resolved historically.

In 1947, all "Unknown" individuals associated with the *USS Oklahoma* were disinterred and sent to the Central Identification Laboratory (CIL) at Schofield Barracks to be processed for potential identification. The identifications could not be made easily due to commingling, and the remains were recommended for group burial. Concurrently, changes in the definition of group burials resulted in this proposal being denied. Unfortunately, the damage was already done. The skeletons had been segregated into caskets of similar skeletal elements (i.e., one filled with skulls, another with femora, another with pelvic bones) in order to reduce the total number of required caskets. Orders to re-segregate the remains into individual skeletons failed and they were reinterred simply as unknown U.S. service members at the National Memorial Cemetery of the Pacific in Hawaii.

In 2003, the Central Identification Laboratory – Hawaii (CILHI) received information that indicated a particular casket among those from the *USS Oklahoma* should contain the remains of five individuals. The unusual treatment and segregation of the remains during the 1947 exhumation had been lost to the historical archives, and as a result, potential problems with these sets of remains were not apparent at the time. The casket was disinterred and initial anthropological assessments of the remains suggested extensive commingling.

Over the last five years, AFDIL has processed a total of 177 skeletal elements from this single disinterred casket. Sequencing has resulted, at the present time, in 95 unique mitochondrial DNA haplotypes, confirming suspicions of a worst-case-scenario in regards to the state of commingling. If one assumes all individuals currently unaccounted for from the *USS Oklahoma* to have a unique mtDNA haplotype, at a minimum, 22.7% of those service members can be attributed to skeletal remains within this assemblage. As this assumption does not take into account common mtDNA haplogroups shared among maternal lineages, nor the known instances of twins/siblings on board the battleship, the situation becomes much more complex. A lack of appropriate references also provides a hindrance. Currently samples have been collected from 53 of over 400 families which could be represented, which has allowed only three skulls to be identified to date. Included in this presentation will be a discussion of this unique case's current status, a look at instances of bone-leaching occurring between skeletal elements, the potential application of improved DNA typing methods (i.e., LCN STR, YSTR, XSTR), and a glimpse into several future directions for this case as it represents only one casket among approximately 65 containing those service members unaccounted for from the *USS Oklahoma.*

The views expressed herein are those of the authors and not The Armed Forces Institute of Pathology, the U.S. Army Surgeon General, nor the U.S. Department of Defense.

Commingled Skeletal Remains, Mitochondrial DNA, *USS Oklahoma*

A135 Management in the Search, Recovery, and Analysis of Skeletal Remains in Colombia

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After attending this presentation, attendees will have an insight on the search, recovery, and processing of the skeletal remains found as a result of information obtained from defendants who enter into plea agreements with the government in exchange for information on their victims, as part of the new Law of Justice and Peace. The most relevant factors involved in the successful identification of the victims of the Colombian domestic conflict will be described, together with some of the resulting challenges.

This presentation will impact the forensic science community by explaining the complexity of recovering decomposed remains. Most of these remains are severely deteriorated by external agents. The remains are analyzed by a multidisciplinary forensic team, made up of various professionals, i.e., medical examiners, forensic anthropologists, forensic odontologists, forensic DNA experts, and facial reconstruction experts. Their experience and expertise has contributed to the determination of the cause, manner, and form of death, as well as to the estimation of age, sex, race, and stature. These are the factors taken into account to make a positive identification of the victims.

When the new law became effective, both the human and technical infrastructure of the Technical Investigation Corp (CTI) of the Attorney General's Office were insufficient to respond to the enormous amount of field recovery requests. A large number of skeletal remains were found on the basis of the information obtained. Consequently, CTI facilities and capabilities had to be expanded by implementing new state-of-the-art technologies and hiring highly qualified staff from the technical and humane standpoints.

Once the remains are found, the primary goal is to ensure reliable and high quality results in the analysis of the remains recovered by the above mentioned multidisciplinary teams. The grief of the victim's family members is somewhat mitigated if positive identification is accomplished and the skeletal remains are returned to the families for them to give proper burial to their loved ones.

Management, Multidisciplinary Teams, Skeletal Remains

A136 Quality Assessment and Alert Messaging Software for Raw Mitochondrial DNA Sequence Data

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After attending this presentation, attendees will understand the principles associated with expert system software analysis and the progress that has been made for mtDNA sequence data.

This presentation will impact the forensic science community by providing another software tool to assist DNA analysts in processing sequence data.

Expert system software programs and rule firings are not new to the forensic community. In fact, many laboratories have validated an expert system for use with single-source convicted offender data to be uploaded into the national DNA database. Expert systems have demonstrated that they can accurately and rapidly evaluate STR data. Similarly, optimized Filter Metrics have been shown to quickly and accurately assess sequence data and to save time and resources. The analyst can immediately evaluate the data after a run is complete. For example, a sample may merely need to be re-injected or a control failure can be instantly identified and the analyst can take action; a decision can be made immediately by the analyst while the plate is still on the sequencer instead of days after the run when the analyst is analyzing the data.

The University of North Texas Center for Human Identification (UNTCHI) is one of three laboratories in the United States funded by the National Institute of Justice explicitly for the identification of missing persons and is a partner in the National DNA Index System (NDIS) database for missing persons. The UNTCHI has established a multi-faceted approach to the identification of unknown human remains for missing person and cold case investigations by integrating both forensic anthropology and odontology with state-of-the-art DNA testing methods which include STR analysis and mitochondrial DNA (mtDNA) analysis.

By far, mtDNA processing and analysis is more time-consuming than STR analysis. A new software tool, eFAST Software (expert Filter and Assessment of Sequence Trace Software) will be presented, which is designed to automate the assessment of trace files generated by the instrument – minimizing the time needed by the operator to review quality of raw data – and quickly alert the operator of any data that do not meet defined metrics. The eFAST Software calculates the Trace Score, the Contiguous Read Length, and Signal Strength for each trace file as soon as it is generated by the instrument. These Filter Metrics are used to identify "high quality," "questionable," and "low quality" sequence trace files. The Filter Metrics are user-defined and can be modified for specific sequence analyses and primers. Additionally, the software will alert an analyst of any control failures as soon as a control run is complete. Negative controls and reagent blank controls are examined for signal and are marked as "questionable" by the software if the signal strength is above a defined threshold. Failed positive controls or failed negative controls on a plate automatically cause all samples in the plate with the same primer to be marked as "fail."

eFAST Software operates on the same computer running the sequencer's Data Collection software and must be launched prior to processing the samples. "High quality" trace files are copied into one directory and "low quality" or "questionable" trace files can elicit an operator alert (*i.e.,* email sent directly to the operator) for immediate intervention. A graphical user interface (GUI) will allow the operator to examine the data, annotate the data, or forward the data to an appropriate directory. Further, eFAST Software maintains Administrative and User-defined security privileges.

Trace files that pass the quality review are automatically distributed into network directories which reduce the time needed by the analyst to sort and filter the data before it is analyzed. The eFAST Software uses file names to differentiate controls and samples and identify the primers used. When all files in a plate have been processed and distributed, the plate directory on the sequencer is removed.

Quality Assessment, mtDNA Sequences, Filter Metrics

A137 A Cold-Case Investigation Utilizing Canine STRs, mtDNA, and Y-STRs

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After attending this presentation, attendees will understand that forensic analysis of canine DNA is under utilized in crime scene investigations. Due to the number of homes with dogs, the close relationships between owners and their pets, and the easy transfer of pet hair to various substrates, pet hair has the potential to provide valuable

probative information. Attendees will be educated on the discriminatory power of canine DNA through presentation of a multi-pronged approach to analysis of dog hairs in a cold-case homicide investigation.

This presentation will impact the forensic science community by stimulating interest in and increasing awareness of an untapped source of potential DNA evidence. The application of this technology can provide investigative leads, elucidate connections between victims and suspects, and contribute powerful empirical data at trial.

In May, 2006, the nude body of an eighteen-year-old female was discovered wrapped in a sheet and shower curtain and deposited in a wooded area. The cause of death was asphyxiation, and she had been dead less than twenty-four hours. At the medical examiner's office, vacuum sweepings were taken from the sheet, shower curtain, and transport sheet. Microscopic comparisons performed by the Federal Bureau of Investigations (FBI) Trace Evidence Unit identified some of the hairs obtained from the vacuum sweepings as dog. The victim did not own pets. Her boyfriend was eliminated as a suspect, and the case went cold. The FBI determined that the hairs were visually similar to those from dogs owned by the man who first discovered the body. To eliminate him as a possible suspect, the questioned hairs, along with exemplars from two dogs belonging to the man, were submitted to the Veterinary Genetics Forensic Laboratory at the University of California, Davis, for DNA analysis and match comparison. The hairs were further sorted at George Washington University for length and root swelling to optimize DNA yield.

Ten hairs were chosen for DNA extraction using a phenol:chloroform protocol and then quantified for canine DNA using a TaqMan-based quantitative PCR assay. One hair from the sheet and one hair form the transport sheet yielded sufficient DNA to proceed to genotyping. Amplification was performed using a panel of 15 autosomal short tandem repeat (STR) markers and the SRY gene for sex identification. Both hairs yielded a partial DNA profile from a male canine that excluded the two suspect dogs as the source. However, amplification of Y-chromosome STRs and sequencing of the canine hypervariable region I (HVSI) of the mitochondrial DNA (mtDNA) provided insights into the relationship between the questioned and known hairs. The questioned hairs yielded Y-STR profiles that matched the Y-chromosome haplotype obtained from the male suspect dog and a mitochondrial haplotype that matched both suspect dogs. Furthermore, the questioned hairs shared an allele at every locus with the female dog, qualifying her as a possible parent or offspring. The male dog was excluded as a parent or offspring at three loci. The two suspect dogs shared a mtDNA haplotype as well as alleles at all loci but one, indicating a potential sibling relationship. Due to the shared Y and mtDNA haplotypes, the amount of allele sharing between the questioned and known hairs, and the exclusion of the male dog as the sire or offspring of the hairs collected from the victim, investigators were advised to locate male siblings of the two suspect dogs as possible sources of the hairs recovered from the victim.

Dog, DNA, Cold Case

A138 Comparison of Quantity and Quality of DNA Recovered From Simulated Arson Cases in Which Burn Temperatures and Conditions Were Varied

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After attending this presentation, attendees will learn the results of systematic experiments performed using controlled burns with pig ribs to determine the quantity and quality of DNA recovered from simulated arson cases in which burn temperatures and conditions were varied. An open flame and convection oven were used for varying times for the controlled burns to simulate potential cases resulting from an accidental fire, arson fire, or a mass disaster event. The quality and quantity of DNA were assayed using UV-Vis spectroscopy, agarose gel electrophoresis, and real time PCR. In particular, each one of these conditions results in different burn rates and final temperatures and differentially affected the quality and quantity of DNA recovered.

This research will impact the forensic science community by providing systematic data that can be used in evaluating and collecting samples in cases of accidental fire, arson, and mass disaster. Agarose gel electrophoresis and UV-Vis spectroscopy methods allow an investigator to determine the presence and quality of DNA samples recovered from the crime scene using rapid and non-destructive techniques and real time PCR is a well-respected amplification and quantification technique for a final quality and quantity analysis. The determination of which samples provide quality DNA in terms of amplifying a short autosomal STR fragment in comparison to those that yield no detectable DNA may help the investigator to decide which samples to collect and package for further DNA processing and which are less likely to produce results.

The use of DNA to identify human remains after an accidental fire, arson fire, or even a mass disaster has become a cornerstone in the forensic community. This presentation involves two different ways of burning pig tissue and bone and will demonstrate how each one can have a unique effect on the recovery of DNA. When dealing with arson victims and the need to identify burned remains, it has not been confirmed when autosomal and mitochondrial DNA typing should be used. There is a definitive window of time, dependent upon the heat of the flame and the length of the burn, when autosomal STR analysis of DNA can be used to identify a burn victim. In this research, the goal was to answer at what temperatures and burn times would DNA become unrecoverable and unusable for identification purposes based on quality and quantity determinations.

The research described in this presentation includes both the detailed systematic methods constructed in this study and answers to the questions posed by concluding the results of each controlled burn including both agarose gel (1%) electrophoresis and UV-Vis spectroscopy (260/280 nm ratio) results. Standard DNA extraction techniques (phenol/chloroform) were utilized using food-grade pig muscle as purchased from the supermarket. In order to determine the effect of burn temperatures and conditions on DNA, one large rack of pork ribs was divided evenly, massed, and each approximately 10 gram piece was analyzed individually. The samples were burned using an open flame using a Bunsen burner (average temperature 526ºC for 25 minutes) and a conventional oven (287ºC for 20, 30, 35, and 40 minutes). The temperatures were evaluated using a Traceable Workhorse Thermometer

with Type-K probe. Control samples of unburned pig ribs were also assayed; negative controls were reagent blanks. Three replicate samples were collected for each burn temperature and time including material from the the top, middle, next to bone, and bone marrow. Agarose gel electrophoresis results for the open flame burn revealed that all the DNA recovered from the top was degraded and the bone marrow samples had the highest quantity of DNA. The results from the 20 minute oven burn revealed that there was very little to no DNA from the top and small amounts of degraded DNA from the middle, next to bone, and bone marrow samples as assayed by agarose gel electrophoresis. The 30 minute oven burn revealed no DNA except for a faint smear in the gel from the bone marrow sample. The 35 and 40 minute oven burns revealed no visible DNA recovery from agarose gel electrophoresis using SYBR Green dye for any of the samples. The 40 minute oven burn yielded mostly calcined bone that easily cracked and demonstrated full penetration of the burn for the small samples although the flesh was not completely burned off. The quality of the extracted DNA after the burns was degraded as indicated by the further migrating fragments at the longest burn time indicating smaller and more degraded DNA and low UV-Vis quality values. The longest burn times yielded no detectable DNA post-extraction from the UV-Vis spectroscopy and gel electrophoresis techniques. Overall, as expected, the surface DNA was most degraded and had the lowest recovery, although the oven burn by 35 minutes demonstrated full degradation. Since the flesh was removed from the pig muscle, the short burn times were sufficient to fully burn the 10 g meat and bone in the 35 and 40 minute oven burns. Real time PCR is being used to extend these results and determine whether the extracted DNA can be amplified to the length of a 308-bp fragment using pig-specific primers and better quantify the recovered DNA.

Arson, DNA, PCR

A139 Efficacy of Organic Osmolytes in the Preservation of Biological Samples for Forensic DNA Analysis

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After attending this presentation, attendees will have knowledge on chemical reagents that can be used to stabilize biological evidence samples for long term storage.

This presentation will impact the forensic science community by providing information on biochemical reagents that can be used to stabilize biological samples for long term storage.

Storage of biological evidence requires expensive equipment including security systems, environmental control systems, freezers, and dehumidifiers. If effective preservatives could be added to the biological evidence, the cost to store the evidence could be reduced. In addition, trace biological evidence could be stored indefinitely awaiting future more sophisticated tests. Osmolytes are naturally produced by organisms that have adapted to extreme conditions such as high temperature, low humidity, and high salinity. These compounds have previously been shown to increase the thermal stability of proteins under stressful conditions. The effect of osmolytes on the long term storage of DNA in biological samples was investigated in the present study. To assess the ability of osmolytes to improve the storage of DNA from biological samples, osmolytes (e.g., trehalose, sorbitol, myo-inositol, taurine, and hypotaurine) were incubated with samples (blood, saliva, and DNA) for four to six months under extreme environmental conditions (e.g., high temperature and humidity). DNA extracted from these samples was analyzed by STR analysis. Osmolytes (polyols, specifically trehalose and myo-inositol) were found to protect DNA from oxidative damage. It is concluded that osmolytes may be used to protect biological samples for long term storage for forensic DNA analysis.

Osmolytes, DNA, Preservation

A140 DNA Extraction and Amplification From Soft Contact Lenses

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The goal of this presentation is to demonstrate to the forensic community the feasibility of obtaining high quality and quantity DNA yields for subsequent analysis from soft contact lenses.

This presentation will impact the forensic science community by presenting pilot data on the successful extraction and PCR amplification of transferred epithelial cells from soft contact lenses. Since the items left at crime scenes are often not the best reservoirs for DNA or in ideal environmental circumstances, it is important to systematically test potential pieces of crime scene evidence in a controlled environment.

Forensic investigators are often confronted with less than ideal crime scene evidence available for the positive identification of an individual or for linking an individual to a particular location. DNA analysis is a popular technique that produces individualizing biological information. However, there is often limited evidence containing DNA of high enough quantity and quality for subsequent analysis. There have been published case reports in which victims have lost contact lenses during an attack or confinement at a particular location. Soft contact lenses are used by a large proportion of the American society and it is very likely that they may be recovered at a crime scene location and become a valuable piece of information in a forensic investigation. There have not been any systematic studies undertaken to examine the utility of contact lenses as a source of viable DNA for PCR amplification based analyses. The goal of this research is to conduct a pilot study to assess the potential of successful DNA extraction and amplification from soft contact lenses.

Soft contact lenses can potentially provide a source of DNA in sufficient quantity to produce a DNA profile due to their close association with human skin. A contact lens fits tightly against the anterior aspect of the eye and contains two types of epithelial cells: corneal and bulbar. The corneal epithelial cells are located along the eye's surface and the bulbar epithelial cells are located on the inner eyelid and corners of the eye. These epithelial cells are shed each time an individual blinks their eye. Since these cells are nucleated and regenerate every six to twenty four

hours, they become a potential source for template DNA. This study exploits the possibility that the epithelial cells are transferred to the inner and outer contact surfaces once they are shed from the body.

This pilot study employed both dry and wet contact lenses that had been worn for various time periods beginning at fifteen minutes. The dry lenses were allowed to air dry for one to three weeks, and the wet lenses were swabbed for DNA immediately after removal from the eyes. The type of DNA employed in this study is nuclear DNA because of its individualizing properties and its use in forensic investigations. PCR amplifications used the HUMTHO1 primer set, and appropriate controls were used to check for contamination throughout the process. The quantity and quality of the amplified DNA was compared between the wet and dry lenses. DNA quantity was assessed by amplicon intensity on an agarose gel and DNA quality was assessed by PCR amplification success. PCR amplifiable DNA was obtained from both the wet and dry soft contact lenses in various quantities, suggesting that contact lenses are a potential source for analyzable DNA at crime scenes.

DNA, PCR Amplification, Contact Lenses

A141 Application Studies on Direct Quantitation, Direct PCR, and mtDNA Sequencing Without DNA Purification From Saliva Spotted Paper

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After attending this presentation, attendees will have information about direct PCR.

This presentation wll impact the forensic science communty by discussing direct PCR without DNA isolation.

Buccal cell DNA concentrations were directly quantified in this study by real time PCR without a prior DNA purification step. For this purpose, a newly developed direct q-PCR mixture was used. A total of 86 saliva-spots were collected and divided into three groups (A, B, and C). The "A" group samples were collected regardless of tooth brushing, but the "B" and "C" groups were collected before and after tooth brushing respectively from the same individuals. The quantification of each sample was performed three times and followed by calculation of their average concentration. The result showed that about 84.9% of quantified saliva spot had a DNA concentration range of 0.041 to 1.0 ng/µL. The average DNA concentration values from 89% of "B" group samples were higher than those from corresponding "C" samples. Moreover, "B" group samples showed higher PCR success rates than those of "C". These results suggest that the PCR buffer can amplify saliva directly, regardless of possible PCR inhibitors in saliva. It is thought that if a sufficient amount of saliva is spotted on saliva spotted paper at the sampling stage, PCR reaction can be successfully performed without a prior DNA quantification procedure. Additionally, mtDNA templates were directly amplified using the same direct PCR buffer, followed by sequence analysis with a cycle sequencing kit. In general, the purified DNA template is required for an amplification of a hypervariable region in routine mtDNA sequencing. It was possible to directly amplify ~ 1 kb mtDNA template using direct PCR buffer system from blood, saliva, and hair roots followed by sequence analysis with a terminator cycle sequencing kit. The resulting HV1 and HV2 sequence data showed good resolution without particular noise peaks and whole sequence concordance with data from a routine method. In the case of hair roots, pre-lysis with DTT and proteinase K is necessary, but needs no further purification step.

In conclusion, streamlined work flow through the studied PCR buffer system appears to be suitable for fast forensic DNA analysis or analysis for criminal DNA databases.

Direct Quantitation, Direct PCR, mtDNA Sequencing

A142 Developement of a New Autosomal STR Multiplex System as a Supplemental Tool With Other Commercial Kits

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After attending this presentation, attendees will be introduced to the developement of a new autosomal STR multiplex system.

This presentation will impact the forensic science community by comparing a supplemental tool with other commercial kits.

A newly developed and highly discriminating fluorescent dye labeled short tandem repeat (STR) multiplex PCR set, which includes 4 non-CODIS loci (D1S1612, D15S659, D11S1978, and D22S691) plus the sex-typing marker amelogenin gene, was developed as part of this study. The new autosomal STR quadruplex plus amel set was performed in one reaction. The amelogenin primers used in this set were different from those commonly used in commercial kits. Sequence analysis confirmed the allele and allele assignment was performed by comparision with the ladder for each locus.

Optimal PCR conditions were determined in singleplex for each locus and the locus combined to a set. This set of a quadruplex plus amel had allele size range of ~97 base pairs (bp) to ~356bp, with the size of amelogenin ranging from ~220bp to ~226bp. The allelic distribution was surveyed using the population DNA from 300 unrelated Koreans and the mutation rate of each locus was determined by pedigree analysis of Korean families.

The combined probability of identity (PI) value from four STR loci was calculated as1.48×10^{-5} in the Korean population. This quadruplex plus amel set may be combined to a previously developed single amplification system with three other multiplex sets (12 STR loci, poster presentation # p-75 in 22th ISFG, 2007). The tests may also be used for paternity tests as a supplemental tool. This combined multiplex system includes a quadruplex plus amel set and appears to be a supplemental tool for use with other commercial STR kits in forensic casework and paternity test.

4 Non-CODIS loci, Multiplex, Korean DNA

A143 Unusual Variations in Mitochondrial DNA Sequences Between Three Maternally Related Siblings

Sean Patterson, MS, Susan Belote, BS, Toni M. Diegoli, MFS, Christopher T. Johnson, BS, Andrew VanPelt, MS, Suzanne M. Barritt, MS, Mike Coble, PhD, Brion C. Smith, DDS, Louis N. Finelli, MD, and Suni M. Edson, MS, Armed Forces DNA Identification Laboratory, 1413 Research Boulevard, Building 101, Rockville, MD 20850*

After attending this presentation, attendees will learn about the intricacies of developing guidelines for exclusion for mitochondrial DNA analysis.

This presentation will impact the forensic science community by demonstrating the importance of collecting multiple mitochondrial DNA references for the identification of skeletal remains.

One mission of the Armed Forces DNA Identification Laboratory (AFDIL) is to aid the Joint POW/MIA Accounting Command (JPAC) in the identification of missing U.S. service members from previous military conflicts. This is accomplished by extracting mitochondrial DNA (mtDNA) from samples of unknown origin collected in the field and comparing the haplotype to a database of mtDNA profiles obtained from family reference samples (FRS). The sequence comparison is used to either include or exclude potential missing service members in the remains identification. AFDIL requests at least two FRS per missing service member to resolve any potential differences between the missing individual and their maternal relatives (e.g., heteroplasmy or any single base mutations that may have occurred), although this may not always be possible.

Recently, two family reference submissions from persons listed as full siblings to an individual missing from the Korean War were found to differ by two polymorphisms in their respective mtDNA sequences. The sister had eight polymorphisms when compared to the rCRS and the brother had the same eight polymorphisms along with two additional polymorphisms, at nt146 and nt152. Examination of the electropherograms showed that both nucleotides exhibited complete homoplasmic changes and were free of any low level heteroplasmy or contamination. According to AFDIL's standard operating procedures and the current SWGDAM guidelines for mtDNA interpretation (SWGDAM, 2003),[1] these two individuals would be excluded from being maternally related.

A maternal half-sister to the siblings submitted a reference sample upon request for additional samples from maternal relatives. The half-sister's sequence was found to have the same eight polymorphisms common to the sister and brother as well as one additional polymorphism (nt146 C). AFDIL confirmed the relationship of the three siblings by testing autosomal STRs as well as an experimental assay analyzing chromosomal X-STRs.

In the 18-year history of AFDIL, 13,243 FRS have been received from 8,146 families and this is the first instance of siblings showing two distinct polymorphic differences in the mtDNA control region (when excluding the HV2 C-stretch and nt16093). Unlike autosomal STRs which allow for discrimination between individuals, mtDNA is typically used to discriminate among maternal familial lineages. The variability among the siblings in this case is explained given the positions at which the sequences are dissimilar. Positions 146 and 152 have relatively high mutation rates as both positions are within the top ten fastest mutating sites in the control region. It can be hypothesized that the mother of the three siblings was likely heteroplasmic at both nt146 and nt152. Unfortunately, the mother is not available for contribution of a sample to verify this hypothesis.

Given the infrequency of such an event, it is unnecessary to modify the current reporting guidelines; however, this can be seen as support for collecting more than one mtDNA family reference for the purposes of identifying unknown remains.

Reference:

[1] SWGDAM (Scientific Working Group of DNA Analysis Methods). Guidelines for Mitochondrial DNA (mtDNA) Nucleotide Sequence Interpretation. Forensic Science Communications 2003, April; 5(2).

Mitochondrial DNA, Sibling Variability, Identification

A144 Pollen DNA: A New Tool for Forensic Investigations

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After attending this presentation, attendees of this presentation will gain practical knowledge as it applies to the extraction and real-time quantification of Pinus echinata (yellow pine) pollen DNA, internal transcribed spacer (ITS) sequencing of extracted pollen DNA for verification of pollen grain origin as being from Pinus echinata, and the genetic analysis of existing *Pinus sp*. sequences for allele frequencies in the development of short tandem repeat (STR) markers used for STR analysis of the selected loci in yellow pine pollen.

This presentation will impact the forensic science community by providing forensic biology laboratories a novel point of view in the use of traditional forensic palynology practices combined with the recognition of species specific pollen DNA STR profiles from yellow pine as it relates in the use of pine pollen to link suspects or objects to specific locations.

Consequences resulting from the failure to undoubtedly associate suspects or objects to a crime and/or a crime scene through the use of traditional investigative techniques, including DNA profiling obtained from collected biological specimens as well as the identification of other crime related indicators, can be mitigated when pine pollen is present.

Yellow pine has the widest range of any pine in the southeastern United States. It grows in twenty two states with a dense population in eastern Texas. Additionally, yellow pine pollen is heavily shed at a time when other pollens are at relatively low numbers by comparison due to its wide distribution across the warmer regions of the Deep South. Yellow pine pollens predominate seasonally in the environment; collecting on clothing and other objects, in hair and even in nasal passages. The identification of yellow pine pollen in association with a specific crime by morphology alone may not provide any forensically defensible insight due to an inability to provide a sufficiently distinct region or subpopulation of taxa of pollen origin, therefore having low evidentiary value in a court of law. Yet, as a wind facilitated pollinator, *Pinus echinata* pollen is unlikely to travel long distances allowing for the evaluation and identification of genetically distinct subpopulations of yellow pine. Pollen grains can be linked to their male conifer donor through the use of population studies on existing pine DNA sequences and the genetic analysis of yellow pine strands using yellow pine pollen DNA.

The goal is to identify polymorphic microsatellite regions suitable for the development of STR markers. This goal will be achieved through the collection and extraction of DNA from yellow pine pollen and the evaluation of Pinus sp. DNA sequences already available through NCBI's Genbank. Once these markers have been developed, they can be used to amplify locus-specific regions in *Pinus echinata* pollen DNA to provide insight into the originating pine tree's associated geographical population substructure. Knowledge of this geographical distribution would allow for pollen grains to be traced back to their individual conifer donors. This presentation will also demonstrate that a system can be developed to enable this protocol to be used for any pollen for more extensive applications.

Pollen, DNA, Investigation

A145 Internal Validation of an Automated Extraction Robot

Mario Galioto, BS, Sam Houston State University, 1011 County Road, Killeen, TX 76543; Diana G. Morales, MS, 504 Wiley Street, Hutto, TX 78634; and Cassie Carradine, MS, Austin Police Department, Forensic Science Division, PO Box 689001, Austin, TX 78768-9001*

The goal of this presentation is to describe the internal validation of an automated extraction robot. Attendees of this presentation will learn how the extraction robot provides for an automated extraction using silica-based spin columns and the procedure by which a laboratory may internally validate such an instrument. The parameters used to validate the instrument will be defined and the methods to test them will be demonstrated for attendees. An example of the results of a successful validation of an automated extraction robot will then be given.

This presentation will impact the forensic science community because it will offer an internal validation plan that may serve as a template that can be applied to any automated technology new to forensic DNA analysis.

There are two levels of validation for any new instrumentation in forensic science. Developmental validation, the first level, is conducted by the manufacturer of new instrumentation during the design process. Internal validation, the second level, is performed within individual laboratories to confirm the results of the developmental validation. Protocols for the internal validation of new instruments are necessary so that forensic laboratories maintain a rigorous standard of integrity and credibility. This presentation will thus be beneficial to forensic science because it will offer an internal validation plan that may serve as a template that can be applied to any automated technology new to forensic DNA analysis.

The objective of this study was to validate an automated extraction robot for use in casework at the DNA Section of the Austin Police Department Forensic Science Division. The authors performed several studies within the framework of the validation. Blood and saliva samples were extracted on the extraction robot, quantified, amplified, and separated to verify that the resulting STR profiles were concordant with the known profiles for each sample. This part of the validation was intended to demonstrate the extraction robot's effectiveness at extracting DNA from different sample matrices. A series of four contamination studies were also completed, in which different configurations of alternating blood samples and reaction blanks were extracted on the robot, quantified, amplified, and separated in order to ensure that the instrument does not cause cross-contamination. A set of mixtures were also extracted on the robot and STR profiles developed to ensure that there was no interference in obtaining profiles composed of alleles from both donors. Reference samples traceable to the National Institute of Standards and Technology (NIST) and mock casework samples extracted on the robot were also analyzed with the objective of achieving fully accurate profiles. Finally, a sensitivity study was conducted using a range of DNA dilutions from 1:10 up to 1:200 to determine the lowest concentration of DNA that can be extracted on the robot and still result in a full profile.

The results of all blood and saliva samples achieved full concordance at all loci. All amplified reaction blanks from each of the four contamination studies contained no detectable DNA. Alleles found in all loci of profiles obtained from the mixture samples were consistent with the donors. Profiles from the NIST standards and mock case samples were determined to be fully accurate when verified against the appropriate references. For the sensitivity samples, full profiles were achievable at DNA concentrations with a lower limit of approximately 0.01 ng/µL.

From these results, this research has demonstrated the extraction robot's ability to extract DNA from a variety of sample matrices without introducing contamination, while maintaining a high level of accuracy and sensitivity suitable for forensic casework.

Automation, Validation, Extraction Robot

A146 Effect of Inhibitors in STR Amplifications From Forensic Samples

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After attending this presentation, attendees will examine allele specific effects of PCR inhibition on STR and Y-STR amplifications and to correlate these data with results from real time PCR measurements.

This presentation will impact the forensic science community by demonstrating the effects of PCR inhibition on locus specific allele dropout by illustrating the ways real time PCR can be used to predict inhibitory effects.

All who use PCR are likely to be impacted by inhibitors at some time, but the wide range of forensic sample types and variety of sampling conditions encountered make forensic scientist particularly vulnerable. PCR inhibitors generally exert their effect through direct interaction with DNA or via interferences with thermostable DNA polymerases. The presence of inhibitors in samples has been the focus of much published literature. Common sample types known to contain inhibitors include blood, fabrics, tissues, bones, and soil.

Inhibitors can produce various effects on amplified DNA including peak balance problems, locus specific dropout, enhanced stutter, and poor sensitivity. The mechanisms may vary with type of inhibitor and sequence of amplicon. Therefore, it is important to understand concentration effects and mechanisms so that inhibition cannot be confused with degradation, dropout, and mixture effects.

STR amplifications were examined with two different commercial kits, STR and Y-STR. The effect of testing different inhibitors on the relative intensity of various alleles in the electropherograms was looked at in both amplifications. Humic acid, collagen, and calcium phosphate was used in different concentrations to evaluate the profiles of alleles inhibited in the amplifications. The effect of DNA template concentration was also examined. These data were correlated with information from real time PCR melt curves and Ct values. Overall, the results show interesting effects with respect to allele loss that appear to correlate with the type of inhibitor and the length of the amplicon.

Inhibition, STR, Y-STR, Real-Time PCR

A147 Internal Validation of Y-STRs for Casework at the Kentucky State Police Crime Laboratory

Sally Edwards, BS, Marshall University Forensic Science Center, 1401 Forensic Science Drive, Huntington, WV 25701*

The goal of this presentation is to make the forensic science community aware of the benefits of Y-STRs for casework at the Kentucky State Police Crime Laboratory.

This presentation will impact the forensic science community by showing the importance and effectiveness of Y-STRs.

Y-STRs allow amplification of human male DNA in a single reaction. Crime laboratories are interested in amplification kits for situations such as sexual assaults. In cases of sexual assault, often times a complete profile for a male contributor is difficult to obtain due to high levels of female DNA and low levels of male DNA. These kits are also effective for blood-blood or saliva-blood mixtures, samples from azospermatic males, and other samples containing male DNA not optimally amplified with autosomal STR kits. One Y-STR kit targets 17 Y-STR markers including the European minimal haplotype markers (DYS19, DYS385a/b, DYS389I, DYS389II, DYS390, DYS391, DYS392, and DYS393), two markers recommended by SWGDAM (DYS438 and DYS439), and six polymorphic haplotype markers (DYS437, DYS448, DYS456, DYS458, DYS635, and Y GATA H4) while another kit targets the European minimal haplotype markers (DYS19, DYS385a/b, DYS389I, DYS389II, DYS390, DYS391, DYS392, and DYS393), two markers recommended by SWGDAM (DYS438 and DYS439), and one polymorphic haplotype marker (DYS437). Some markers, such as DYS385a/b, are multi-copy markers. At this specific marker, the a/b indicates two peaks at this locus. In actuality, the locus is amplified with a single set of primers, which may result in the peaks being the same height (seen as one peak) or different heights (seen as two peaks).

An internal validation for Y-STRs was performed at the Kentucky State Police Central Laboratory in order to determine which commercial amplification kit meets the needs for forensic casework at the KSP. The validation studies included: sensitivity, female/male mixtures, male specificity, allelic dropout, distinguishing profiles from both contributors in male/male mixtures, adjusting stutter filters, documentation of common artifacts, reproducibility of results, accuracy of results using NIST Standard Reference Material® (SRM) # 2395 samples, contamination, precision, and Y-STR database statistics. One Y-STR amplification kit was chosen for validation purposes because more markers were amplified as well as an established relationship with the manufacturer. In the validation studies performed, this kit proved to be sensitive and able to produce complete profiles from samples containing template DNA as low as 125 pg. Samples with as little as 50 pg had 88.2% alleles called. Female DNA is not amplified at strengths of 200 times that of male DNA (e.g., 100 ng:0.5 ng mixtures) because the primers bind specifically to the 17 Y-STR markers. This means that at concentrations as strong as 100 ng, female DNA will not interfere. Male/male mixture samples were created to mimic casework-type samples. These mixtures could be discerned at a ratio of 70:30 in samples with 1.2 ng, 0.6 ng, and 0.3 ng total DNA and most 60:40 samples. For 90:10 mixtures, samples with 1.2 ng total DNA had 95.70% of alleles called and for samples with 0.3 ng total DNA, 77.42% of alleles were called. Stutter peaks were documented and adjustments to stutter filters were based on the highest stutter value observed. During this validation, it was found that the following loci needed higher stutter filters than those recommended by the manufacturer: DYS456, DYS390, DYS389II, DYS385 a/b, DYS393, and DYS392. Based on the results, this internal validation shows that reproducible results from a Y-STR amplification kit will be beneficial for forensic casework purposes.

A future study using a Y-STR amplification kit may be performed to determine whether or not there will be any interference with male DNA amplification if female DNA is present at stronger concentrations (e.g., >100 ng). Other studies of interest include increasing the PCR cycle number during amplification, analyzing male/male mixtures with additional genotypes, and performing post-amplification purification to remove primer peaks.

Y-STR, Validation, Y-filer

A148 Comparison of Different Amplification Reagents for Alleviating Inhibitory Effects of Indigo Dye in PCR

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After attending this presentation, attendees will have learned about the effectiveness of a commercially available PCR enhancing reagent in comparison to 3X Taq polymerase/BSA in alleviating inhibitory effects of indigo dye during PCR.

This presentation will impact the forensic science community by presenting data to confirm the effectiveness of different reagents in combating inhibitors such as indigo dye during PCR. This knowledge is important because forensic scientists can better select which reagents to use in their future PCR studies based on the outcome of this experiment.

PCR is an indispensable tool in forensic science studies. All who use PCR are likely to be impacted by inhibitors at some time, but the wide range of forensic sample types and variety of sampling conditions encountered renders forensic DNA samples particularly susceptible to inhibitors. There are several approaches that have been utilized to address PCR inhibitors including simply diluting the sample. This approach may not always be effective depending on the concentration of the inhibitor and the template concentration. Another method recently developed involves removing inhibitors from DNA samples using an automated instrument. This method appears promising, but the backlogs at crime labs, and the expense and time of purifying each sample before PCR may make this method impractical for all cases.

Another method of addressing PCR inhibitors is to find reagents that will alleviate the inhibiting effects during the PCR process. Knowing which reagents to select to accomplish this goal has multiple advantages. First, this may reduce sample consumption as the number of re-amplifications of inhibited samples may be reduced. Second, it may also increase productivity by reducing the need for analysis and review of replicate samples. Third, it will also likely reduce costs.

A number of studies claim that the use of a variety of reagents can enhance PCR performance by improving sensitivity and specificity during amplification of genomic DNA templates. The goal of this study is to evaluate the effectiveness of different reagents in alleviating the

inhibitory effects of indigo dye (known inhibitor) from denim, which is a frequently encountered evidentiary substrate from blue jeans.

Control 9947a DNA will be first quantified using qPCR and spiked with different amounts of Indigo dye to mimic samples that contain co-extracted indigo dye. In addition, DNA extracted from blood delivered on blue jeans will also be utilized. Comparisons of three reagents will be performed on control DNA spiked with Indigo Dye and DNA extracted from blood on denim at different concentrations: (1) A PCR enhancing reagent (commercially available); (2) tripling the amount of DNA polymerase with additional bovine serum albumin; and, 3) a combination of both 1 and 2. After PCR, capillary electrophoresis will be used to separate the amplicons and computer analysis will be used to evaluate the results in terms of degree of amplification (eg peak heights and peak height ratios) and the number of alleles recovered. It is hypothesized that the combination of both approaches will be most effective in alleviating inhibitory effects of indigo dye.

The long term goal of this study is to investigate the possible mechanisms of indigo dye inhibition on PCR. Overcoming inhibition with different reagent strategies may provide useful information to this end. There are several possible mechanisms of inhibition. First, indigo dye molecules may bind to DNA and inhibit the amplification process. Second, it is possible that indigo dye interferes with primer extension by the DNA polymerase. If such is the case, PCR cannot take place properly. Finally, in order to utilize indigo dye for staining denim, it is must be reduced to the negatively charged leucoindigo (soluble form) and when in solution (as it may be in co-extracted DNA samples), may interfere with the cofactors (eg Mg++) necessary for successful PCR. Other experiments with varying amounts of DNA template, indigo dye, and additional Mg2+ will also be performed. Knowing the indigo dye inhibitory mechanisms is important because further research can be made to enhance reagents aimed to alleviate indigo effects on PCR, thus making this tool more accurate and effective in forensic identification.

PCR, Inhibition, Indigo Dye

A149 Internal Validation of the Short Amplicon Y-STR Multiplex System for Use in Forensic Casework

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After attending this presentation, attendees will understand a new Y-miniplex system that may be a supplemental tool in the examination of degraded forensic casework samples with other commercial kits.

This presentation will impact the forensic science community by demonstrating how Short Amplicon Y-STR makes it possible to analyze degraded forensic casework samples effectively and reliably.

Y-chromosome short tandem repeat (Y-STR) markers are being used as tools for distinguishing male DNA as is present in many sexual assault samples. DNA samples from forensic cases, however, are often degraded and/or tainted by environmental contaminations. To increase the success rate of Y-STR genotyping for degraded forensic samples, a new Y-miniplex system (DYS391, DYS439, DYS385, DYS392, DYS390, DYS438, DYS635) was developed in previous research (M.J. Park, K.J. Shin, 2007). In this study, an internal validation study of a new Y-miniplex system was performed to implement into routine forensic casework analysis. In a concordance study between the commercial Y-STR kit and the new Y-miniplex system, no genotype differences were revealed in 100 randomly selected Korean-male individuals. A sensitivity test using serially diluted standard 9948 male DNA showed that all the values of loci in the Y-miniplex were reliable at template concentrations as low as 30 pg. In the male-male mixtures, a complete profile from the minor component was detected up to 1:16 ratio. Complete Y-STR profiles were obtained when 30 pg male DNA was mixed with female DNA at ratios up to 1:8000. According to results from the test on degraded and tiny amounts of Forensic DNA samples (old bone & rape case sample), the new Y-miniplex system was proved to be quite an effective tool for analyzing forensic DNA samples. It is concluded that the new Y-miniplex system appears to be a possible supplemental tool in the examination of degraded forensic casework samples with other commercial kits.

Short Amplicon, Forensic Casework, miniSTR

A150 Development of Standardized Protocols for the Intervention of Forensic Pathologists and BPA Experts in the Solution of Violent Crimes

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The goal of this presentation is to highlight the need for standardization of investigations in the field of forensic pathology and of their integration with the Bloodstain Pattern Analysis (BPA) within the framework of judicial on-site inspections regarding deaths by firearm, which is one of the most frequent causes in murder and suicide cases.

This presentation will impact the forensic science community by dealing with a real case brought to the attention of the authors of the present study and will allow the forensic community to understand that an adequate drive to aid in the further development of criminal investigations can only come from the standardization of on-site inspection techniques and their integration with the medico-legal and laboratory procedures, which will allow the sharing of the know-how and competence of experts operating in the field of forensic sciences.

The case at the center of the study is reported from the Calabria Region, a geographic area in Southern Italy with a high rate of murders connected with organized crime, largely in part to the activities of a criminal organization called "Ndrangheta," whose goals are the control of weapons and drug trafficking as well as extortion. In summer, at approximately 10:00 p.m., the corpse of 70-year-old man was found. The decedent was lying on the lawn in front of his country home and had a wound by a single-charge firearm at the level of his left cheek. The scene of the crime included about 500 square meters of a steep rural area with several natural obstacles. Wide areas stained with blood could be observed. Several blood traces were found, in particular, on leaves and bushes. Immediately after the finding, the inspections converged towards the assumption of murder, as the distribution of blood traces along a lengthy and winding path with ascents, descents, and obstacles to be

overcome appeared compatible with a subject on the run, thus supporting the hypothesis of murder. From the thorough on-site inspection carried out by the forensic pathologist and the technicians with an expertise in BPA, it turned out, however, that the morphology of blood traces, their distribution on the corpse, and the surfaces stained, raised serious doubts about the relationship between the real dynamics of the events and the initial hypothesis assumed by investigators. The BPA analysis carried out thus allowed the consideration of a different sequence of events. It was only after a long and thorough on-site inspection that the revolver used for this action was found among some leaves, thus allowing the completion of the investigation on the spot. The study of the corpse and the medico-legal postmortem examination, performed in compliance with the standards set forth in Recommendation No. R(99)3 of the Council of Europe, provided the correct solution via an intra-body ballistic exam. The overall evaluation of the technical data allowed the investigators to conclude a suicidal event. BPA applications led the authors to reconstruct the event and to evaluate each step from the firing of the shot to the moment of death.

An evaluation of the blood flow in the vascular sections caused by the lesion allowed the calculation of the hemorrhage volume and made it possible to reconstruct the victim's survival time after the shot was fired into his mouth. Additionally, lacerations were found on the neck of the subject, which may have made it possible for the undoubtedly frightened subject to run around for some time until his vital functions slowed. This study should reveal the need for investigators to focus their inquiries on correct assumptions and avoid possible evaluation mistakes regarding the dynamics of an event and the involvement of different subjects.

BPA, Standardized Protocols, On-Site Inspection

A151 Performance Evaluation of a New 14-Channel Extraction Robot

Mario Scherer, PhD, and Thomas Schnibbe, PhD, QIAGEN GmbH, QIAGEN Str. 1, Hilden, 40724, GERMANY*

The goal of this presentation is to share validation and customer evaluation data on a new platform for automated low- to medium-throughput extraction of nucleic acids from demanding trace material as well as reference samples.

This presentation will impact the forensic science community by enabling forensic investigators to process case evidence with higher speed and accuracy and in a standardized manner with greater consistency and reproducibility.

Forensic DNA laboratories are challenged by the requirement to provide results on the identity of genetic evidence within a very short time. This holds true for important casework evidence as well as for reference samples taken from suspects. This often requires the start of DNA extractions immediately after reception of samples and to work in comparatively small batch sizes. Fast low-throughput robotic extraction systems have found widespread utilization for this purpose.

Recently, a second generation instrument system has been developed incorporating additional functionalities to meet increasing requirements regarding forensic process safety: A UV lamp decontaminates the inner surface of the workstation, which helps to eliminate sample carryover from run-to-run. Forensic data management and chain of custody are improved in the new system. Barcode reading enables complete tracking of samples and reagents throughout the entire purification process. Reagent identification and lot numbers are logged and all relevant process information is documented in a report file that can be either sent to a connected PC or a small printer available for the system.

The instrument enables nucleic acid purification from a wide range of forensic reference and casework samples. Utilization of pre-filled reagent strips reduces the risk of contamination during setup. Throughput is increased to accommodate the simultaneous extraction of up to fourteen samples in a single run which allows the integration of positive and negative extraction controls more easily. The instrument is operated using application specific protocol cards. A dedicated protocol card for human identity related applications stores various protocols for the extraction of forensic samples. A large volume protocol allows the use of up to 500 µl lysate as input for nucleic acid extraction. A so called "tip dance" protocol simplifies handling of samples that contain solid substrates, such as swabs, dried blood spots, fabrics, or cigarette butts. Furthermore, there is no need for removal of solid material prior to extraction. Various elution volumes down to 40 µl can be combined with any protocol to yield more concentrated DNA and to improve sensitivity in downstream STR analysis.

The 14-channel instrument was evaluated for the extraction of various typical crime scene or reference sample types. Buccal swabs were reliably processed using the "tip dance" protocol. Negative extraction controls run in parallel all turned out to be free of contaminating DNA, proving exclusion of sample carry-over. DNA was purified from cellular material on demanding casework samples known to contain high amounts of potent PCR inhibitors, like strongly colored leather substrates. No inhibitory effects were observed in downstream quantification PCR or STR analyses and full profiles were obtained.

Automation, Nucleic Acid Extraction, DNA

A152 Liquid DNA Extraction and Expedited PCR for the Analysis of Forensic Biological Samples

Jenny A. Lounsbury, MSFS, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

After attending this presentation, attendees will have gained an understanding of a phase-less DNA purification method to prepare biological samples for direct transfer to an expedited DNA amplification reaction.

This presentation will impact the forensic science community by describing a simplistic and faster method for DNA purification, as well as a more rapid method for DNA amplification. These improvements have the potential to greatly decrease overall analysis time and, therefore, increase sample throughput in forensic laboratories.

Solid phase extraction (SPE) is a widely used DNA extraction method, which typically utilizes a silica-based solid phase to reversibly bind DNA, followed by a series of washes to remove cellular debris, proteins, and PCR inhibitors. The bound DNA can then be eluted from the solid phase by using a low ionic strength buffer. SPE methods have been successfully adapted for use on a microdevice, providing purified DNA in a concentrated, small volume.[1] However, success with microfluidic-based SPE can be hindered by several problems that may arise, such as uneven packing of the solid phase within the microchannel and high backpressure, if the method is not well-optimized. Many of the issues with microscale SPE methodologies can be resolved by moving to a phase-less, liquid purification method, thus eliminating the need for a

solid phase and simplifying microscale DNA extraction by making it less time consuming and more automatable.

Microfluidic devices provide a rapid, cost-effective alternative to conventional DNA analysis techniques and provide a platform for integration of multiple techniques on a single device. Along with SPE, PCR can readily be adapted to a microdevice where amplification can be performed in nanoliter reaction chambers. A non-contact heating method, such as infrared (IR)-mediated PCR, provides faster heating and cooling rates than can be achieved in a conventional thermal cycler, resulting in more rapid thermal cycling times.[2]

Previous expedited PCR studies have demonstrated the successful amplification of DNA in ~36 minutes using a commercially available STR amplification kit, commercially available polymerases that have been modified to have faster extension rates and improved processivity over traditional polymerases, and a conventional thermal cycler.[3] While a substantial advancement for the forensic community, improvements could broaden the use of this method to compromised and/or degraded samples with the use of a mini-STR amplification kit as well as more rapid thermal cycling technology. Using faster polymerases and the mini-STR amplification kit, in combination with IR-mediated heating on a microfluidic device, could lead to even faster amplification times and therefore, decrease the overall analysis time.

The current work presented here focuses on the evaluation of a DNA purification process without the use of a solid phase that requires only a 20 min incubation to obtain PCR-amplifiable DNA from crude samples. The sample, either whole blood or epithelial cells eluted from a buccal swab, is added directly to the purification reaction mix that consists of buffer and enzyme. Several purification reaction recipes were evaluated to maximize the amount of DNA recovered. Once purified, the DNA was added to an expedited PCR mixture, was loaded onto a microdevice, and PCR was performed using an IR-mediated thermal cycling method. The results indicate that the phase-less DNA purification method is able to produce amplifiable DNA, yielding full (nine of nine loci) mini-STR profiles. This method will demonstrate the first example of a phase-less DNA purification method in combination with IR-mediated PCR on a microfluidic device in ~ 1 hr, a reduction of three hours in analysis time in comparison to conventional methodology.

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PCR, DNA Extraction, STR Analysis

A153 Detection of Pathogen Mixtures Using Luminex® Technology

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After attending this presentation, attendees will gain some insight into how Luminex® technology may be used to address the perennial threat of bioterrorism.

This presentation will impact the forensic science community by demonstrating that the Luminex® technology is capable of detecting pathogens with a celerity and specificity that surpasses alternative methods, thus allowing for a swift and appropriate response to potential cases of bioterrorism.

Luminex® technology is a bead-based liquid array platform that relies on small (5.6 μm diameter) polystyrene microspheres that are each internally labeled with their own unique dye combination. DNA probes unique for a particular bacterial species were attached to the microsphere surface. Target DNA (*i.e.*, the unknown) was prepared by PCR and labeled with a reporter fluorophore. Hybridization between the DNA probes and the target DNA causes a fluorescent emission which is then detected using Luminex® xMAP technology and MiraiBio MasterPlex® software. The instrument classifies the microspheres by using a red diode laser (635 nm) to detect the fluorescence emitted by the internal dyes of the microspheres, and a green diode laser (532 nm) to detect and quantify the target DNA by measuring the intensity of the fluorescence emitted by the reporter.

It was hypothesized that the robustness of Luminex® technology would be validated not only when screening for individual pathogens, but also when screening mixtures of several pathogens. First, the ability to detect each of four individual pathogens (*Bacillus cereus*, *Escherichia coli*, *Staphylococcus aureus*, or *Salmonella enterica*) was evaluated using probes complementary to sequences in the respective 23S ribosomal RNA genes, *rrl*. The specificity of the assay was confirmed, although some cross-reactivity was observed between *E. coli* and *S. enterica*. Adjustments made to the buffer salt concentration and hybridization temperature did not remedy the problem.

The ability to detect DNA in mixtures was then evaluated. To begin, all possible binary, ternary, and quaternary mixtures of pathogen DNA were examined using 10 ng DNA from each respective pathogen. In all mixtures, the highest median fluorescent intensity (MFI) values always corresponded to the bacterial DNA that was present. However, the MFI values did not always meet the minimum threshold (> 2X background MFI), and thus there were several instances of false negatives. No false positives were observed. Most of the false negatives involved the probe for *S. enterica*, which exhibited MFI values below the threshold even when *S. enterica* DNA was present. This was possibly due to cross-reactivity with the *E. coli* probe, which exhibited 85% sequence homology with the *S. enterica* probe.

A subsequent mixture study examined all possible binary mixtures of the four pathogens' DNA when present in various ratios (1:1, 1:2, 1:5, 1:10, and all converse ratios). Again, the highest MFI values always corresponded to the bacterial DNA that was present, even when the minor component was present at 1/10 the concentration of the major. As before, there were several instances in which the MFI values unexpectedly failed to meet the minimum threshold, thus yielding a false negative. All false negatives involved the *S. enterica* probe, possibly due to the cross-hybridization described above. No false positives were observed.

Future studies will include specificity, sensitivity, and mixture studies on DNA from additional pathogens that are more closely related. The use of markers with minimum sequence homology is expected to reduce potential problems with cross-reactivity. Multiple markers for each pathogen will also be sought, so that the likelihoods for false positives among closely related pathogens can be minimized.

Luminex®, Pathogens, Bioterrorism

A154 Rhizobial Profiling of Soil for Forensic Applications

Ethan S.T. Smith, BS, and David R. Foran, PhD, Forensic Science Program, Michigan State University, 560 Baker Hall, East Lansing, MI 48824*

After attending this presentation, attendees will understand the utility of identifying soil via microbial fingerprinting, using a novel quantitative polymerase chain reaction (qPCR) assay designed to determine Rhizobium abundance.

This presentation will impact the forensic community by addressing a novel method for soil identification.

Soil can be of tremendous evidentiary value in forensic investigations, wherein questioned and known samples can either be distinguished from one another or can be shown to have a common origin. Historically, this has been accomplished through physical or chemical examinations, revealing what are functionally class characteristics. More recently, microbial analysis has emerged as a possible way to individualize soils. Within soil there are hundreds or thousands of species of microorganisms, each differing in abundance. These differences can potentially be targeted and assayed, producing a unique microbial "fingerprint" for a given soil sample. However, as with all scientific evidence, microbial profiling of soil must withstand *Daubert* challenges. In this regard, a technique that can generate measurable error rates and is widely accepted in the scientific community would be of great utility in cases where soil evidence plays a large role.

Rhizobia are an ideal group of bacteria for a forensic soil assay, owing to the fact that they are found in virtually all soils, and are well characterized scientifically. However, a present/absent assay, which earlier studies have utilized, may be undesirable because bacterial species that are present at very different levels among soils still test positive, indicating the soils are the same. The goal of this study is to take advantage of well-established frequency variability among soil bacterial species. By developing a quantitative assay that measures the abundance of different rhizobial species known to exhibit high levels of variability in their abundance among soils (largely related to plant species present), one should be able to generate a profile for any soil sample. qPCR has previously been used for microbial profiling, including quantifying rhizobia in experimental settings; however it has not been utilized in a forensic context. The assay presented focuses on the recombination A (recA) gene, as it is one of the most highly conserved bacterial genes, being essential for the DNA repair and maintenance, but still contains hypervariable regions that allow for species identification. These regions were targeted through the utilization of species-specific TaqMan probes. By incorporating different dyes on the probes, multiple species can be detected and directly quantified within a single soil sample. Such quantification allows unique profiles to be generated for different soil types, based on the abundance of the different species assayed. The assay helps decrease run-to-run variability observed in previous studies, lends itself to high-throughput capabilities within a 96-well format, and allows for statistical analysis that will prove vital in translating the assay into a useful forensic application.

Soil Analysis, Bacterial (Rhizobial) Fingerprinting, Quantitative PCR

A155 mtDNA and STR Analysis of Stored Maggot Crop Content Extractions Following Real-Time PCR Quantitation

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After attending this presentation, attendees will understand a comparison of real-time PCR and Quantiblot method used for quantitating human DNA recovered from maggot crop contents, and learn the relationship between the success of mtDNA and STR analyses and the quantity of DNA in the extraction.

This presentation will impact the forensic science community by providing mtDNA and STR data from maggot crop content extractions that have been quantitated using real-time PCR.

DNA analysis of maggot crop contents can be used to identify a missing victim if maggots are discovered at a suspected crime scene in the absence of a corpse or can be used to associate a maggot with a specific corpse in a chain of custody dispute. Maggot crop DNA analysis is a new area of study; many of the limitations of this method have been explored in recent years. In a previous study by Linville and Wells, maggots fed on human tissue were preserved under eight different conditions, where the presence and type of preservation fluid, storage temperature, and length of storage time were varied. In a second study, the ability to recover human DNA from the maggot throughout its development and the persistence of DNA in the crop after the maggot's removal from human tissue were observed. In both studies, maggot crops were removed, extracted, and human DNA was quantitated using Applied Biosystems' Quantiblot Human DNA Quantitation Kit. Amplification and analysis of mitochondrial DNA (mtDNA) and short tandem repeat (STR) loci were attempted on all samples.

While the Quantiblot method provided an adequate method for quantitating samples, the test relied on subjective interpretation of band intensities, was unable to detect low levels of DNA in samples, and did not provide any information on the presence or absence of inhibitors in a given extraction. For example, in the preservation study, 45.8% (33/72) of the quantitation results fell below the level of the last visible standard, which was 0.06 ng/ul. In the development study, 88.9% (64/72) of the quantitation results fell below this standard. Several samples that fell below 0.06 ng/ul were successfully analyzed, producing mtDNA sequences and/or STR profiles. Successful analysis of the samples did not directly relate to the quantity of DNA in the sample, suggesting other factors, such as inhibition, may affect the ability to amplify.

The objective of this study was to lower the detection limit, increase the precision of results, and evaluate the presence of inhibitors by retesting the same maggot crop extractions from the previous studies using real-time PCR and the Quantifiler™ Human DNA Quantification kit (Applied Biosystems). Also, based on the real-time PCR quantitation results, mtDNA and STR analyses were reattempted on 8 maggot crop content extractions selected from each study in order to examine the consistence between the current test and the original test.

Compared with the Quantiblot method, real-time PCR lowered the detection limit, increased the precision of the quantitation results, and provided some evidence that inhibition was not an issue in these samples. The Quantifiler kit detected DNA in more samples than the Quantiblot kit used in the previous studies. Quantifiler failed to detect DNA in 22.2% (16/72) of the maggot crop content extractions from the

preservation study and 66.7% (48/72) from the development study. The lowest amount of DNA detected by real-time PCR was 0.001 ng/ul. The internal positive control (IPC) included in each Quantifiler reaction did not indicate any PCR inhibition in most of the samples. The success of previous and repeated mtDNA and STR analyses did not always directly relate to the quantity of DNA in the extraction.

Forensic Entomology, Maggot Crop, DNA Analysis

A156 FidoTyping™ and FidoSearch™: Validation of a Forensic Canine Mitochondrial DNA Protocol and a New On-Line Canid Mitochondrial Hypervariable Region Database

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After attending this presentation, attendees will be aware of laboratory protocols and a new database for the forensic use of mitochondrial DNA (mtDNA) analysis in dogs and other canids.

This presentation will impact the forensic community by demonstrating that mtDNA analysis of domestic dog hair is straightforward and that the current inability to place matches between crime scene hairs and donor dogs in a population genetics or statistical context for meaningful presentation in court can be resolved by use of a new validated forensic database.

Canine hairs may link suspects, victims, or crime scenes. MtDNA analysis applied with few modifications from human mtDNA protocols can provide nucleotide sequence data from the canine hypervariable region for comparisons between samples. As in other species, a published and curated reference dog sequence is available as a benchmark (Genbank, NC_002008).[2] In canids, the mtDNA hypervariable region extends from nucleotide positions (nps) 15,458-16,727, and contains 30 copies of a 10 bp imperfect repeat region (at nps 16130-16430); the tandem repeats are difficult to analyze and relatively uninformative. For a standard forensic analysis, overlapping hypervariable regions HV1 (nps 15431-15782, 352 bp), HV2 (nps 15739-16092, 354 bp), and HV3 (nps 16451-00014, 298 bp)[3] are amplified and sequenced. Abundant canid mtDNA sequences (N = 2,807, including 866 and 696 domestic dogs from Europe and North America, respectively) were available in Genbank to populate the new forensic database, where standardization of the database entries was per.[4] To aid in developing a statistical forensic context for canine mtDNA matches, a software package called FidoSearch™ was developed.

For laboratory validation of the analytical process (FidoTyping™), a total of 18 domestic dogs and wolves were sampled for various tissues (guard and undercoat hairs, saliva, blood) to establish the optimum conditions for canid mtDNA analysis. Animals tested more than once gave the same profile for each analysis; a positive control DNA was prepared for future use in casework. No substantive modifications to standard Mitotyping protocols (extraction, amplification, or sequencing) were necessary to analyze the mitochondrial DNA of dogs. New primer pairs based on[3] amplify and sequence with reliability providing a robust product. Pale and fine undercoat hairs down to 0.5 cm in size amplified well. Some cross-species primer hybridization was observed between dog, cat and human in the limited number of experiments performed, and as it is impossible to test all mammalian species to check for cross-hybridization, all amplification products that result from casework will be need to be sequenced and submitted to Genbank for a species identification as a confirmation of canid origin.

The validation of the database and its accompanying search software package, FidoSearch™, will be described in the presentation. This database and search engine will be resident and searchable on the Mitotyping Technologies website (www.mitotyping.com). The software package will allow entry of a profile of interest, designation of species (*Canis familiaris*, *C. lupus*; *C. latrans*; etc), continent of interest, setting of search parameters, and printout of final results. Partial or full hypervariable region profiles may be entered and polymorphisms will be entered according to standard parameters, allowing for ambiguous sites, insertions, and deletions, as well as all polymorphic variants.

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Canine, mtDNA, Database

A157 Forensic Discrimination of Bacillus Spores Grown With Different Media Based on Cellular Fatty Acid Composition: Implications for Biocrime Investigations

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After attending this presentation, attendees will be familiar with fatty acid profiling of bacteria, the diagnostic phenotypic signatures associated with different growth substrates and culturing conditions of spore cells, and the potential applications of fatty acid profiling for microbial forensic investigations. In addition, attendees will be exposed to statistical techniques that can aid in analyzing complex phenotypic systems and differentiating closely related forensic samples.

This presentation will impact the forensic science community by introducing novel applications of accepted microbiologic techniques that can assist forensic investigators in identifying the culture methods used to produce microbial bioterrorism agents.

Fatty acids are the main components of bacterial membranes that protect the cell from its environment. The types and relative proportions of different fatty acids present in a laboratory grown bacterial culture is in large part determined by the nutrients available in the culturing media and the environmental conditions present during growth. Fatty acid profiling is a common technique for bacterial characterizations of environmental

samples and species identification of unknown microbial agents in academic, industrial, and clinical settings. However, the potential for fatty acid profiling to assist in biocrime investigations by identifying phenotypic markers for different growth media within spores of a forensically relevant organism has not been explored.

In this study, cellular Fatty Acid Methyl Ester (FAME) profiling was investigated as a method to resolve the differences in membrane composition among spore cultures of *Bacillus cereus* T-strain each grown on different substrates. Ten media formulations were chosen that varied in the sources and concentrations of protein/amino acids, sugars, carbohydrates, and inorganic salts. *B. cereus* was used as a forensically relevant surrogate for *B. anthracis* because of the genetic, structural, and biochemical similarities between these two organisms. To analyze FAME profiles and identify biomarkers that were diagnostic for the growth media used to culture *Bacillus* spores, total profile dissimilarities were assessed with non-metric multidimensional scaling (nMDS) and analysis of similarities (ANOSIM). Discriminant Function Analysis (DFA) was subsequently used to isolate a subset of fatty acids that maximized profile differences among spore groups and determined which variables are contributing most to sample discrimination. In addition, profiles for each spore sample were characterized either by the relative abundances of the four structure classes of *Bacillus* fatty acids (iso-odd, iso-even, anteiso, and straight-chained) as well as the abundance of individual FAME biomarkers.

Results showed that FAME profile differences were most pronounced among spore cultures grown on media with varying sources of proteins and amino acids in their formulations ($R>0.8$, $p<<0.01$ for ANOSIM). Organisms grown on chemically defined media with exogenous protein sources either absent or in low concentrations were easily differentiated. In addition, spore cultures grown on media supplemented with disparate protein sources (i.e., tryptone versus peptone) exhibited the largest variation in FAME composition. One FAME biomarker, oleic acid (18:1 ω9c), was found exclusively in spore cultures grown on Columbia Agar supplemented with sheep blood. DFA indicated that the proportion of anteiso fatty acids (15:0 anteiso, 17:1 anteiso A) contributed significantly to the discrimination of spores grown in yeast extract media whereas branched-even (14:0 iso, 16:0 iso) and branched-odd (17:1 iso ω5c, 17:1 iso ω10c) fatty acids drove differentiation of spores grown on media supplemented with singular sources of supplemental protein (peptone or tryptone). For spores prepared on media containing multiple protein sources, discrimination functions were influenced most by branched odd variables 17:1 iso ω5c and 17:1 iso ω10c. The fact that different sets of FAME markers are needed for various group comparisons indicates that forensic differentiation of spores may require a hierarchical classification system based on dicriminant functions. These results suggest that FAME profiling can detect individual biomarkers and multivariate differences among spore cultures that are diagnostic for the protein/amino acid components of growth media and that this technique may be a promising tool in biocrime investigations.

Biocrime, Microbiology, Fatty Acid

A158 Identification of Distant Relatives Using Haplotypes Constructed From Multiple Linked Autosomal STRs

Kristen E. Lewis, MS, Melanie R. Caserza, BS, Tom Walsh, PhD, and Mary-Claire King, PhD, University of Washington, Department of Genome Sciences, Box 355065, Seattle, WA 98195-5065*

After attending this presentation, attendees will learn how linked autosomal STR loci can be used to support relationship in complex kinship cases. Additionally, attendees will learn how the presented genetic and statistical approaches can be applied to other complex kinship cases.

This presentation will impact the forensic science community by providing a new genetic approach to identify distant relatives when traditional forensic markers fail to provide sufficient statistical support for or against the hypothesized relationship.

Relatedness of living persons separated by multiple historical generations or by natural disaster or war can generally be determined if the survivors share a Y-chromosome haplotype or a mitochondrial DNA (mtDNA) sequence. However, establishing relatedness of individuals not expected to share Y or mtDNA sequences has posed a dilemma. This problem can be overcome by identifying haplotypes, each consisting of multiple closely linked autosomal STR markers, which are shared by the putative relatives but not present in large numbers of controls.

Remains of an American soldier missing since WWII were discovered in 2002 in Papua New Guinea. Mitochondrial DNA sequencing of his remains and of surviving maternal cousins led to his identification. The proposita, an Australian woman raised to believe she was the soldier's posthumous daughter, was not related to the soldier by mtDNA or Y lineages. Bones from the soldier's remains did not yield adequate DNA to genotype autosomal markers. Eight of the soldier's surviving relatives contributed DNA to compare with that of the proposita. Each of the eight relatives would be a second cousin of the proposita were she related to the family. Forty forensic STRs were genotyped in all persons using Identifiler™ and the NIST-developed 26plex, but these markers failed to provide sufficient statistical evidence for or against the hypothesized relationship. Therefore, clusters of linked STRs on each of multiple chromosomes were genotyped, and haplotypes were determined among undisputed relatives. On several chromosomes, genotypes of the proposita were consistent with haplotype sharing with one or more family members. To test whether these genotypes were shared by descent or by chance, 960 controls (1,920 chromosomes) with ancestry matched to the family were genotyped for the STRs in each linked cluster. It was critical to genotype multiple informative relatives so as to infer phase (haplotypes) of STR clusters to which unphased genotypes of the proposita could be compared. It was not necessary for the phase of genotypes among population controls to be known, so long as the presence of the index haplotype could be unambiguously excluded.

At several STR clusters, the proposita and her putative second cousins shared an entire haplotype not present among controls. For any one such cluster, the probability that the genotypes were shared by chance, rather than by descent, was less than 1/1920, or 0.00052 (upper 95% confidence limit, 0.00312). Based only on the upper confidence limit, the likelihood of the data is 320 times greater if the haplotypes belong to relatives of the proposita than if the haplotypes belong to individuals not related to her. The same reasoning holds for other STR clusters with haplotypes shared by the proposita and her putative second cousins and absent among controls. As many independent chromosomes

as necessary may be evaluated to provide additional statistical support for the test of relationship.

Identification of genetic relationship depends on individuals sharing genotypes by descent rather than simply by chance. Identity by descent can best be established when genotypes are very rare in the general population. Such rare genotypes can be defined by haplotypes constructed from linked markers.

Complex Kinship, Relatedness Testing, Linked Autosomal STRs

A159 Determining the Evidential Strength of mtDNA and Y-STR Matches

John S. Buckleton, PhD, ESR, Private Bag 92021, Auckland, WA , NEW ZEALAND; and Bruce S. Weir, PhD, University of Washington, Department of Biostatistics, Box 357232, Seattle, WA 98195*

After attending this presentation, attendees will be aware of methods to determine the numerical strength of lineage marker profiles.

This presentation will impact the forensic science community by introducing an improvement on existing methods of giving the numerical strength of lineage marker profiles.

The interpretation of mtDNA and Y-STR evidence differs from autosomal DNA largely because these two types of DNA are inherited uniparentally and without recombination. The usual method for interpreting such markers, refereed to collectively as lineage markers, has centered around the empirical count in a database. This is termed the counting method. Areas of current debate relate to the assessment of sampling uncertainty in such a count and methods to deal with subpopulation effects.

Sampling uncertainty is often assessed using the method of Holland and Parsons.[1] This method assumes normality and Holland and Parsons recognized that such an assumption would not be appropriate for low frequencies. However, the method has not been refined in the 10 years since publication. In this paper we present a standard frequentist approach, known since 1934,[2] and a Bayesian approach that remove the difficulties associated with non-normality. Trials with these two methods confirm that the Holland and Parsons method is inaccurate, as suggested by the initial authors, not conservative, and should be replaced.

Lineage markers are known to show strong subpopulation effects.[3] As such it is expected that a general population database count may not be applicable to a more localized subpopulation. However, the application of the known subpopulation correction appears extreme. The known formulation would change the database count f to . Here is the coancestry coefficient that is often assessed as being of the order of 0.02 - 0.10 for lineage markers so that such a correction would completely dominate the frequency term. However, although variation between subpopulations is large, variation within subpopulations is also large if the full haplotype is utilized suggesting that from single loci may overstate the differentiation. Recently Budowle et al[4] recognized this and estimated for the full haplotype utilizing the method of Weir and Cockerham[5] which will not produce reliable estimates for such sparse data. Another approach, that of Ewens[6], does appear applicable and this suggests that, indeed, estimates from single loci are misleading and that much lower estimates of may be sustainable for multilocus lineage marker haplotypes, as envisaged by Budowle et al.

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mtDNA, Y-STR, Lineage Markers

A160 Comparison of Commercial Multiplex Kit Performance With Low Template DNA

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The goal of this presentation is to provide attendees with an understanding of the relative merits and disadvantages of several commercial STR multiplex kits when dealing with low template DNA, including the sensitivity of each and common artifacts at low input concentrations.

This presentation will impact the forensic science community by providing information that will aid in the selection of the most appropriate STR kit for amplification of quantified evidentiary extracts.

The Armed Forces DNA Identification Laboratory has validated the Promega PowerPlex® 16, Applied Biosystems AmpfℓSTR® Minifiler® and AmpfℓSTR® Identifiler® amplification kits, which provide the scientist with additional tools for evaluating evidentiary material. Extracts that quant at the low end of the sensitivity spectrum can be processed with Minifiler®, but the question remains whether or not it is worthwhile to attempt amplification with PowerPlex® 16 or Identifiler®, especially if the quant values are on the cusp of the sensitivity of these traditional kits. Minifiler® has proven to be a useful tool with degraded samples but its sensitivity makes it prone to artifacts and peak height imbalances. Though many laboratories are investigating methods of dealing with low copy number specimens, there is a dearth of information directly comparing different commercial kits, particularly at low template amounts.

This study was undertaken to examine the behavior of the Identifiler®, PowerPlex® 16, Minifiler® and PowerPlex® 16 HS commercial kits with low template DNA and provide information that will assist the analyst in choosing which method to pursue. The results of this study will also aid laboratories that are considering bringing another commercial amplification kit online.

Buccal swabs from two highly heterozygous individuals were extracted using a standard organic extraction protocol. A known human DNA standard was also utilized. All three known human DNA samples were quantitated using Quantifiler®.

The three known DNA samples were amplified in triplicate with the PowerPlex® 16, Identifiler® and Minifiler® kits at the following six DNA templates: 0.500, 0.250, 0.100, 0.050, 0.025 and 0.010ng. Amplification was conducted in accordance with validated protocols. One of the specimens was also amplified in triplicate at both 30 cycles and 32 cycles using PowerPlex® 16 HS at 1.000, 0.500, 0.250, 0.100, 0.050, 0.025 and 0.010ng input concentrations. All amplified products were typed and injected for 5 and 10 seconds at 3KV on the 3130*xl* Genetic Analyzer. The data was analyzed using GeneMapper® ID v.3.2 with a 40 RFU detection threshold.

The criteria used to assess the STR typing results for each of the kits included detection of profile alleles and the number of profile alleles above the laboratory-designated reporting thresholds of 75/150 RFU (heterozygotes/homozygotes) for the Identifiler® and Minifiler® kits and 100/200 RFU (heterozygotes/homozygotes) for the PowerPlex® 16 and PowerPlex® 16 HSkits. Peak height ratio was calculated for all heterozygous loci, and average peak height was calculated for both homozygous loci and heterozygous loci within and across replicates. The data accumulated from these examinations will be presented and discussed.

The decision of which commercial kit is appropriate to employ for amplification is crucial, whether on a small scale such as an analyst processing a single evidentiary sample or a technical leader deciding which amplification kits will be validated for use in the lab. Sensitivity to time and cost as well as the potential for limited extract volumes makes the choice of an appropriate amplification kit imperative.

The opinions and assertions contained herein are solely those of the authors and are not to be construed as official or as views of the United States Department of Defense or the United States Department of the Army.

STR Multiplex, LCN DNA, Sensitivity

A161 Comparison of PowerPlex®16 HS to Minifiler® and Identifiler® Amplification Kits

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After attending this presentation, attendees will be familiar with the advantages and disadvantages of using PowerPlex®16 HS over Minifiler® and Identifiler® for common forensic samples, including degraded, inhibited, and low copy DNA. The performance of each amplification kit was evaluated for sensitivity and overall quality of DNA profiles obtained, including the number of alleles obtained and peak height and balance.

This presentation will impact the forensic science community by providing an informative initial evaluation of PowerPlex®16 HS, along with its comparison to other common amplification kits. Currently, a number of commercially available short tandem repeat (STR) amplification kits are available for use in forensic DNA laboratories and new, potentially promising kits frequently emerge. It is time consuming and costly for a laboratory to investigate each and every new methodology that arises, which can result in a laboratory's decision to forego evaluations of new products due to the uncertainty of their benefits over current methods. Thus, the forensic community greatly depends on individual laboratories' evaluations of new products. This study will aid other laboratories in need of an alternative protocol for challenging samples by presenting an unbiased view of the performance of three amplification kits, thereby allowing attendees to decide whether pursuing the implementation of PowerPlex® 16 HS would be beneficial to their laboratory.

The PowerPlex® 16 HS kit was designed to reliably type problematic forensic samples, including degraded, inhibited and low copy nuclear DNA samples. An initial sensitivity study was performed to compare the ability of PowerPlex® 16 HS, Minifiler®, and Identifiler® to obtain profiles from 0.01-1.0ng of DNA from blood stains and buccal swabs. Typical low quality forensic samples prepared and/or collected for additional studies are as follows: blood degraded by heat, UV, environmental conditions, and treatment with active oxygen products; blood inhibited by dyes found in denim; high quality cell line DNA inhibited by common PCR inhibitors like hematin, tannic acid and humic acid; swabbings and cuttings from a variety of potential low copy DNA sources, ranging from telephones to worn clothing; and other common forensic or clinical samples, including cigarette butts and biopsy slides. Signs of degradation and/or inhibition for each sample were evaluated by comparing quantitation values obtained via the Quantifiler® Human and Duo Quantification Kits. In order to effectively evaluate and compare PowerPlex® 16 HS's performance to that of the FID's current methodologies, development of DNA profiles were attempted from each sample through amplification using PowerPlex® 16 HS and, at a minimum, Minifiler® (if enough DNA was available, Identifiler® was also used). Additionally, for the cell line DNA spiked with inhibitors, overall profile quality was evaluated using 28, 30, and 32 PCR cycles.

Minifiler® and PowerPlex® 16 HS performed better than Identifiler® in each study evaluated. The first full profile was obtained by Minifiler® at 0.10ng, followed by PowerPlex®16 HS at 0.25ng and Identifiler® at 0.50ng. Profiles obtained from Minifiler® and PowerPlex® 16 HS were comparable for the forensic samples, with both outperforming Identifiler®, but both also exhibiting gross over-amplification on samples that were not truly low quality. Examination of PCR cycle number for inhibited DNA revealed that PowerPlex®16 HS performed best using 30 cycles at 0.50ng, while Minifiler® peaked using 30 cycles with 0.25ng, and Identifiler® showed that a 28 cycle, 0.25ng DNA input was optimal. The presence of inhibitors may account for the lower than usual (0.50-1.0ng) optimal Identifiler® DNA input. Though Minifiler® and PowerPlex® 16 HS often exhibited comparable results, it is very important to note that Minifiler® is only capable of providing STR information for eight loci plus Amelogenin, whereas PowerPlex® 16 HS can potentially amplify all 13 CODIS loci plus Amelogenin and two additional penta repeats. Thus, a "full profile" from Minifiler® is not as informative as a full profile from PowerPlex® 16 HS.

PowerPlex®16 HS, Low Quality DNA, PCR Cycle Number

A162 Improved Genotyping Performance of Complex Multiplexes on DNA Mixtures

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After attending this presentation, attendees will understand the performance of complex STR multiplexes in DNA mixtures and the parameters influencing mixture interpretation.

This presentation will impact the forensic science community by providing information on factors that affect the performance of different STR multiplex systems in compromised samples and solutions to improve the recovery of information from complex multiplexes.

Evidence submitted for DNA analysis can be recovered from a variety of biological samples including blood, saliva, or semen stains on different substrates, body surface swabs, hair, bones, and finger nail scrapings. Forensic analysts seek technologies to maximize the quality of results obtained and increase the success rate of obtaining a DNA profile from these types of samples. Multiplex short tandem repeat (STR) assays simplify genotyping processes and preserve sample by eliminating the need for multiple amplifications and/or electrophoretic injections. Observations have previously been presented that there is varying performance with different STR multiplexes. Therefore, a study was undertaken to investigate the effect of multiplex complexity on genotyping performance in mixtures by comparing STR assays of different complexity (e.g., 10-16 markers/reaction) using simulated inhibited samples at various mixture ratios (1:0, 1:1, 1:5, and 1:7). Amplifications were performed with a total DNA input of 1.5 ng in either 1X TE, 15µM hematin, or 6ng/µl humic acid concentrations, chosen to provide a moderate level of inhibition and generate a pattern characteristic of inhibited profiles. Allelic drop-out of the minor alleles in prepared inhibited samples was observed in all of the assays at each mixture ratio; but when compared to the 10-plex assay, the 16-plex assay detected an equivalent or greater number of alleles from the minor contributors in all the mixture samples. Comparison of the intra-locus balance values of the major and minor contributors were similar for all assays. Some loci exhibited greater sensitivity to PCR inhibition in a larger multiplex so modifications were made to the PCR buffer and thermal cycling parameters in an effort to improve performance of these loci. The improvements in PCR buffer and cycling conditions enabled recovery of all alleles in the inhibited mixtures amplified using the 16-plex assay and eliminated the ski slope effect seen with the other kits tested. This study illustrates how large multiplexes can be optimized successfully for use on challenging casework samples.

Multiplex, STR, Mixture

A163 Increasing STR Analysis Success Rate and Potential Discrimination With Improved Multiplexes

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After attending this presentation, attendees will understand potential strategies for handling challenged samples and increasing discrimination for difficult relationship testing using an increased number of loci.

This presentation will impact the forensic science community by demonstrating capabilities of new typing strategies.

Multiplex short tandem repeat (STR) analysis remains the primary technique for human identification. At the beginning of this decade, focus of STR multiplex design was on increasing the number of concurrently analyzed markers, largely to meet the demand of having the FBI CODIS core 13 loci in a single assay. Forensic analysts require STR systems that are compatible with ever more challenging samples, prompting the need for greater performance from assays. Additionally, the complexity of relationship testing for immigration and familial searches has prompted the need for increased marker availability. This combination of greater performance and increased marker availability has driven the design of the most recent generation of STR multiplexes.

Forensic samples routinely include impurities known to inhibit PCR and reduce genotyping success rates. Additionally, high heat and other environmental impacts can reduce the integrity of the DNA. Improved buffer systems and incorporation of shorter amplicon primer design (mini STR) have significantly increased the tolerance to common inhibitors and yield from degraded samples. Additionally, increased sensitivity can improve the likelihood of obtaining interpretable data from low concentration samples and challenging mixtures.

The recommendation to extend the current European Standard Set (ESS) for STR systems has prompted inclusion of several new markers in the latest STR multiplex designs. Coamplification of two multiplexes can provide full CODIS and ESS panels, plus Amelogenin, SE33, Penta E, and Penta D, for a total of 24 markers. Compared to the CODIS core panel, the additional markers add significantly to the power of discrimination that can be applied to statistically-challenging cases.

Comparison data of these systems will be presented with inhibitors and challenging samples along with developmental validation data. We will also present strategies for use of these newer STR systems in the forensic laboratory.

STR Analysis, Mini STR, Inhibition

A164 Human Genetic Identification in Cases of Uncertain Kinship

Andrea Pinzon, MSc, Instituto de Medicina Legal, Calle 4B Nº 36-01, CALI, COLOMBIA*

After attending this presentation, attendees will understand how in forensic genetics cases, human identification is an important tool to relate victims to their closest blood relatives. This requires highly polymorphic molecular markers in order to find probable kinship between the victim and his/her family members with a high level of certainty. The purpose

of this paper is to explain the limitations of identity orientation when kinship with family members may not be established for purposes of genetic comparison.

This presentation will impact the forensic science community by showing human identification tests when no first of kind are available. In this case, the lab is required to develop strategies to clearly and objectively report to the authorities the conclusions on unexpected findings observed in genetic studies and supplementary analyses conducted to establish unclear kinship and identity when no truthful information is provided or genetically available.

Ideally, before conducting the identification process via molecular markers, the victim's ante mortem information is required (technical interview with family members of the missing person, physical antemortem information, dental charts, medical history, a description of the individual's physical characteristics), as well as positive information on kinship with family members available for testing. This will help orient the case and contribute to the future interpretation of findings by the DNA analyst.

However, it is sometimes difficult to find information to help orient the case. Reference samples from the closest blood relatives are frequently hard to find. Additionally, sometimes it is necessary to use genetically useful family members who are not ideal for victim "identification," i.e., presumptive siblings, half-siblings, uncles or aunts, cousins, etc. The genetic information provided by these relatives sometimes does not confirm the information reported during the preliminary investigation. Consequently findings are unexpected and the lab needs to make decisions when submitting a preliminary report on the genetic results of the investigation. Additionally, the lab is required to request and report future actions to clearly establish the victim's identification.

This problem has been found in the lab's casework. Therefore, mtDNA and Y chromosome testing have been conducted, but the information obtained only helps establish maternal and/or paternal lineage, which does not provide certainty on the degree of kinship with family members or the identification of the unidentified body.

The genetics lab of the National Institute of Legal Medicine will present a case where the victim's identification based on kinship with the presumptive father and siblings was impossible. Consequently, the probabilistic analysis had to be conducted based on various hypotheses, taking into account the inherited and/or shared genetic information. The positive identification of the victim required a direct comparison with the skeletal remains of the actual mother, which lead to a conclusion on the positive identification of the individual.

Human Identification, Kinship Probability, Maternal and/or Paternal Lineage

A165 Genetic Approach to the Identification of Enforced Disappearance Victims in Colombia

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This goal of this presentation is to describe the problems posed by the internal armed conflict and enforced disappearance of over 15,000 victims in the last four decades in Colombia. The results obtained by the Forensic Genetics Lab of the National Institute of Legal Medicine, in the area, of DNA identification will be shown. This effort was undertaken to support the Colombian legal system, particularly the Justice and Peace project implemented in 2005. The audience will also understand the resulting technical obstacles, challenges, constraints, and recommendations of the genetics lab. Some examples of the cases analyzed will be presented.

This presentation will impact the forensic science community by providing the key aspects of this approach to the identification of victims of enforced disappearances, such as the evaluation of the genetic information provided by living family members. Some technical problems include a complete kinship relationship (e.g., siblings who share father and mother), paternity certainty (e.g., presumptive father), and number of informative family members.

The protocols for DNA extraction from skeletal remains, amplification via autonomic PCR STRs and Y Chromosome, as well as mtDNA sequencing used by the Genetics Lab of the Institute will be presented. The genetic approach to the analysis of maternal (mtDNA) and paternal (Y Chromosome) lineage will be highlighted, together with the construction and implementation of genetic profile databases obtained both from missing persons (unidentified bodies) and presumptive family members. The purpose of the above is to determine positive identity and return the remains to family members in order for them to grieve for their loved ones.

In some identification cases, the only information available to conduct a genetic analysis is the victim's presumptive living sibling. This poses a technical challenge to the genetics lab, primarily because of the probabilistic kinship assessment. Therefore, it is necessary to conduct an orientation study on the maternal and/or paternal lineage through sequencing of HVI and HVII regions of mtDNA and Short Tandem Repeats (STRs) of Y chromosome. The lab must have information concerning the circumstances in which the body was buried and/or exhumed, potential kinship among victims, body mutilation, etc.

A molecular approach protocol is proposed, depending on the living family members that may provide genetic information. The requirements of the lab to effectively support the Colombian legal system in the field of identification of missing Individuals within the framework of the Justice and Peace Project will be presented.

Two cases that show technical constraints from the genetic standpoint will be presented as an example of the current problems. Recommendations will also be made.

Enforced Disappearance, mtDNA, Y Chromosome

A166 Investigations Into Fast STR Assays for Rapid Screening of DNA Samples

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The goal of this presentation is to provide information on the investigations into decreasing PCR cycling time of multiplex STR assays to enable faster screening of DNA samples.

This presentation will impact the forensic science community by providing information on the effects of utilizing a more processive DNA polymerase on the performance of STR multiplexes.

Forensic DNA typing currently requires approximately one day to process the sample. The workflow involves DNA extraction, quantification of DNA, PCR amplification of STR loci, separation of fragments by capillary electrophoresis followed by data analysis. Significant effort has been invested into decreasing the separation time

from 45 minutes to approximately 15 minutes using microfluidic devices. However, the STR amplification step takes approximately 2.5 to 3 hours to complete representing a significant portion of the workflow.

Many companies have advertised "fast" PCR master-mixes for shortening PCR times to less than one hour. However, these products have predominantly been used on single marker targets which are then used for other downstream applications and therefore do not need to meet the quality standards required by a forensic laboratory. Interest in developing fast master-mixes or utilizing fast PCR protocols for multiplex STR assays has attracted the attention of forensic scientists as a method for improving the time to results. Novel DNA polymerase enzymes for PCR amplification have been developed by our research group. The efficacy of these alternative and more processive DNA polymerase enzymes were investigated to decrease PCR cycling time. It was necessary to balance the benefit of shortening the time to result against the need to address factors which can impact the interpretation of a DNA profile. Examples of these factors are: generation of stutter products, non-template addition, intra-locus balance, accuracy, and species specificity.

In this presentation, the results will be presented of the evaluation of different DNA polymerase enzymes, optimization of a new DNA polymerase for a fast multiplex PCR assay, initial feasibility studies, and experiments to overcome PCR inhibition and species cross reactivity. These results show that this assay can decrease PCR cycling time to less than one hour.

Fast PCR, STR Multiplex, DNA Polymerase

A167 Body Fluid Identification by Mass Spectroscopy

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The goal of this presentation is to demonstrate the usefulness of mass spectroscopy for routine body fluid identification.

This presentation will impact the forensic science community by discussing how successful completion of this work will establish a fast, reliable, sensitive, and confirmatory test for body fluid identification in a single assay significantly improving forensic testing for body fluids.

It is proposed that body fluid specific peptide fingerprints can be used to simultaneously detect multiple body fluids from a mixed sample in a single confirmatory test with high sensitivity and discriminatory power.

The nature of biological forensic evidence is complex and challenging. This is particularly true for body fluids which are composed of both cellular and non-cellular components and are often present in mixtures of varying ratios and in small amounts. Conventional forensic methods used for body fluid identification are typically performed serially, are often labor-intensive, technologically diverse (requiring personnel skilled chemical, immunochemical and microscopic techniques), costly in terms of time and sample, and not always confirmatory. The goal of this work is to identify multiple, body fluid specific proteins from which to assemble unique peptide fingerprints that can be used in a single confirmatory tests for all body fluids present in a sample.

The five body fluids under investigation are: semen, saliva, blood, menstrual blood and vaginal fluid. The ideal peptide fingerprint would consist of three peptides from each of three proteins that are unique to or highly enriched in each body fluid. Positive body fluid identification would require the detection of all, or nearly all, fingerprints peptides. Methods for fingerprint identification include: protein extraction and separation by isoelectric focusing (IEF), peptide separation by liquid chromatography, and MALDI MS/MS peptide detection.

To date peptide fingerprints have been identified for blood, semen and saliva, and even without IEF protein separation these body fluids can be easily identified from 1 mg of body fluid protein which corresponds to approximately 0.003 ml of blood, 0.05 ml semen, and 0.2 ml of saliva, demonstrating the sensitivity of these markers. Six candidate marker proteins have been identified for both menstrual blood and vaginal fluid. Results of all body fluid markers will be presented.

Successful completion of this work will establish a fast, reliable, sensitive and confirmatory test for body fluid identification in a single assay.

Body Fluids, Proteins, Mass Spectroscopy

A168 Odor Availability and Its Effect on Canine Detection of Explosives

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The goal of the presentation is to familiarize the audience with the canine detection of explosives by discussing the available odor of explosives and the factors that govern the amount of explosive vapor.

This presentation will impact the forensic science community by improving knowledge about explosives-detecting canines so that canine trainers and handlers can more effectively train, evaluate, and utilize these assets.

Trained canines are commonly used as biological detectors for explosives; however there are some areas of uncertainty that have led to difficulties in training and canine testing. The odor available to canines depends upon multiple factors which include explosive vapor pressure, the rate with which the explosive vapor is transported from its source, the extent to which the explosive degrades into more (or less) volatile substances and the degree to which the explosive is confined. To better understand odor availability, experiments with varying amounts of pure nitroalkanes (nitromethane, nitroethane and nitropropane) was completed by simple headspace GC/MS. The results demonstrated that once the headspace of the container is saturated any subsequent increase in sample volume will not result in the release of more vapor. This was predicted by the ideal gas law and the vapor pressure and densities of the nitroalkanes can be used as a predictive model for odor availability. For example, the minimum amount of nitromethane needed to saturate a 20 mL volume is only 2.3 µL. This model can also be used for other compounds in containers used for canine training and testing (e.g., two ounce sniffer tins as well as quart size and gallon size tin cans). The effect of temperature was also explored showing that increased temperature resulted in an increase of vapor within the headspace of a container.

Additional experiments were completed with the use of the container within a container method utilized for testing canines, in which a two

ounce tin can is placed inside a quart size can and then placed inside a gallon sized paint can. The two ounce tin can had a perforated lid and this perforation was varied to demonstrate how confinement affected the amount of vapor released. This was completed by the measurement of mass loss with an analytical balance. The mass loss recorded over time aided in the determination of the evaporation rate and the subsequent flux of the nitroalkane's vapor. Preliminary results indicated that confinement directly affected the amount of odor available. The mass loss was measured and recorded, over a period of time, directly from a quart size can which aided in the determination of the concentration of vapor present. Analysis via headspace GC/MS was completed to complement the gravimetric measurements. As stated above, the minimum amount of a pure liquid needed to saturate the headspace is easily determined with different sized containers and the subsequent increase of volume will result in the same amount of vapor released at room temperature.

Further experimentation with solutions of nitroalkanes in water via simple headspace GC/MS was conducted. This study demonstrated the effect of sample volume (and hence phase ratio (β)) on headspace concentrations. It was predicted that since nitromethane is volatile it will be more abundant in the headspace with increasing sample volume as opposed to nitroethane and nitropropane, which will diminish in relative abundance. The effect of temperature was also analyzed with nitroalkane solutions and it was predicted that the semi-volatile nitroethane and nitropropane will increase in relative abundance with increase of temperature.

Canine, Detection, Explosives

A169 Improved Location of Forensic Evidence Through Implementation of the Scientific Working Group on Dog and Orthogonal Detector Guidelines (SWGDOG)

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After attending this presentation, attendees will have a better understanding of how establishing best practices for detection teams is improving interdiction efforts as well as courtroom acceptance of dog alert evidence by improving the consistency and performance of deployed detector dogs.

This presentation will impact the forensic science community by providing a better understanding of how improving the consistency and performance of deployed detector dog teams and their optimized combination with emerging electronic detectors improves the collection of evidence by maximizing the discovery of trace evidence in an efficient, cost effective manner while minimizing the collection of samples not relevant to an investigation.

The Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG) are being developed by a membership of respected scientists, practitioners, and policy makers representing diverse backgrounds. SWGDOG is cooperatively funded by the NIJ, FBI and DHS with general meetings held biannually since 2005. This project was undertaken as a response to concerns coming from a variety of sectors including law enforcement and homeland security regarding the need to improve the performance, reliability, and courtroom defensibility of detector dog teams and their optimized combination with electronic detection devices.

The approval of each subcommittee best practice document takes six months to complete including a two month period of public comments. The nine SWGDOG subcommittees and target timetable for posting of the best practice guidelines are as follows: (1) Unification of terminology (Part A - April '06; Part B - October '06; Part C - March '07; Part D - August '07; Part E - March '08; Part F – September '08); (2) General guidelines (April '06) - Publication in FSC October '06) First Revision (September '08) Second Revision (September '09); (3) Selection of serviceable dogs and replacement systems (October '06); (4) Kenneling, keeping, and health care (October '06); (5) Selection and training of handlers and instructors (October '06); (6) Procedures on presenting evidence in court (October '06); (7) Research and technology (March '07); (8) Substance dogs: Agriculture; Accelerants; Drugs; Explosives; (August '07) Human remains (September '09); and, (9) Scent dogs: Scent identification; Search and Rescue; Trailing dogs; Tracking dogs (Part A - March '07; Part B – August '07; Part C – March '08; Part D – September '08; Part E – March '09; Part F – September '09)

Establishing consensus based best practices for the use of detection teams is providing a variety of benefits to local law enforcement and homeland security. Benefits include improved interdiction efforts as well as courtroom acceptance by improving the consistency and performance of deployed teams and optimizing their combination with electronic detection devices. This paper also provides an update of ongoing studies involving the identification of odorants used by certified law enforcement detector dogs and using these signature chemicals for instrumental detection to reliably locate forensic specimens including drugs, explosives and human scent.

The current success of SWGDOG is being manifest by a shift of some national canine organizations to adopt the approved best practice guidelines proposed. Though SWGDOG guidelines are not mandatory, this positive change is the ultimate goal of the working group. The continued approval and revision of SWGDOG documents has received an increased number of public responses and input which has shaped the documents making them publicly vetted. While it is not technically part of the scope of SWGDOG, a future accreditation program based on SWGDOG guidelines is being proposed to further facilitate the adoption of these SWGDOG guidelines.

Detector Dog, Evidence Recovery, SWGDOG

A170 Temperature and Humidity Effects on the Stability of Human Odor

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After attending this presentation, attendees will learn the effects of various environmental conditions on the stability and durability of human odor.

This presentation will impact the forensic science community by highlighting the effects of environmental conditions on the stability of human odor. In turn, the information presented will enhance the validity of human scent as a source of evidence when brought into courts of law.

Courts in the United States have increasingly utilized human scent canine evidence as additional scientific research expands in this area. Challenges faced by scent evidence has its roots in the limited number of scientific publications in this field as well as the possible procedural

errors made by canine law enforcement personnel in a criminal investigation scenario. Due to the lack of standard protocols, the procedures by which canine scent evidence is collected and handled has a wide range of variation across agencies thus leading to more criticism as to measurable canine performance. This is why there is an extreme importance in assessing proper canine performance so that there is a clear understanding of their capabilities and/or limitations. In general it could be stated that the goal is to obtain a clear understanding of how canines work and what variables affect their detection probability.

Human odor is influenced by a number of different factors such as genetics, biological body functioning and environment conditions. Together, they all directly affect the collected odor samples from any single individual. In turn, the transfer and ultimate detection of this odor by canines could be potentially linked to many variables. The survivability and stability of human odor has been of great interest since it is important to understand how long scent is available after its initial collection or presence at a certain location. Furthermore, it could be of great help to verify through scientific validation the presence of human odor after extreme temperature changes such as explosions, or even when in presence of environmental conditions such as humidity. Thus far, studies have shown the survivability of human scent which was still detectable to the canine in order to make a positive scent match even after undergoing violent thermal conditions. However, even though canine field testing has been conducted, a laboratory approach as to the effects of temperature changes on human odor has not been properly performed.

The goal of this study is to evaluate environmental variables such as temperature and humidity on the stability of human odor samples. Dry scent samples are compared to water saturated scent pads at various temperatures to compare obtained chemical profiles. The studies include an instrumental evaluation via SPME-GC/MS analysis of all collected scent samples. Furthermore, in addition to a headspace extraction of the collected scent pads, a parallel study evaluated the chemical profiles obtained from a direct extraction of the water portion of the scent sample. The hydration technique is used by canine handlers in training procedures and thus will help further elucidate this process. The hydration technique has allowed handlers to train canines at a much faster rate. The training involves the target subject spraying the concentrated scented water along the traveled path. Handlers use different concentrations of the scented water and slowly decrease it until the canine is following nothing but the actual human odor. In this experiment, scent samples are allowed to soak for different time ranges in room temperature water. A fiber optimization is also performed so as to obtain the best results with SPME with a solvent such as water.

In addition to a controlled laboratory study, parallel canine field testing is also conducted to include the above mentioned environmental conditions including survivability of human odor. This field evaluation tests the durability of human odor after extreme thermal changes as seen from collected post-blast debris using human scent specific canine teams to locate and identify individuals who have been in contact with improvised explosive device (IED) components and/ or delivery vehicles.

Human Odor, Hydration Technique, SPME-GC/MS

A171 Evaluating the Deposition Sequence of Overlapping Bloodstains Caused by Transfer and Airborne Droplets

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Attendees of this presentation will learn if it is possible to sequence overlapping stains produced by airborne droplets and contact transfers.

This presentation will impact the forensic community, and those being served by it, by evaluating the validity and boundaries of a technique used to reconstruct the sequence of bloodstains deposited during violent crime.

The order of deposition of bloodstains found at crime scenes can be useful when reconstructing the events of violent crime. This information can reveal the movements and actions of those involved (victim, perpetrator, and witness) and can be useful in corroborating or refuting statements made by the victim, suspect, or witnesses.

While there are many different mechanisms that can cause blood to interact with a target surface, they can all be grouped into two broad categories. Blood can appear from contact with the target surface or it can appear from the deposition of airborne droplets. It is possible, and even common, for airborne droplets to overlap with other airborne droplets. The same holds true for multiple bloodstain patterns produced by contact with a surface. For this preliminary study, only patterns produced by the combination of airborne droplets and contact transfers were evaluated.

Stains were produced on two commonly encountered surfaces; painted sheetrock and linoleum floor tile. The stains were made with recently acquired defibrinogenated ovine blood brought to body temperature in a water bath. Initial experiments illustrated no demonstrable difference in the patterns produced between fresh drawn human blood and the defibrinogenated ovine blood at body temperature.

Patterns were produced by creating contact stains on the two substrates and then overlapping airborne droplet stains at different stages of the initial contact stains' dryness. Each pattern was then photographed and evaluated. This same process was repeated with airborne droplet stains first and then overlapped with stains from contact at different stages of the initial airborne droplets' dryness. Temperature, humidity, and air circulation were monitored for all of the experiments.

Evaluation of the stains was first performed visually with the unaided eye and then with low power (5X and 10X) overall magnification. When possible, stains were also excised and evaluated under higher magnifications with epi-illumination. Since it is not uncommon for bloodstains to be dry before they can be adequately documented, additional work was conducted with traditional digital photography as well as infrared and ultraviolet imaging. Various adjustments were also attempted in image processing software to aid in the determination.

The interpretation of overlapping bloodstains has limitations, yet also significant information potential. Specific information is often required to make the analysis of such stains possible. This preliminary study has identified these boundaries and will outline future studies necessary to evaluate the same phenomena with two overlapping contact transfers or two overlapping airborne droplet stain patterns.

Bloodstains, Interpretation, Overlapping

A172 Epidemiological and Biomechanical Studies of Falling Fatalities in Taiwan

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After attending this presentation, attendees will learn to use the legitimate measures of horizontal distance and height to calculate the initial velocity and to speculate the falling patterns and the manner of death.

This presentation will impact the forensic science community by determining the falling pattern by measuring the height and horizontal distance.

Due to lack of information, falling from a height can be difficult to determine the manner of death. The point of trajectory, the horizontal distance and the impact point are closely related to the initial velocity, angle and height. Prospective study of 18052 forensic cases were reviewed, 1,144 falling fatalities with 794 male (69.4%) and 350 female (30.6%) during 1994 to 2007 in Taiwan's Institute of Forensic medicine, Ministry of Justice are collected. Biomechanical study of the standing jumps of swimmers during the initially jump were estimated at the angle of 36.35±3.62° using Phantom V4.3 high speed digital imagine system connected with IEEE1394 computer, and calculating results according to the Shaw and Hsu's equation (J Forensic Sci 1998; 43(4):765-771). The Manners of death of accidental, suicidal and homicidal cause are 69.2%, 19.8% and 4.2%, respectively. The heights of accidental, suicidal and homicidal falls are 13.9±11.5 (n=107), 25.8±15.9 (n=67) and 15.6±8.8 meters (n=9), respectively. The initial velocity (at the angle of 36º) of accidental, suicidal and homicidal falls are 1.1±0.6, 1.9±0.9, and 0.7±0.4 meters/second, respectively. By defining the initial velocity above 2.3 meters/second implies jump with running acceleration, the initial velocity of jump with vs. without acceleration of suicidal jump are 3.1±0.9 vs. 1.5±0.3 meters/second. These results indicate that horizontal distance and height are legitimate measures to speculate the falling pattern and the manner of death. Speculating the initial velocity (meter/second) at the angle of 36º after converted with height and horizontal distance, can become the criterion of the falling cases during the medico-legal investigation.

Fatal Fall, Standing Jump, Biomechanical Study

A173 Evaluating the Validity of Angle of Impact/Incidence Determinations Made From Very Small Bloodstains

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After attending this presentation, attendees will know if the size of a bloodstain affects the analyst's ability to determine the angle of impact or incidence of that bloodstain.

This presentation will impact the forensic science community by guiding bloodstain pattern analysts in how to select bloodstains that will provide accurate calculated angles of impact after being measured using the technique outlined in this study.

The error associated with calculating the angle of impact or incidence of bloodstains has never been fully elucidated. The calculation was originally created by Balthazard in 1939 and has been involved in many studies since then. Laturnus demonstrated the fluctuations in how bloodstains are measured, particularly in determining the length. DeForest attributed at least a plus or minus 5° range of error for well-formed stains. Analysts; however, are often faced with interpreting bloodstain patterns comprised of stains that are not always well-formed. Sometimes the individual stains are more circular in shape or very small, which may result in measuring difficulties as well as the potential for increased error in calculating the angle of impact or incidence. The stain may be a result of a deviation from the light model of how the angle of impact or incidence calculation is made. These deviations can include expansion of the droplet upon contact with the impact surface or a continuation of oscillations in flight up until the point of impact. Little research has been conducted to determine if the size of a stain will affect its impact with the target surface, and therefore alter the determination of the angle of impact or incidence.

This study is working to determine a more specific rate of error associated with calculating the angle of impact. Bloodstains at different angle ranges were compared to determine if the rate of error differed based on the angle at which the blood impacted the surface. The bloodstains analyzed were also of varying sizes to establish any connections between the accuracy of the calculated impact angle and the size of the bloodstain.

To accomplish this goal, a device was made to create very small bloodstains. The device involved the use of a modified spring hinge, which would spatter blood onto pieces of Foam Board™ that were held in a fixed position on either side of the device. The extremely fine impact patterns created on the Foam Board™ was at known angles due to the fixed position of the target surface as well as the stationary impact source. The individual stains, some smaller than 0.3 mm, were excised using a scalpel and placed on a microscope slide. Mounted stains were then placed under a transmitted light microscope at low magnification (40 x overall) and captured via a digital photomicrograph. The images were then opened in Adobe® Photoshop®, enlarged, and measured.

The results of this study illustrate which stains are suitable for use and which are more prone to error. This study will also correlate data from very small stains which are not often used with larger stains which are often used in bloodstain pattern reconstructions.

Bloodstain Pattern Analysis, Angle of Impact, Validity

A174 Re-Evaluating Previously Published Methods for Determining the Volume of Dried Bloodstains and Its Height of Fall

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After attending this presentation, attendees will have learned how pertinent blood volume determination is not only helping reconstruct and possibly solve a crime, but also in calculating the estimated height the blood droplet fell from. The correlation between volume, diameter, and height has long been disputed and this presentation will hopefully bring some clarity to that topic.

This presentation will impact the forensic science community being that inconsistencies have been found in previous published research on this topic. By bringing clarity to these issues people will have a better understanding of how blood droplet volume and height can help in the reconstruction of a crime scene.

Early in the study of bloodstain patterns certain relationships were observed that were not fully understood. One such relationship was the correlation between the diameter of a bloodstain and the height from which the resultant droplet fell. Often experiments were developed where a volume of blood was dropped from different heights onto a non-porous target surfaces. The resultant stains were evaluated and exhibited different diameters based upon the differences in height. As useful as this might prove, Balthazard and then later Pizzola pointed out that this relationship is dependent on the volume of the drop. Pizzola went on to further dispel the myth of the "normal droplet" demonstrating that the volume of the blood droplet will vary greatly based upon the surface from which the blood was dripping.

While not always significant on every case, there are times when the height of fall of bloodstain can be of reconstructive significance. To address this issue, a study done in 1986 evaluated if it is possible to determine the volume of blood from examination of the dried blood stain. This information would then be used in conjunction with the stain diameter to conduct experiments on the same target substrate to determine the approximate height of fall.

Four different methods were developed to obtain the dry weight of the blood on different substrates. Once the dry weight was obtained, the original volume was calculated by multiplying the dry weight by a dry weight constant (0.4167 mL/mg). The authors developed the dry weight constant through experiments with known volumes of human blood. The slope of the plot of dry weight vs. volume was the dry weight constant.

Currently this remains the only method in the peer reviewed literature to conduct such a determination and it is widely cited. Initially, the purpose of this study was to evaluate the error associated with this method. A more critical evaluation of the initial publication revealed significant issues. It was not possible to reproduce the published dry weight constant. Replotting the published data revealed what appears to be a typographical error. Instead of the published 0.4167 mL/mg, the dry weight constant was calculated to be 0.004135 mL/mg. When the experiments were reproduced with five different human subjects, the constant was not constant fluctuating between 0.0035 to 0.0040 mL/mg. Similar results were obtained when blood samples were collected with EDTA tubes or with no anticoagulant.

In light of these developments, this project will reevaluate the ability of this method to calculate the volume of dried stains and to determine the height of fall of individual droplets.

Dry Weight, Height of Fall, Blood Volume

A175 *Lucilia sericata* and Their Effect on the Morphology and Presumptive Chemistry of Medium Impact and Pooled Bloodstain Patterns

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After attending this presentation, attendees will have a better understanding of insect stains, their importance in bloodstain pattern analysis, and practical applications of locating and identifying insect stains.

This presentation will impact the forensic science community by increasing knowledge of confounding variables, specifically the activity of Lucilia sericata, on bloodstain patterns and the means of using this knowledge to make more accurate scene reconstructions.

Bloodstain pattern analysis can give insight into many events of a crime scene. However, bloodstain patterns can be altered in the presence of insects. To address this problem, we conducted an experiment to test the effect of *Lucilia sericata* on medium impact and pooled bloodstain patterns and to assess presumptive blood tests for differentiating between blood spatter and insect stains.

The experiments were conducted in microscenes (.46 m^3 wooden boxes) that had two glass walls and a plexiglass ceiling to facilitate observation and photography. Interchangeable inserts were made to allow for surface changes in the microscenes. Surfaces used in this study were combinations of indoor materials commonly found at crimes scenes. Combinations of white linoleum with white textured and painted walls (Combination 1), wood floor laminate with a wallpapered wall (Combination 2), and mid-grade carpet with light hued paneling (Combination 3) were used to demonstrate surface texture and its effect on the flies' ability to feed and deposit artifacts. Medium impact bloodstains were made from fresh (within five minutes of drawing) human blood on two walls and a pool was formed on the floor. The flies were placed in holding cages that attached to the microscene. This provided an opportunity for the flies to choose to enter the microscene. The flies were provided access to the microscenes for forty eight hours at a temperature of 22 ºC ± 2 ºC. Flies entered the microscene within two hours with combinations 1 and 2. They entered the microscene within 3 hours with combination 3. After they were removed, measurements, photo documentation, and presumptive tests were performed. Five commonly used presumptive tests were used: phenolphthalein, Hemastix®, leucocrystal violet, fluorescein, and an alternate light source.

Lucilia sericata fed from the pooled bloodstains but left little physical evidence of feeding. *Lucilia sericata* added insect stains through regurgitation and defecation of consumed blood but no artifacts were deposited on the carpet (Combination 3). Defecation was the most common source of insect stains. *Lucilia sericata* formed defecatory trails of artifacts that indicated directionality. No evidence of tracking was observed. There was no difference (< 2 seconds) in the reaction times between blood and insect stains tested with phenolphthalein, Hemastix®, leucocrystal violet, and fluorescein. However, defecatory artifacts fluoresced under light at 465 nm when viewed through an orange filter (Marumi, 58 mm, YA2) with no added chemicals. Thus, insect stains differ with different surfaces and textures and *L. sericata* will likely only form insect stains within 48 hours of the formation of bloodstain patterns without the presence of an additional food source.

Insect Stains, Bloodstain Pattern Analysis, Fly Spots

A176 Differentiation of Tire Rubber by Pyrolysis-Gas Chromatography/Mass Spectrometry

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The goal of this presentation is to demonstrate how pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) can be used to differentiate tire rubber samples.

This research will impact the forensic community by showing that tires between and within manufacturers and product lines are chemically

distinct allowing methodologies to be developed that can lead to their differentiation and identification.

Vehicles are commonly associated with crimes, whether deliberate or accidental, such as hit and runs, kidnapping or carjacking. Traces of tire rubber can be found on road surfaces due to the friction between the tire and road as the vehicle applies its brakes or quickly accelerates.[1] The main component of a tire is rubber, which is approximately 60% of a tire's composition. Rubber can be natural or synthetic. The tire industry typically uses styrene-butadiene rubber (SBR), along with natural rubber (isoprene), and butadiene rubber.[2] In previous research, Sarkissian *et al.*[2] performed research on tires and tire traces using pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS). They collected 59 samples for analysis and used a pyrolysis temperature of 450°C to pyrolyze the tire rubber. A total of twenty seven compounds were used to classify the samples by target compound identification. Principal Component Analysis was used to identify the scores for the principal components. The first six components scores were calculated and used for linear discrimination analysis. Linear discrimination analysis was able to discriminate 98.3% of the samples, making it the respectable method for analysis.

Used passenger tires from different manufacturers were collected from various auto body shops to determine if brands and styles within brands could be distinguished from each other. Two separate runs were performed on each of the tire rubber samples on different days to account for reproducibility within a particular type of tire. Samples were placed in quartz tubes and placed in a coil probe and pyrolyzed at 550°C for 20 seconds using a CDS Analytical Pyroprobe 5000. Ion chromatograms were produced using an Agilent 6890N Network GC System 5873 Network Mass Selective Detector. Chromatographic runs were performed at a maximum temperature 315°C for 30 minutes. The GC total ion chromatograms obtained were examined and differences in peaks present and relative ratios of the peaks were noted. In cases where the total ion chromatograms between samples were similar, select ion profiling using ions common to tire rubber was performed to differentiate the samples.

Tires were tested for homogeneity within a single tire by collecting samples from five random locations on the tire's tread.

Results showed that the five samples for each tire were analytically indistinguishable, demonstrating homogeneity within each tire. Samples collected from tires of the same product line that were manufactured at different weeks and years from the same manufacturing plant were also analytically indistinguishable. Tires produced from the same manufacturing plant in the same week and year were also collected and analyzed. Results showed homogeneity of all tested rubber batches. Tires of the same brand but different styles were also studied. Results of this test set showed that styles within a brand could be differentiated from each other. Lastly, tires of different brands were differentiated using the methodology employed.

All tire rubber samples tested were differentiated using this method. Thus, Py-GC/MS shows potential to be a valid, reproducible method for the differentiation of tire rubber between and within manufacturers.

References:

1 Sarkissian G. The Analysis of Tire Rubber Traces Collected After Braking Incidents Using Pyrolysis-Gas Chromatography/Mass Spectrometry. J Forensic Sci 2007;52(2):1050-1056.

2 Sarkissian G, Keegan J, Du Pasquer E, Depriester J-P, Rousselot P. The Analysis of Tires and Tire Traces Using FTIR and Py-GC/MS. Can Soc Forensic Sci J 2004;37(1):19-37

Tire Rubber, Pyrolysis-Gas Chromatography/Mass Spectrometry, Trace Evidence

A177 *In Situ* Identification of Bismuth Vanadate in Automotive Paints Using Extended Range FT-IR Spectroscopy (4000-250cm-1) and Elemental Analysis

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After attending this presentation, attendees should be able to identify a yellow inorganic pigment, bismuth vanadate, *in situ* in automotive and other types of paint using infrared spectroscopy and elemental analysis. This can be useful for both identification of automotive paints and for distinguishing between paints having similar colors.

This presentation will impact the forensic science community by providing forensic paint examiners with background information about a relatively new pigment used in automotive and other types of paint.

Yellow pigments play an important role in formulating paints as they are used to help produce yellow, orange, brown, green and other colors. This is particularly true in the automotive industry, as the finishes formulated by automobile color stylists span essentially the entire range of hues and heavy pigment loads are often used to achieve the vivid colors favored by consumers. Hydrous ferric oxide, for example, is a very common yellow inorganic pigment that was identified in a large number of U.S. automobile original (OEM) finishes (1974 to 1989) from the *Reference Collection of Automotive Paints* (*J Forensic Sci* 1996;41:393-406). These included finishes with yellow, orange, red, brown, and green nonmetallic and yellow, orange, brown, olive, and green metallic hues.

In addition to hydrous ferric oxide, two other yellow inorganic pigments, Nickel Titanate (*J Forensic Sci* 2006;51:532-47) and Chrome Yellow (*J Forensic Sci* 1996;41:393-406), were also commonly used in these paints. When used as masstones (undiluted), hydrous ferric oxide and Nickel Titanate produce pastel shades (pencil yellow and lemon yellow, respectively). In contrast, Chrome Yellow, a lead chromate pigment, produces a bright hue (school bus yellow) and is more amenable for production of brilliant "glamour" shades. Use of lead-containing pigments, however, was discontinued for U.S. automobile OEM finishes in the early 1990s due to health concerns, although they continued to be used for vehicles produced in Europe (*Sci and Justice* 1999;39:181-7). Most of the replacements for Chrome Yellow were organic pigments as they usually produce brighter colors than inorganic pigments. Compared to these organic pigment replacements, Chrome Yellow was more durable, had a greater opacity, and cost considerably less. The loss of Chrome Yellow from the palette of U.S. automobile color stylists thus had a pronounced adverse effect on the formulation of some automobile paint hues.

In 1985 a new yellow inorganic pigment, Bismuth Vanadate ($BiVO_4.nBi_2MoO_6$ n = 0 to 2), was introduced commercially. Like Chrome Yellow, Bismuth Vanadate produces a very bright hue and is quite durable. Its other attributes include high tinctorial strength, high gloss, good gloss retention, good hiding power, excellent solvent- and heat-resistance properties, and low toxicity. Consequently, Bismuth Vanadate has become an important automotive paint pigment in recent years. It has, to some extent, filled the large void that was created when use of Chrome Yellow was discontinued.

This presentation describes the identification of Bismuth Vanadate *in situ* in automotive paints using Fourier transform infrared (FT-IR) spectroscopy (4000 to 250 cm^{-1}) and X-ray fluorescence (XRF) spectrometry. The various formulations of Bismuth Vanadate produced by BASF and Ciba, the main suppliers of this pigment for the North American automotive OEM and refinish markets, differ somewhat. In a

few cases, they can be distinguished in automotive paints using infrared spectroscopy, elemental analysis, or both, particularly based on the presence or absence of molybdenum and certain far-infrared absorptions. Bismuth Vanadate is rarely used as a masstone and most automotive finishes in which this pigment was identified also contain Isoindoline Yellow, a common organic pigment used for automobiles (*J Forensic Sci* 1999;44:1151-75), hydrous ferric oxide, rutile, or combinations thereof.

Paint, FT-IR, XRF

A178 Detecting Gravesoil from Headspace Analysis with Adsorption on Short Porous Layer Open Tubular (PLOT) Columns

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After attending this presentation, attendees will have a solid understanding of headspace analysis with adsorption on short porous layer open tubular (PLOT) columns, a technique developed recently to collect ppb levels of low volatility compounds, along with the benefits and advantages of detecting gravesoil with this technique, as well as, an example of an application of this technique to the detection of trace vapors of ninhydrin-reactive nitrogen in actual gravesoil.

This presentation will impact the forensic science community by presenting a simple and reliable technique that can be used to detect ninhydrin-reactive nitrogen in the air above gravesoil, paving the way for developing a reliable and cheap in-the-field devise for the detection of clandestine graves.

Victims of crimes are often buried in clandestine graves. While there are several methods to find bodies, none of these methods are very reliable; thus, a simple and rapid diagnostic tool for forensic detection of clandestine gravesites would be invaluable to criminal investigators. Cadaver decomposition results in the release of nitrogenous compounds into the surrounding area/dirt. Some of these nitrogenous compounds react with ninhydrin to form Ruhemann's purple, a reaction that is often used to detect latent fingerprints. Ninhydrin is low cost and readily available to law-enforcement personnel. Recently, an improved headspace analysis technique for sampling low volatility, as well as trace volatile, compounds by applying low temperature collection on short alumina-coated porous layer open tubular (PLOT) columns was developed (T.J. Bruno, "Simple Quantitative Headspace Analysis by Cryoadsorption on a Short Alumina PLOT Column" Journal of Chromatographic Science, 2009). This method was modified for the in-the-field (ambient temperature) collection of ninhydrin-reactive nitrogen from the air (headspace) above decaying rats. Frozen feeder rats were laid in individual grave boxes on top of 3 inches of dirt. Half of the rats were then covered with another two inches of dirt. Additionally, gravesites that contained only dirt (no rats) were also examined. The graves were sealed for the duration of the experiment. The headspace was sampled via piecing a PLOT column through a septum port on the lid of each grave using a pump to pull the headspace air through the PLOT column. After headspace collection, analytes that adsorbed onto the PLOT column were eluted into 0.5 mL of 2% ninhydrin reagent using 0.5 mL 2M KCl. The solution was then incubated at 100 °C for 25 minutes, diluted with 10 mL 50/50 v/v ethanol/water, and the absorbance of the solution read at 570 nm. Measurements were made over several months. Ninhydrin-reactive nitrogen was detected in each grave at each time point at levels significantly above the dirt-only graves

An in-the-field method will be presented for detecting trace quantities of ninhydrin-reactive nitrogen in the air above decaying rats and present the results from the above experiment that took place over a several month period. This work paves the way for developing a portable device for detecting clandestine graves.

Gravesite, Headspace, Adsorption

A179 Improved Methods for the Discrimination of Automotive Paint Clear Coats Using Microspectrophotometry and Chemometrics

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After attending this presentation, attendees will have a better understanding of how automotive clear coats are analyzed for forensic purposes, how proper sample preparation and UV microspectrophotometry can discriminate among clear coats, and how chemometrics can provide further distinction among visually similar clear coats.

This presentation will impact the forensic science community by providing a new analytical tool in the characterization of automotive clear coats.

The purpose of this research is to revaluate this analytical technique for its ability to discriminate among automotive clear coat finishes by applying a different sample preparation technique. Automotive paints have been important examples of trace evidence in crime laboratories for many years. Paint evidence is often found at the scenes of automobiles crashes and can be transferred between cars or from a car onto a person. Automobile paint consists of several layers. These include one or more primer layers which serve to provide a good adhering surface for subsequent layers. Over the top of primers are topcoats (color coats) which give the finish its color and help protect the body of the car. Since the early 1990s, car manufacturers have been adding clear coats to their paint finishes. The clear coat protects the topcoats from scratches, dents, breaks, and damage caused by ultraviolet light. In most situations, paint cannot be attributed back to a specific source so testing focuses on generating as much physical and chemical data on the paint in question and a known sample of paint from the automobile. Frequently this analysis focuses on the colored paint including the number and sequence of the layers. Automotive clear coats have not been studied extensively because they have no color and have only become a staple on automobiles within the last twenty years. By studying clear coats, more data can be generated about paint evidence and thus a better association can be drawn between the transferred and native paints.

Samples of automotive finishes were obtained with the make, model, and year data, from paint and body shops and junkyards, resulting in 360 spectra. This database is larger in size and more diverse than before, now including a few foreign exemplars. Initial sample preparation included the use of a microtome with an association binding medium (Lensbond). The chemometric data resulted in three main classes of clear coats; however, these results were skewed due to this mounting medium

absorbing in the UV range. The current research involved a different sampling technique that involved shaving off the clear coat and using these paint peels and thus avoiding a mounting medium issue. Statistical techniques including clustering, principal component analysis, and discriminant analysis were applied to the spectra. Based upon cluster analysis, four main classes of clear coats were present among the data set. Overall, the results show that this technique is more useful in discriminating clear coats. This improved method resulted in more defined spectra, and overall the database improved in size and diversity. The chemometric analysis resulted in more discrimination and reliable classes.

Clear Coat, UV Microspectrophotometry, Chemometrics

A180 Application of Cathodoluminescence (CL) Microscopy and Spectroscopy to Forensic Sediment Analysis

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After attending this presentation, attendees will understand the principles of cathodoluminescence (CL) microscopy and spectroscopy applied to forensic sediment analysis, as well as sample preparation, mineral component identification, digital image processing, and elemental analysis.

This presentation will impact the forensic science community by illustrating the key steps in practical application of the method and its integration into techniques currently used in forensic sediment analysis.

This presentation describes and demonstrates the application of cathodoluminescence (CL) microscopy and spectroscopy to the characterization of mineral components of sediment. Forensic geologic samples are often comprised of varying concentrations of both light and heavy minerals, as well as foraminifera, diatoms, and organic particles, making them amenable to identification by a variety of methods. Quartz, carbonates, and feldspars are the most abundant minerals on the Earth's crust and, as such, are usually encountered as constituents of sediment samples. Because these minerals are ubiquitous, they may be found in even very small amounts of trace geologic materials, such as smears and dust. Application of CL microscopy and spectroscopy is suitable to differentiate among common minerals and classes of minerals, such as feldspars, carbonates, zircons, and quartz, all of which exhibit characteristic CL colors when bombarded with an electron beam. The CL emission is related to the presence of trace element activators, such as Cr^{3+}, Mn^{2+}, Mn^{4+}, Fe^{3+}, and rare earth elements ($REE^{2+/3+}$), such as hafnium, dysprosium, and europium, as well as due to lattice defects within the crystal.

Within the mineral types, CL microscopy and spectroscopy will provide information that can discriminate among different sources of each mineral. The additional discrimination among sources of quartz, for example, would provide a useful tool for the forensic comparison of these geologic materials. Further, CL microscopy and spectroscopy, combined with traditional forensic geologic methods, may offer information for source determination by providing information about the conditions under which the mineral was formed.

At the 2009 AAFS Annual Meeting, study results including suitable sample preparation for processing with multiple techniques and particle elemental analysis, using automated SEM-EDS, and micro-XRF were presented. The focus of this study was to develop an optimized analytical scheme for processing small sample sizes with these microanalytical methods. Considerations of sample size and sequence of analyses necessary for sample manipulation, integrity and beam damage, as well as automation of processing for high sample throughput, was presented. This presentation will expand on these prior results, including refinement of the sample preparation process, comparison of CL and SEM-EDS particle identification results for hundreds of particles from different size fractions of several sources of sediment. Additionally, the application of automated digital image processing of CL images will be presented and evaluated in the context of its utility to process the large numbers of particles for necessary for source characterization.

Cathodoluminescence, Sediment, Microscopy

A181 Molecular Features Observed in Spark-Induced Breakdown Spectroscopy (SIBS) of Biological Warfare Agents

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After attending this presentation, attendees will understand the principles of Spark-Induced Breakdown Spectroscopy (SIBS), the equipment and techniques used, and how SIBS compares to Laser-Induced Breakdown Spectroscopy (LIBS). The aim of this work was to investigate further use of SIBS for bioaerosols as an alternative to the more expensive and well-known LIBS.

This presentation will impact the forensic science community by introducing a unique method for rapidly screening and analyzing biological warfare agents as airborne pathogens.

The development of SIBS will impact the forensic community by introducing a unique method for rapidly screening and analyzing biological warfare agents as airborne pathogens. SIBS has the ability to distinguish between atomic spectra of airborne biological particles. These spectra can then be used to differentiate between harmful and harmless biological species, such as *Bacillus anthracis* (Anthrax) vs. *Bacillus thuringiensis* (Bt). Therefore, SIBS can be used as a real-time trigger sensor for biological warfare agents.

SIBS was initially developed as a real-time sensor for toxic heavy metals in aerosols at detection limits of 1 to 10 mg/m^3. SIBS uses a high-energy electrical spark between two electrodes to ionize, vaporize and excite the elements of the sample of interest. The aerosol sample passes through the spark gap containing rod-shaped electrodes, which ablates the sample creating a plasma. Within this plasma, the ablated material dissociates into ionic and atomic species. After plasma cooling, atomic and molecular emission lines of the sample can be observed. The SIBS apparatus is coupled with a spectrometer and an ICCD detector. The more familiar technique LIBS, on the other hand, is very similar, except that it uses a focused laser pulse as the excitation source. When the highly energetic laser is discharged, it ablates a small amount of the sample and creates a plasma.

Previous experiments compared biological warfare simulants Bt, Ragweed Pollen, and Johnson Grass Smut in the spectral region around 380nm. Both atomic and molecular features (CN (B to X), N_2^+, OH) were present in the previous data. However, the size distributions of the simulants are drastically different. Preliminary results concluded that due to the radically different size distribution, it is very difficult to compare processes of the particles.

In this experiment, a sheath flow system was built as a modification to the existing SIBS apparatus to alleviate size distribution complications. The addition of a sheath flow allows for single particle analysis of various biological samples by eliminating accumulation of particles on the electrodes. The sheath flow system also collimates particles for determination of the upper particle size limit for quantitative analysis of aerosols. Biological warfare simulants Bt, ragweed pollen, and johnson grass smut were again compared in the spectral regions around 300, 380, and 442nm. Biological samples of similar size distribution were also compared using the sheath flow system. This presentation will include data acquired in each of the three spectral regions at a variety of delay times. This presentation will also include a comparison of the molecular features CN (B to X), N_2^+ and OH.

The results of this and other studies demonstrate that biological samples have unique molecular features that behave differently, and this information can be used for more complete sample analysis. SIBS can spectrally distinguish between biological and non-biological samples, as well as distinguish between biological samples within the same species. The low detection limit, sensitivity, and discrimination potential of SIBS indicates this system as an alternative to the costly LIBS system.

SIBS, Bioaerosols, Air Sampling

A182 Detection of Burnt Bloodstains Using Light-Emitting Enhancement Reagents

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The goal of this presentation is to show how three different light-emitting blood enhancement reagents: Luminol, Bluestar©, and Hemascein™ compare with respect to their ability to detect liquid blood, untreated bloodstains, and bloodstains subjected to simulated fire conditions. Attendees will learn how the three reagents differ in both the magnitude and duration of light emission when testing these types of blood samples.

This presentation will impact the forensic science community by discussing the complex nature of arson-homicide scenes, which pose a significant challenge to both crime scene investigators and forensic scientists trying to locate and identify biological evidence such as bloodstains in the fire debris. The availability of a quick and easy screening test that selects only relevant bloodstains can reduce the number of samples selected for DNA typing analysis, thereby reducing analytical time and cost.

Investigators and forensic scientists employ a variety of blood screening tests in an effort to find the presence/absence of blood at a crime scene. Color-based blood screening tests, such as the Kastle-Meyer test, are conducted on any stain which visually appears to be blood in origin. Only those stains which test positive are collected for subsequent laboratory tests. However, when the perpetrator has purposely cleaned up the scene in order to remove any blood evidence, sensitive light-emitting blood enhancement reagents are typically employed to locate residual blood. Luminol is a very sensitive blood enhancement reagent. Unfortunately, the reagent must be prepared fresh and the crime scene darkened in order to see the short-lived chemiluminescent blue-light emission. Bluestar© is a relatively new product which uses a modified luminol reagent, emitting an intense blue light in the presence of blood. Hemascein™ is a new commercial product emitting a green light when excited with an intense blue light source.

Criminals have also used fire to destroy any incriminating evidence. In these situations, bloodstains may be completely destroyed, difficult to locate in the fire debris, or difficult to recognize due to the charring of surfaces by the intense heat. This study evaluated the effectiveness of luminol, Bluestar©, and Hemascein™ as screening reagents when testing burnt bloodstain samples. The three reagents were tested for their intensity and duration of light emission using a Bio-Rad VersaFluor™ fluorometer. With the Luminol and Bluestar© reagents, the excitation light from the instrument was blocked and only an emission filter of 460 ± 5 nm was used. With Hemascein™, an excitation filter of 460 ± 5 nm and an emission filter of 520 ± 5 nm were used. To determine the sensitivity of detection of each reagent, dilutions of canine blood were prepared from 1:10 to 1:10,000, and 25 ul of each dilution were mixed with 2 ml of reagent for analysis on the fluorometer.

To determine whether or not the reagents could detect burnt blood, bloodstains of approximately 2 x 2 cm, were prepared on glass microscope slides using 5 ul of a 1:10 canine blood dilution. The resulting bloodstains were exposed to the direct flame of an alcohol fire for one to five minutes. The burnt stains were removed using a cotton swab moistened with distilled water and the cotton tip was agitated in 2 ml of test reagent for analysis on the fluorometer. Light emissions were monitored and recorded for 5 minutes for each of the test conditions.

The results showed that both Luminol and Bluestar© performed equally well when the limits of detection of liquid blood were compared. Light emissions above background were detected with test samples from the 1:10,000 dilution of blood. Light emissions were strongest during the first 30 to 90 seconds, decaying to near background levels at the end of the five minute assay period. The Hemascein™ reagent exhibited a limit of detection of only 1:1000, however, strong and continuous light emissions were observed over the entire five minute testing period.

With burnt blood samples, Luminol exhibited weak light emissions with only the one minute burn sample, whereas Bluestar© emitted light with the one, three, and five minute burn samples. The Hemascein™ reagent yielded maximum light emission values similar to that of Bluestar© for each of the timed-interval burn samples. However, Bluestar's emission decayed rapidly, whereas light emissions from the Hemascein™ reagent were stable over the five minute assay period.

By comparing the light emitting properties of Luminol, Bluestar©, and Hemascein™ in a quantitative manner, it was determined that Bluestar© and Luminol exhibited the greatest sensitivity with liquid blood samples. With burnt bloodstain samples, both Hemascein™ and Bluestar© detected bloodstains that had been exposed to the direct flame of an alcohol fire for up to five minutes. However, Hemascein's™ light emission was stable over the entire assay time. Although both Bluestar© and Hemascein™ successfully detected burnt bloodstain samples, the research indicates that Hemascein™ would be the reagent of choice for the detection of burnt bloodstains at arson-homicide scenes.

Luminol, Bluestar©, Hemascein™

A183 A Fingerprint Search Program Validation Study

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The goal of this presentation is to explore the capabilities of a fingerprint search program and identify its optimal settings and deficiencies.

This presentation will impact the forensic science community by discussing validation strategy and ramifications of the *Daubert* Ruling.

Validation strategy and ramifications of the *Daubert* Ruling will be discussed. This is the companion paper to *A Comparison of Fingerprint Screening Ability between a Computerized Search Program and Human Examiners.*

Two types of experiments were performed in this study. One group of experiments sought to optimize the software's selectivity setting to the number of minutiae in the search. The other group of experiments measured search accuracy by comparing search results to known theoretical outcomes.

The search program uses two categories of prints in its operations, the print being searched called the "Latent Print" and the library of prints called the "Database." In the following experiments the latent print was always the test print being searched against the database. Using rolled and plain (slapped) fingerprints of high quality, several tests were performed and the results were compared to known theoretical outcomes. Graphs and tables of the data will be presented and the experimental design is described below.

Optimized Settings Experiments: Starting with a known number of minutiae, what is the optimal selectivity setting that gives the highest number of true candidate latent prints with the fewest false candidate prints? A test print was searched with minutiae ranging from 18 to one and the highest selectivity settings that identified a true candidate were determined for each number of minutiae. As the number of minutiae for searching declined, the search selectivity needed to be reduced to identify the matching print in the database. It was also noted that as the search selectivity was lowered, a greater number of non-matching candidates increased. The optimized balance between these search parameters, i.e., the highest selectivity for a given number of minutiae was determined.

Search Accuracy Experiments:

1. Can the software find an exact copy of the full latent in the database? This is a self-matches-self experiment with the expected outcome of a match on every attempt.

2. Can the software match the full print by searching portions of an exact copy of the full print? This is a self-matches-self experiment that simulates searching the database with an ideal partial print. To mimic a partial print the full latent print was divided into quarters or quadrants and each quadrant was searched as a separate latent print. Fifteen minutiae were arbitrarily chosen for all experiments as it is generally accepted that a full latent can be identified from twelve to sixteen minutiae even if only a partial print is present.

3. Can the software match the full print by searching a series of plain prints of the same finger that have varying quality and spatial orientation? In this case the database contained only prints made with the same finger as the full latent. It is also another version of a self-matches-self test. Each plain print was searched with fifteen minutiae with the theoretical matching expectation of 100 percent.

4. This experiment was the same as experiment three except non-matching prints were included in the database to better simulate a real life search. The same settings and number of minutiae were used as before except the theoretical outcome changes to include non-matching candidates for examination.

Summary: In some cases fifteen minutiae were not sufficient to identify the full print in the database. And at times, true candidates present in the database were omitted from the list of candidates for consideration. The results will be discussed as they apply to the use of this software and also to the broader debut about the ACE-V approach of fingerprint examination's compliance to scientific methodology and Daubert considerations such as an error rate.

Fingerprint, Validation, Daubert

A184 Opinions of Forensic Professionals on Key Issues Facing Friction Ridge Analysis

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After attending this presentation, attendees will have an increased understanding of the views, perspectives, and opinions of forensic practitioners on key issues facing friction ridge analysis.

This presentation will impact the forensic science community by highlighting current opinions of forensic professionals in light of recent government publications. This data will create a deeper appreciation for the gap between perception and the reality of friction ridge analysis in forensic laboratories.

Since the National Academy of Sciences Report, *Strengthening Forensic Science in the United States: A Path Forward*, was released in February 2009, many forensic disciplines have been under increased scrutiny, including friction ridge analysis. As part of an award-winning series of on-line continuing professional development courses, 150 forensic practitioners were surveyed between 2007 and 2009 with the following eight questions:

1) Do you believe that fingerprint identification is a science?

2) Do you feel that fingerprint identification should be admitted into courtrooms as expert testimony?

3) What type of research, if any, should be done to correct the misidentifications that occur?

4) Should there be a minimum number of points for identification? Why?

5) Do you feel that other misidentifications have occurred that have never been caught?

6) Do you believe that innocent people are in jail or on death row because of fingerprint errors?

7) What additional quality assurance steps should be taken for fingerprint examiners?

8) Do the *Daubert* factors apply to fingerprint identifications?

The practitioners' represented local, state, and federal agencies in the United States and ranged from 0 to 20 years or more experience.

The responses to the questions varied more than might be expected for certain questions but less than expected for others. For example, in response to the question as to whether a minimum number of points for identification should be used, two participants responded:

"No. The ACE-V process is based on an overall examination of the latent print presented, and that includes the level 1 examination of pattern

type, ridge flow and creases along with the level 2 points, and level three ridge edges and pores."

"My personal preference is for a number of points of comparisons which would likely give fingerprint evidence more legal standing and public acceptance."

Consensus in the field of forensic science can be difficult given the variance in jurisdictional requirements. While, the majority of practitioners surveyed believed that fingerprint identification is a science, this survey demonstrates that a clear, coherent message as to what constitutes that science is yet to be achieved.

Friction Ridge, Fingerprint Identification, NAS Report

A185 21st Century Forensic Education: Surveying Lab Director Entry-Level Examiner Requirements and Attitudes Regarding Educational Standards

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After attending this presentation, attendees will know what laboratory directors reported as their current educational background requirements across a range of forensic disciplines (including QDE, LPE, firearms, toxicology, serology, etc.), and what directors felt were the most important social and legal forces that impacted their standards.

This presentation will impact the forensic science community by providing them with the results of a social scientific survey of entry-level educational requirements (updating research from the 1980s and 1990s) and an analysis of the socio-legal forces that may be impacting those standards.

Over the past twenty years, the field of forensic science has undergone a myriad of technological as well as socio-legal changes. These changes include, but are not limited to, advancements in DNA technology (i.e., RFLP to PCR method, the mapping of the human genome), the construction and maintenance of the Combined DNA Index System (CODIS, 1994) and the Integrated Automated Fingerprint Identification Systems (IAFIS, 1999). As technology has advanced, so has the burden placed on forensic examiners to keep up with innovative procedures, tools, and techniques in the field. This burden is, perhaps, never more acutely apparent than in the courtroom.

Because of these and many other developments, decades-old attitudes regarding the value of advanced degrees in forensic and forensic-related sciences can no longer be expected to accurately describe the level of expected educational attainment for entry-level forensic examiners. This study was designed to update and expand upon the previous survey work by surveying currently practicing lab directors and include additional attitudinal measures that were not presented in the original survey series (see Furton, Hsu, & Cole, 1999; Higgins & Selevaka, 1988; Siegel, 1988; and Lee & Gaensslen, 1988). Through this expansion the authors explored not only *what* educational background forensic lab directors expect or require their applicants to have, but *why* they have developed the standards that they ostensibly enforce. Using traditional survey methodology (Schwarz, Groves, & Schuman, 1998), this study sampled forensic laboratory directors and solicited a variety of responses including indications of the director's own background (i.e., education, work history, etc.), desired educational background for entry-level examiners, amount and kind of prior professional experience, and explored a variety of attitudes toward the forensic sciences.

It was found that overall the coursework and degree requirements have not changed. An emphasis on chemistry across all forensic specialty categories employed in this survey (drug chemist, trace/ impression, serologist/ DNA, firearms examiner, questioned documents, and latent fingerprints) is consistent with the research conducted by Furton, Hsu, and Cole (1999). One notable descriptive difference that appeared is the seemingly increased emphasis on mathematics and statistics. The modal response indicating that Bachelors-level degrees are the dominant degree requirement is also consistent with the previous research, as is the lack of an internship requirement, even when *Daubert* and non-*Daubert* states were compared. The lack of required specialization within the degree background for entry-level examiners in the fields of firearms examination, questioned documents, and latent fingerprint examiners appears to differentiate those practice areas from drug chemist, trace/ impression, and serologist/ DNA analysts. There has been an historic division within the forensic sciences that differentiates between the "hard" and "soft" sciences. The descriptive results regarding areas of specialization suggest that this division is still present. Extending beyond a mere update of previous entry-level education requirements research, the authors found that, in some cases the factors that directors felt influenced the current entry-level educational standards differed according to the *Daubert* vs. non-*Daubert* status of the state as well as the state's caselaw history of judicial evaluation of expert forensic witness educational background.

It has been over fifteen years since *Daubert v. Merrell Dow Pharmaceuticals, Inc.* changed the way that the court interacts with forensic science, and it has been nearly ten years since *Kumho Tire Co., Ltd. v. Carmichael* rounded out the *Daubert* trilogy. Only time will tell if the methodological and technological advances in the field of forensic science or the socio-legal changes that are introduced in the courtroom will fundamentally change the education requirements for entry-level forensic examiners entering the laboratory environment. This survey was a preliminary foray into the potential factors that may be influencing requirements in the forensic laboratory environment.

Director Survey, Education Requirements, Socio-Legal Influences

A186 Development and Implementation of a Custom Paperless LIMS Serology Module

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After attending this presentation, attendees will learn how to create their own customizable modules in LIMS. The creation of the Harris County Medical Examiner's Office serology modules will be used as a model to demonstrate how to create customized modules to record and maintain testing results. The validation and implementation of paperless serology modules as well as the increased data capturing capabilities that this type of system requires will also be discussed.

This presentation will impact the forensic science community by demonstrating that customizable modules can be created in-house for LIMS without the need for vendor intervention. It will also provide an example of how a laboratory might approach creating a paperless system for serology case notes and other documentation.

Laboratory Information Management Systems (LIMS) have been implemented in crime laboratories to different extents and with various levels of success. Maintaining a case file in an electronic format, thereby creating a "paperless system" is the future of laboratory documentation.

The ability of a LIMS system to respond to the specific needs of each crime laboratory and to record and report their findings electronically are of great importance. Therefore, a LIMS system must include characteristics such as security, flexibility, and customization.

Case management at the Harris County Medical Examiner's Office (HCMEO) is maintained in an electronic LIMS. The system has been implemented throughout the laboratory to track chain of custody of evidence and some sections also use it to maintain data and create reports. Its current use in the Forensic Biology Laboratory is limited to maintaining an electronic chain of custody of the evidence because an acceptable software solution for tracking serology and DNA casework has been implemented. The laboratory is moving towards a paperless case management system that requires new ways of capturing forensic biology processing and results.

In response to this need, a unique serology module customized for in-house serology testing within LIMS was created. This module consists of four separate forms designed to capture the analysis results for four different types of submitted evidence: (1) swabs from sexual assault kits; (2) swabs from non-sexual assault cases; (3) non-swab evidence; and, (4) known reference samples. These modules capture all data generated during testing, reagent lot numbers and expiration dates, samples for DNA extraction, witness verification steps, and anything else that is currently tracked in the case file. Upon completion of analysis, a report is generated which includes all data in a worksheet format which can then be stored electronically or printed whenever needed. The laboratory successfully validated these modules and they are currently in the final stages of casework implementation.

This serology module presents a step towards greater efficiency of evidence examination by creating a paperless case management environment. It provides an example of an irreplaceable tool for evidence processing in a fully computerized crime laboratory. The implementation of this module is expected to streamline serology evidence processing, provide standardization of case documentation, and enable faster case turnaround times.

In addition, the serology examination areas are being outfitted with computers on stands equipped with bleach-resistant keyboards and mice designed to ensure accessibility and proper ergonomics.

Serology, Paperless, LIMS

A187 Comparison of Organic Components of Pre- and Post-Blast Smokeless Powders by HPLC

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After attending this presentation, attendees will gain an understanding of the analysis of smokeless powders using HPLC. Also, attendees will understand the significance of pre- and post- blast analysis of explosive debris.

This presentation will impact the forensic science community because it provides a way for comparing pre- and post- blast samples of smokeless powders. Since smokeless powders are being used more now than various black powders, it is important for the community to understand the analysis of smokeless powders.

This presentation aims to show how a simple gradient high performance liquid chromatography (HPLC) system can lead to the identification of several of the explosive and stabilizing components of many common smokeless powders. The smokeless powders can be extracted using a single solvent and injected directly into the HPLC system.

Black powder was once the frontrunner for use in homemade explosive devices, but now more smokeless powder substitutes are being used in place of black powder. The main advantage of using a smokeless powder rather than black powder is that several stabilizing components have been added to the smokeless powder. Gas chromatography followed by mass spectroscopy was the initial method studied for the examination of smokeless powders. However, several components found in smokeless powders have low thermal stability. HPLC can be used as an effective way of separating the different components found in a smokeless powder.

Smokeless powders can be analyzed using high performance liquid chromatography after a simple extraction process using a solution that is 25% butanol and 75% methanol and sonication in an ultra sonic bath. Methanol and an internal standard of *beta-naphthol* were added to the extracts before being analyzed using HPLC. A gradient HPLC system, using a reverse phase octyl (C8) column, and UV detection can show separation of many components including: Nitroglycerin; Dimethyl phthalate; TNT; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene; Dibutyl phthalate; Diphenylamine; 2-Nitrodiphenylamine; 4-Nitrodiphenylamine; and N-Nitrosodiphenylamine. The wavelength of maximum absorbance was determined for each component listed above and each component was then analyzed at this maximum wavelength. The extracted smokeless powders were analyzed over a range of 210-400 nm, separating the range into five different channels of analysis.

Also, using this system a comparison can be made between pre-blast and post-blast samples taken from an explosion. It is essential in bomb debris analysis to be able to compare smokeless powders before and after the blast has occurred. Unburned and partially burned powder found among the bomb debris can be compared to samples of powder before the blast occurred. This can link the powder in the debris to the brand of powder, lot, or even a single can of powder based on morphology and specific component concentrations.

High Performance Liquid Chromatography (HPLC), Pre- and Post-Blast Comparison, Smokeless Powder Analysis

A188 Identification of Peroxide and Traditional Anion Explosive Residues by Capillary Electrophoresis

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The goal of this presentation is to describe the analysis of peroxide explosives through capillary electrophoresis (CE) with a traditional borate buffer, which allows the detection of peroxide explosives in a method that was designed to detect anions associated with low explosives.

This presentation will impact the forensic science community by being the first use of CE to screen for peroxide explosives in addition to its more traditional ionic analytes and will enable an explosives' chemist to screen for anions commonly associated with low explosives and

peroxide explosives simultaneously, without the use of separate methods and preparations.

The analysis of traditional explosive residues can be a difficult task for the forensic chemist. There are many methods to choose from and they can be performed on a wide variety of instruments. Few of the methods give definitive answers, but instead provide results that investigators use to infer the types of explosives employed. Due to the nature of explosives, it is unusual to find a single method that will analyze for multiple types of explosives without the use of several extractions or instruments. Although not new to the scientific world, peroxide explosives are now the explosive of choice for terrorist bombers and present new challenges to scientists as investigators attempt to identify residues left behind after an attack.

Terrorists choose to use peroxide explosives in improvised explosive devices (IEDs), because they offer devastating explosive power without the challenges of procuring and packaging traditional explosives. Even though they have destructive power close to TNT, peroxide explosives are not used in military or commercial applications due to their low stability, sensitivity to impact, and high volatility. Most recently peroxide explosives have been used by Richard Reid in 2001, the London Train Bombings of 2005, and by Joel Heinrichs III outside a University of Oklahoma football game in 2005. Peroxide explosive residues are an analytical challenge due to their volatility, as well as their simple structure which lacks distinctive metallic and ionic signatures.

Capillary electrophoresis (CE) is a separation technique that is used in many different aspects of forensic science and is common to most crime laboratories. CE is considered an excellent separation technique for explosives due to its sensitivity, ease of sample preparation, reproducibility, and rapid analysis. CE offers the explosive analyst the ability to detect multiple explosive ions in a single examination. Although successfully used to identify traditional explosives (anion, cation, and commercial explosives), CE has yet to be used to identify peroxide explosives.

The method presented uses a borate buffer, a dichromate chromophore, and diethylenetriamine (DETA) as the electroosmotic flow (EOF) modifier. The method was optimized from traditional borate buffer methods by adjusting the pH and DETA content. Samples are visualized by a UV detector in the indirect mode using both 200 and 254 nm wavelengths. This buffer system is able to separate traditional anion oxidizers as well as TATP.

Peroxide Explosives, Capillary Electrophoresis, Anions

A189 Hyperspectral Imaging of Post-Blast Explosives Residues

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The goal of this presentation is to provide attendees with an introduction to the theory and practice of hyperspectral image analysis and its potential for use in examining post-blast explosives residues.

This presentation will impact the forensic science community by demonstrating the significance of using hyperspectral imaging to locate, identify, and characterize trace chemical evidence, such as post-blast explosives residues, which might otherwise be overlooked or destroyed in a crime scene investigation. In addition, the determination of a standard protocol for fixed, in-laboratory hyperspectral imaging of post-blast explosives residues will be both novel and necessary for the advancement of the technique within the field of forensic science. The goal of the authors is to adapt the protocol determined in the current study for use in airborne hyperspectral imaging systems, which would allow for large-scale imaging of crime scenes where the presence of post-blast explosives residues is questioned.

Identification of key wavelengths for analysis of post-blast explosives residues in the visible-near infrared (VNIR) and shortwave infrared (SWIR) regions of the electromagnetic spectrum will be made using a handheld point spectrometer with a tungsten halogen source. During each sample analysis, the spectrometer automatically measures reflectance over a set spectrum of wavelengths. For every sample scanned, the spectrometer obtains and averages five readings to account for error. Spectroscopic analysis of post-blast explosives residues will allow for the construction of a spectral library of "clean" samples. The spectral library will provide a point of comparison between post-blast samples and a previously assembled spectral library of pure explosive samples, as well as provide a possible means for identifying unknown post-blast residues at a crime scene. In addition, key wavelengths for post-blast explosives residues identified by the spectrometer will allow for a focused study of both "clean" and questioned samples using two hyperspectral imaging camera systems (VNIR and SWIR, respectively).

While the point spectrometer is beneficial for its portability and general ease of use, the fixed hyperspectral imaging camera systems provide a much higher level of spectral resolution and control of external conditions. For each pixel in an image, a hyperspectral camera acquires the intensity of light (radiance) for a large number of contiguous spectral bands. Every pixel in the image therefore contains a contiguous spectrum (in radiance or reflectance) and is used to characterize the objects in a scene. One narrow spatial line in the scene is imaged at a time and this line is split into its spectral components before reaching the sensor array. On the 2D sensor array, one dimension is used for spectral separation and the second dimension is used for imaging in one spatial direction. The second spatial dimension is obtained by scanning the camera over a scene or object. The result can be seen as one 2D image for each spectral channel or simply stated, every pixel in the image contains one full spectrum.

Preliminary results confirm the ability of the handheld spectrometer to detect post-blast explosives residues on a metal substrate. While low-reflectance (i.e., black) samples such as some of the low explosives, are not ideal samples for analysis using the point spectrometer, results have been obtained from several high explosive samples. The present focus of this study is the optimization of production and collection of "clean" post-blast explosives residues for analysis by both the point spectrometer and the hyperspectral imaging cameras. Once these methods have been determined, key wavelengths for explosives samples can be established and used to construct a spectral library.

Preliminary results confirm the ability of the hyperspectral imaging camera systems to detect post-blast explosives residues on a metal substrate. Initial results indicate that the key wavelengths for the detection of these samples may exist in the VNIR region of the electromagnetic spectrum.

Hyperspectral Imaging, Explosives, Post-Blast Residues

A190 Electrostatic Lifting-Coupled With Nanomanipulation-Electrospray Ionization for the Analysis of Illicit Drugs

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The goal of this presentation is to address a method of lifting drug residues that comes from a common technique used to lift dust prints at crime scenes and coupling it with nanomanipulation-nanospray ionization instrumentation. From this distinct combined method, it will be shown how increased sensitivity of analysis and lower limits of detection for drug analysis can be achieved with ease and efficiency of this two-part method. The principles of electrostatic dust lifting can be applied to lifting different types of drug residues on various surfaces. Nanomanipulation-coupled to nanospray ionization instrumentation has been used in the analysis of multiple solution mixtures and is known to be a very sensitive technique.

This presentation will impact the forensic science community by discussing how the standard limits of detection for most types of drug analysis can be improved with this proposed method of electrostatic drug lifting and nanomanipulation-nanospray ionization by bringing the analyzing capillary tip to the sample, as opposed to preparing the sample and bringing it to the tip.

In most cases, many illegal drugs are in the physical form of dust particles when found at crime scenes. Investigators often have to gather the amount they find at these crime scenes and send it to the laboratory for analysis. There are often times when there is not enough to send to the laboratory since there may be too small of amounts to gather or the crime scene has been cleaned. There are standard limits of detection with various types of drug analysis that laboratory personnel will follow when doing drug analysis, and so extremely small amounts cannot always be detected.

With that fact in mind, the introduction of this unique method will show how drug residues can be lifted with the electrostatic dust lifter and then analyzed with nanomanipulation-nanospray ionization mass spectrometry. Drug residues that are lifted from crime scenes with the electrostatic dust lifter can be detected and verified in amounts normally not considered enough for standard limits of detection. The metallic film that the drug is lifted on serves as a great platform to dissolve the drug residue with a prepared solvent. The dissolved drug can then be withdrawn into the nanospray capillary so that analysis can be performed. Nanomanipulation-nanospray ionization is a method that provides greater sensitivity to trace analysis work. Extremely small sample amounts of compounds (nanoliter to picoliter amounts) can be detected with efficiency and ease. The technique is very direct in that the drug residue is dissolved with a prepared solvent and withdrawn into the nanospray capillary for nanospray ionization by the mass spectrometer. Single crystal extraction produces ample signal for this sensitive technique. The drug residues on the film can also be magnified under a microscope before analysis is performed to verify that there are suspected drug residues present.

The intent is to demonstrate how effective this two-part method is for lifting drugs off of various surfaces and objects and to show how well it may facilitate drug analysis in the laboratory. Various types of drug standards will be analyzed in the current methodology and compared with the analyses of drugs lifted onto the metallic film. The technique as well as the procedure utilized will be explained at length according to the best practice implemented throughout the experiment.

Electostatic Lifts, Illicit Drug, Nanomanipulation

A191 Design and Development of the Human Scent Collection Device

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After attending this presentation, attendees will have learned how the human scent collection device was designed to be a scientifically validated means by which to collect human scent evidence.

This presentation will impact the forensic science community by showing how a scientifically designed human scent collection device represents a critical step towards gaining acceptance, within the scientific and legal communities, of the process by which human scent evidence is collected and stored for future use.

The ability of trained canine teams to locate contraband substances and explosives or to track fleeing suspects and missing persons is generally well accepted by the American public and law enforcement community due to clear successes in the field. When trained canine teams use human scent to indicate that a person may have been present at a crime scene, however, widespread acceptance is weak. Conversely, many European countries have been using scent-discriminating canines in criminal investigations for decades with strong success. One important step towards the use of scent evidence in U.S. courts is to gain credibility for the process by which human scent is collected from evidence and stored for future use.

The Technical Support Working Group (TSWG) sought to address the need for a rugged, reliable, and compact human scent collection device, yet also one that has a scientific basis, for canine handlers to collect human scent for future use. When held over an item, such a device pulls air across a cotton gauze pad to collect a volatile's profile onto the pad from the item. The resulting "scent pad" can then be presented to a canine trained in human scent detection to identify or trail the person matching the volatile's profile.

Laboratory testing verified that the principle of operation used in such a device was capable of allowing the transfer of a human scent compound to a cotton gauze pad. A mockup device was exposed to a low concentration (< 1 ppm) of dodecane, a common constituent of human scent, and scent pads were generated under the same procedures as would be used in the field. The gauze pads were stored in glass jars, where the headspace vapor was captured with solid phase microextraction (SPME) fibers. SPME fibers were analyzed via gas chromatography/ mass spectrometry to determine if the gauze pads had retained dodecane. The laboratory evaluation was also used to evaluate the efficacy of the cleaning procedure, as the potential cross-contamination of scent pads must also be addressed in the design of a scent collection system.

Initial field tests with a mockup device were conducted with canines trained in human scent detection to determine some of the key design specifications of a human scent collection device, including the fan flow rate, collection time, and efficacy of the cleaning procedure. Specifically, the ability of the canine to initiate trailing in the direction of the target trail was observed when presented with a positive scent pad, and the response to being presented with negative or blank scent pads was also observed. Similar field tests were conducted with a fabricated human scent collection device to demonstrate the performance of the device. Volunteer targets provided articles of clothing to be used as sources of

human scent. Targets walked specific paths in normal operational environments, including residential neighborhoods and parking lots. Canines trained in human scent detection were presented the scent pads and evaluated for their ability to begin trailing the appropriate target path.

Tests were also conducted to evaluate the ability of such a device to withstand high temperature exposures and mechanical shock.

Canine, Human Scent, Scent Transfer

A192 Nanomanipulation-Coupled to Nanospray Mass Spectrometry Applied to Document and Ink Analysis

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The goal of this presentation is to address the usage of nanomanipulation-coupled with nanospray mass spectrometry as applied to the extraction of small volume ink samples from questioned documents. Utilization of this technique is of special importance in maintaining the integrity of century old documents.

This presentation will impact the forensic science community by providing a non-destructive approach to analyzing ink samples from questioned documents with small sample volumes.

This technique will provide a non-destructive approach to the analysis of ink samples from questioned documents. The key advantage of using the nanomanipulation technique is that the process does not leave any destructive tracks on the surface of the document, which enables the analyst to retain the document in the original form.

Ink analyses are important aspects in the investigation of questioned documents. Ink analyses provide information on the type of ink used and give an estimate of the time frame in which the document was generated. Nanomanipulation-coupled with nanospray mass spectrometry can be advantageous in the field of questioned document examination where dealing with extremely small sample volumes is typical.

The advent of nanospray ionization has allowed the forensic science community to use extremely small sample volumes for trace analyses. Nanomanipulation-coupled with nanospray mass spectrometry is known to be an ideal approach for analyzing samples with increased sensitivity and resolution. The application of the nanomanipulator allows extraction of very small volumes (nanoliter to picoliter) of the ink sample from the questioned documents using a nanospray capillary.

The advantage of using the nanomanipulator is that one can use a microscope to visually determine the extraction of the ink sample from the document in question. The nanomanipulator is coupled with a Nikon AZ 100 microscope with 2X objective lens and has total optical zoom of 16X. A nanopositioner controls capillary placement and it can be electronically moved in the x, y, and z direction using a joystick. Piezoelectric motors control the nanopositioner which are capable of translational resolution that is beyond the optical limit of 200 nm in both courses of fine mode, allowing for discrete placement of the nanospray capillary in relation to the document surface. A PE200b four-channel pressure injector is used to supply up to 60 psi of injection pressure and 24 inches of mercury of fill vacuum to the nanospray capillary. Once the extraction has taken place, the nanospray tip can be taken directly from the nanomanipulator to the ionization source of the mass spectrometer for analysis.

To demonstrate this technique, a nanospray capillary is filled with an appropriate solvent and mounted on a nanopositioner. The capillary is then maneuvered very close to the surface of the document where the extraction is to be made. A very small drop of water can be placed on the surface of the ink using a gel loader pipette tip. The water drop is then allowed to sit for a predetermined amount of time to allow the ink to diffuse into the water. The dissolved ink is then collected into the nanospray capillary and analyzed by nanospray mass spectrometry.

This novel technique will impact the forensic science community by providing a non-destructive approach to analyzing ink samples from questioned documents with small sample volumes. This will be an improvement from past analytical methods such as HPLC and TLC where higher sample volumes were required along with more preparation time. This approach will provide a more direct and efficient way to do ink analysis.

Ink Analysis, Non-Destructive, Nanomanipulation

A193 Microcrystal Tests of Cocaine With Levamisole and Sugar Added as Adulterants

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After attending this presentation, attendees will have a basic understanding of microcrystal tests, the effect of levamisole and sugar on the cocaine microcrystal morphology, and general trends to observe when performing microcrystal tests on cocaine.

This presentation will impact the forensic science community by documenting crystal behavior of cocaine when diluted with levamisole and sugar and has potential application for profiling cocaine in order to track trends in drug trafficking.

Every year there are tons of pounds of cocaine seized in the United States. However, this cocaine is not always pure. The cocaine submitted into evidence is generally between 60-70% pure. Common adulterants such as lidocaine, sugar, baking soda, caffeine, and levamisole are added to pure cocaine to add bulk and increase the street value. The microcrystal analysis of cocaine, once used as a confirmatory test, still has a place in forensic science. However, there have not been any studies conducted to determine the ratio of adulterant to cocaine in samples of cocaine submitted for analysis. The purpose of this project is to document the changes in the crystal morphology of cocaine in the presence of the sugar and levamisole adulterants.

The most common microcrystal test for cocaine uses gold chloride reagent to form a distinctive cross shape with branches perpendicular to the axis. After preparing and observing samples of these adulterants in concentrations of 10%, 20%, and 50%, the changes in the shape of the cocaine crystals formed were linked to a specific adulterant and concentration.

In order to determine the homogeneity of the powder samples mixed from purchased standards, three samples from different parts of the levamisole/cocaine mixture were injected on a GC/MS and the ratio of cocaine to adulterant was plotted and the correlation determined. Even with careful grinding and mixing with a mortar and pestle, the line of best fit had a correlation of 0.97.

Finally, FTIR spectra of the levamisole/ cocaine powdered mixtures were taken and entered into a searchable library for future analysis of cocaine mixtures.

Future plans include testing the homogeneity of other adulterants and building the library to include more adulterants and illicit drugs.

Microcrystal, Levamisole, Sugar

A194 Evaluation of Nitrogen Spray Freezing Technique for Separating Duct Tape and Recovery of Latent Impressions

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The goals of this presentation are to: describe a nitrogen freezing technique using a cryogun for the separation of duct tape, describe the separation of duct tape by use of gradual force at ~22°C. (72°F), process latent impressions with a suspension powder, and enhance and evaluate latent images using computer software.

This presentation will impact the forensic community by discussing a technique involving the controlled release of liquid nitrogen using a cryogun to neutralize the adhesive on duct tape. This technique can be effectively used to separate tape for latent print processing.

Duct tape was introduced in the early 1940s and has been commercially available for use over sixty years. Duct tape has been used as a restraint in some crimes, as well as for sealing packages and containers collected into evidence. The tape may contain trace evidence as well as latent impressions. Both surfaces, adhesive and non-adhesive, may contain latent impressions. In this study, 200 donor impressions were placed on the surface of duct tape samples. One-hundred impressions were placed on the adhesive surface and 100 impressions were placed on the non-adhesive surface of the tape samples.

General purpose Scotch® 3M Duct Tape samples were prepared by cutting 100 pieces of cardboard into rectangular sections measuring ~88.9 x 215.9 mm (3½ x 8½ in). Pieces of duct tape ~50.8 mm (2 in) wide by 101.6 mm (4.0 in) long were cut and affixed to the approximate center of each piece of cardboard. A donor latent impression was placed on the non-adhesive side of the tape that was affixed to the cardboard. A second piece of duct tape ~50.8 mm (2 in) wide by 101.6 mm (4.0 in) long was cut and a donor latent impression was placed on the adhesive side of the second tape sample. The second duct tape sample was placed on top of the first piece of tape that was affixed to each piece of cardboard.

Two hundred duct tape samples with impressions were stored at ~22 C. (72 F) for 24 hours. One hundred of the samples, 50 impressions on the adhesive surface and 50 on the non-adhesive surface, were separated using gradual force and processed for latent impressions. One hundred impressions, 50 impressions on the adhesive surface and 50 on the non-adhesive surface, were separated by spraying the tape with liquid nitrogen using a Brymill CRY-AC® Cryogun. The liquid nitrogen exited the cryogun nozzle at approximately −196 C (−321°F) and within seconds neutralized the tape's adhesive. After separating the tape, 200 latent impressions were processed with WetWop™, a suspension powder, and enhanced with Jasc® computer software.

To determine the more superior method for separating duct tape when latent prints are present on the tape, latent impressions were developed on tape separated by gradual force and compared to impressions on tape separated with liquid nitrogen applied with a cryogun. Once the tape samples were separated, the suspension powder was brushed onto the tape surfaces with a camel hair brush. Following a period of 15 seconds, each sample was rinsed with distilled water to remove excess suspension powder. Next, the samples were photographed with a moticam digital camera on a stereoscopic microscope at 7 magnification. Each of the 640 x 480 pixel images were corrected with Jasc software. Then each image was sharpened, converted to a grey scale, and the contrast was enhanced prior to being evaluated. A rating of poor, medium, or excellent was assigned to each impression based on its quality. Poor quality impressions displayed no minutiae to limited ridge minutiae. Medium quality impressions had some minutia and pattern. Excellent quality impressions had numerous minutiae and a more complete pattern.

When gradual force at ~22 C. (72 F) was used to separate the duct tape, the non-adhesive surface produced 40 out of 50 impressions that were poor, 8 out of 50 impressions were medium and 2 out of 50 impressions were excellent. For the adhesive surfaces, there were 6 out of 50 impressions that were poor, 20 out of 50 were medium and 24 out of 50 were excellent. For the samples that were separated using liquid nitrogen, the non-adhesive surface had 43 out of 50 that were poor, 6 out of 50 that were medium, and 1 impression out of 50 that was excellent. The adhesive surfaces of the tape yielded 1 out of 50 that was poor, 7 out of 50 that were medium and 42 out of 50 that were excellent.

In this study, the tape separated with liquid nitrogen using a cryogun yielded more latent impressions on the adhesive surface that were rated excellent compared to latent impressions recovered at ~22 C. (72 F) using gradual force. Of the 200 impressions processed, 21% (42) of the impressions were rated as excellent when liquid nitrogen was used on the adhesive surface compared to 12% (24) of the impressions when gradual force was used. However, only 0.5% (2) of the impressions were rated as excellent compared to 1% (1) with liquid nitrogen for non-adhesive surfaces. Therefore, when collecting latents from multiple layers of duct tape, investigators should consider using liquid nitrogen applied with a cryogun to separate the tape.

Liquid Nitrogen, Latent Impressions, Duct Tape

A195 Biomechanical Study of Identifying and Matching the Chop Angles and Knives on Bone Tissue

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After attending this presentation, attendees will gain the knowledge of the patterns of chop marks including the type of knife, angle of blade, and the correlation between angle of blade and impulsive force by using digital microscope method developed in this study.

This presentation will impact the forensic science community by refocusing on the retention of knife marks on the hard tissue which can play a crucial role to profile the characteristics of knives during the medico-legal investigation procedure.

According to Edmund Locard's Principe (1910), the tool marks can play a crucial role to profile the shape, nature and characteristics of the weapon. The imprint of the sharp-force instruments in the hard tissue may implicate a prominent role in the forensic sciences, although little research has been directed specifically quantitative analyses of cut marks on the bone. Knife tool marks on the hard tissue retain their characteristics including knife shape, knife striate and engraved patterns that are useful to outline the type of knife including the shape and angle of the blade. The purpose of this study is to characterize the retained tool marks after knives chopping the bone tissue. A 2.5 meters chopped stage with a fixed handle of knife in a gravitational bar and a simultaneously gravitational accelerator with adjustable heights of fall were set up to mimic the human chopping action. In addition, a polyester resin fixed-

bone platform that fulfilled with a compact plain bearing and a bearing shaft rolled on balanced rolling gears are also used to make sure that pork skulls were perfectly fixed and horizontal to ground. A digital microscope (HIROX KH-7700, Japan), which is able to take images from different focal planes and digitally merge them into a single 3D picture, is applied to measure the angle of blade (θ) and the angle of chopping mark in pork skull (ψ). The certificated block gages (thickness of 1.0 mm and 1.5 mm) was used to calibrate the method that measured by digital micro scope in this study. The measured values of block gages are 1.50 ± 0.00 mm (mean ± SD) and 1.00 ± 0.00 mm. The results show the reproducibility and precision of optical measurement method are well acceptable. Establish the k value (elastic coefficient; θ/ψ) after comparing the angle of knife (θ) accompanied with height (19.6 ~ 122.5 cm), velocity, impulsive force of knife and retained angle (ψ) in the chopped bone tissue were performed. At constant knife weight (gravitational acceleration) engaged at the impulsive force between 9.8 to 24.5 (kg-m/s) reveals an angle (ψ) and elastic coefficient (k) of bone tissue between 31.28 to 10.16 degree and 1.125 to 2.179, respectively. The experimental results show a positive, linear correlation between angle of blade and impulsive force. These data are eligible for us to profile the pattern of knife including the weight and type of knife, angle of blade as well as the impulsive force. In addition to the striate of the bone, the retain knife marks on the hard tissue can play a crucial role to profile the characteristics of knife during the medico-legal investigation.

Biomechanical Study, Tool Mark, Chop Marks

A196 Rapid and Automated Chromatographic Analysis of Drugs and Metabolites in Biological Specimens using Disposable Pipette Extraction (DPX)

William E. Brewer, BS, PhD, Department of Chemistry and Biochemistry, 631 Sumter Street, Columbia, South Carolina, 29208; and Demi J. Garvin, PhD, 5623 Two Notch Road, Columbia, South Carolina, 29223*

After attending this presentation attendees will learn how to automate sample preparation for solid forensic drug case samples.

This presentation will impact the forensic science community by demonstrating how the automated method presented will improve laboratory throughput and minimize sample handling. Most importantly, this method should allow drug chemists more time for case review and courtroom testimony.

Disposable Pipette Extraction (DPX) is a dispersive solid-phase extraction device that mixes solutions in a pipette tip to provide rapid extractions with minimal solvent volumes. By using DPX, extractions can be performed from 30 seconds (for sample cleanup procedures) to less than six minutes. The extractions are performed completely automated using a dual rail GERSTEL MPS-2 instrument.

Several applications of automated DPX are described. One application is for comprehensive screening of basic, acidic and neutral drugs in blood, urine and oral fluid using GC/MS. Another application focuses on opiates for pain management using GC/MS and LC/MS/MS. These analyses are accomplished using cation exchange sorbent (DPX-CX) with reversed phase characteristics.

Another application of DPX combines desalting and phospholipid removal in a single extraction in less than 1 minute for LC/MS/MS analysis. This extraction eliminates the deleterious effects of ion suppression and matrix effects in LC/MS methods of analysis.

This study focuses on the automated extraction of biological samples coupled to GC/MS and LC/MS/MS to provide high throughput analysis "one sample at a time." The concept is to decrease the extraction time so that the extraction of one sample is completed during the chromatographic analysis of the previous sample of a sequence. This type of high throughput analysis is advantageous because all of the samples are being processed exactly the same.

Sample Preparation, GC-MS, Illicit Drugs

A197 The Statistical Evaluation of Duct Tape Fracture Match as Physical Evidence

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After attending this presentation, attendees will have an understanding of the uniqueness of duct tape shearing. Data and a statistical evaluation of a series of physical matches of randomly assigned duct tape samples will be provided.

This presentation will impact the forensic community by providing a statistical basis for the analysis of duct tape shearing.

Duct tapes are often submitted to crime laboratories as evidence associated with abductions, homicides, or construction of explosive devices. As a result, trace evidence chemists are often asked to analyze and compare commercial duct tapes to establish a possible evidentiary link between a suspect and a victim, or a suspect and a particular crime or between different crimes. Duct tape physical matches, which is the subjective arrangement or association of two or more separated fragments, have a significant higher evidentiary value and are considered to be the strongest association in forensic science comparative examination. Even though it is a fairly routine examination, there is a lack of sufficient statistical data and objective criteria to support what constitutes a physical match. The typical statement from a crime laboratory report is that the specimens in question physically match. This statement is assumes an absolute association without the consideration of any statistical data or error rates. This study was designed to examine duct tape physical matches in order to determine the statistical significance of a "match" conclusion. Two study participants separately evaluated three sets of experiments consisting of 174 torn duct tape specimens. Each of these experiments included the assignment of random numbers to the question specimens and the inclusion of at least five specimens that were not part of the exemplar sets. In experiment one, 100 specimens were torn by hand. In experiment two, 50 specimens from two similar duct tape samples were torn by hand and in experiment three, 24 specimens were torn by an Elmendorf Tear Tester. The examiners were able to correctly associate all the question and exemplar specimens and properly exclude the specimens not associated with the exemplars. To compare all the question specimens to all the exemplars, each examiner had the potential to conduct 13, 076 comparisons.

Duct Tape, Fracture Match, Physical Match

A198 Evaluation of Individualization of Shoe Wear Patterns

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After attending this presentation, attendees will have a greater appreciation for the amount of wear necessary to change a shoe print from class evidence to individual evidence.

This presentation will impact the forensic science community by providing information about the effects of wear, weight, gender, and sole tread on shoe wear patterns. It is expected that these factors contribute to the individualization of wear patterns. This information could be used to assist in the evaluation of shoe prints and impressions at crime scenes.

Shoe print evidence is found at a significant number of crime scenes each year. Two-dimensional footwear prints are often found in dust, blood, and oil. They can also be found on glass, paper products, and human skin. Three-dimensional impressions can also be found. Random wear patterns affect the impressions found at scenes; however, this study focuses on shoe prints. Some of these prints may be class evidence while many others are individual evidence. If the footwear evidence found at a crime scene is class evidence then it is difficult to draw definitive conclusions. However, if the footwear evidence is found to be individual, then it could link that pair of shoes to the scene and possibly the individual who wore the shoes. The class evidence of shoe prints can be transformed into individual evidence based on random wear patterns.

In this study, nine subjects were given new sneakers to be worn at their discretion. Of the nine subjects, there were three males and six females. Three of the females wore the same size and model New Balance sneakers. The remaining females wore the same Reebok model; two of the three females wore the same size shoe. Two of the men wore the same model of Champion sneakers in different sizes. The third man wore a pair of Asics sneakers. The shoe wear patterns were tracked through weekly prints taken with black magnetic powder while the subjects wore the shoes. The subjects were asked to take a typical step, as if while walking. These prints were photographed with a scale, as well as preserved using hairspray and protective covers. Shoe prints were compared using transparencies. Individuals' prints were compared to their own earlier prints, and weekly prints were compared between individuals.

The study resulted in distinct wear patterns between individuals' shoes. The weight and gender of the subject also seemed to influence the time required for the wear patterns to become individualized. One subject had a distinctive gait which produced an unusual wear pattern. While the other subjects' left and right shoe patterns were very similar, this individual's shoe patterns differed significantly between feet.

Shoe Prints, Random Wear Patterns, Individual vs. Class Evidence

A199 Bullet Ricochet Off Water

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After attending this presentation, attendees will have learned about the minimum depth of water necessary to allow a bullet to ricochet, and at what angle the bullet has departed the water as a factor of incident angle.

This presentation will impact the forensic science community by revealing the dangers inherent in bullet ricochet off of water and offer the calculations used to make these determinations.

There are many different surfaces from which a bullet can ricochet. These surfaces could include but are not limited to hard, unyielding materials such as concrete or automobile glass, and soft, yielding materials such as soil or water. These surfaces have incident angles at which a bullet will ricochet, whereas angles larger than this critical angle will cause the bullet to either penetrate into and/or fragment upon contact with the surface.

The bullet morphology may also affect the ricochet. Round-nose bullets may produce a ricochet angle that is quite different than hollow point bullets. Impact velocity will also affect ricochet. For most unyielding surfaces, the ricochet angle increases as the incident angle increases, and the ricochet angle tends to be slightly lower than the incident angle, whereas for yielding surfaces the ricochet angle is greater than the incident angle. This is due to the formation of a small hill or "ramp" which the bullet must now overcome instead of the smooth flat surface that it originally encountered.

This research was undertaken to explore the ricochet phenomenon on a commonly encountered yielding substrate– water. It is already known that bullets can and do ricochet off water, but at what incident angle will the bullet no longer ricochet, and how deep must the water be to allow the bullet to ricochet? This project involved the construction of a large shallow water tank at which bullets were fired at various angles and at various depths of water. The height of the ricochets were documented by witness panels at the end of the water tank, and using high speed photography to determine the impact point on the water surface, trigonometry was applied to calculate the ricochet angles. The water depth was then varied and the results of additional shooting documented. It was surprising at just how shallow the water level could be lowered yet ricochets were still possible without impacting the bottom of the tank. In addition to providing information for the application of trigonometry, the witness panels also confirmed that bullets that ricocheted were in destabilized flight, resulting in somewhat unpredictable trajectories, especially as the distance measured from the impact point became greater.

Bullet, Ricochet, Water

A200 The Forensic Assessment of HID (Xenon) Headlights: Determining Energization State and Identifying Illegal Vehicle Modifications

Harry R. Ehmann, MS, 2501 Lake Road, Apartment #120, Huntsville, TX 77340*

After attending this presentation, attendees will have a basic understanding of the construction and operation of HID headlights, have a tentative method of determining the on/off state of HID headlights prior to vehicular impact, and be able to identify illegal vehicle modifications.

This presentation will impact the forensic science community by breaking new ground on a little touched aspect of vehicle forensics. The knowledge to be presented will allow analysts to address two investigative questions in the course of one analysis.

Methods for determining on/off state of halogen headlights from vehicles involved in accidents are well established and are used often. However, for the last fifteen years these lights have slowly been phased out in favor of newer high intensity discharge (HID or Xenon) headlights. No known method yet exists to determine on/off state of HID lights from vehicles involved in crashes. As the number of HID equipped road vehicles continues to increase, this gap in knowledge needs to be filled. Furthermore, the popularity of HID lights has fostered the development of an entire underground industry dealing in illegal HID retrofits. These illegal retrofits violate federal rules, however enforcement of said rules is sparse at best.

The purpose of this research is twofold: (1) analyst should be able to recognize what aspects of the various functional components of HID lights vary in crashes dependant upon energization state, thereby allowing one to determine if the headlights were on or off at impact; and, (2) analysts should be able to distinguish HID light configurations common to illegal retrofitting from HID lights common to legally equipped vehicles. Together, these will allow analysts to address two important investigative questions in the course of one analysis.

For the experiment, several high intensity discharge headlight bulbs were destroyed in a manner approximating vehicle impact events; being destroyed in energized and non-energized states. The glass, electrodes, halide salts, and lead connectors were then analyzed with stereomicroscopy with application of UV light & SEM/EDX to determine what aspects of each vary dependant upon hot or cold breakage. Of all aspects observed, oxidation of electrodes and dispersal of halide salts secondary to inner chamber rupture are best for distinguishing an energized lamp from a non-energized lamp. Lamps broken while off/cold showed no oxidation of the electrodes and the salts remained affixed as an amalgam to the lower eighth of the inner chamber. Application of EDX confirmed oxidation/non-oxidation of electrodes. UV light application to the salts can also confirm hot/cold break determinations, as salts exposed to air after a cold break will fluoresce at 350 nm whereas salts exposed while hot do not. Furthermore, signs of electrical arcing of the lead connectors were present if an energized lamp was broken along that part of the bulb's axis.

The inner chamber and outer shield glasses could be separated from each other with a UV light when fragments of each were mixed together. The idea being tested was that the inner glass experiences more extreme temperature variation than outer shield glass and that a large temperature difference could manifest in the form of unique fracture morphologies. Analysis of hot and cold break inner chamber glass under SEM, however, did not reveal any significant differences.

Evaluation of illegal vs. legal HID lights was conducted by researching legal manufacturing practices and applications of HID's in the car market. This included technical specifications of legal lights and on what vehicle models HID's are normally equipped. Then, online exploration of illegal retrofit retailers, purchase and examination of their lights, and research into instances of federal enforcement of violations was conducted.

Legal lights are characterized by being available in only two configurations, with lights being made after 2007 additionally being mercury free. Illegal lights from retrofits are characterized by having a multitude of configurations mimicking those of the halogen lights they are meant to replace. Furthermore, EDX analysis confirmed the presence of mercury in retrofit lights. In regards to enforcement of federal rules, only one instance in 2003 appears in the last decade.

The results obtained from this preliminary research have led to the development of a method to tentatively determine if a HID light was on or off at impact. It also presents a way to distinguish legal lights from illegal lights. Though further research is needed, the first steps in a new direction have been taken.

Xenon, Headlight, Filament

A201 A Study Conducted to Address the Significance of Submission of Fingerprints Obtained From Unidentified Human Remains to Various Fingerprint Databases

Marzena H. Mulawka, MFS, 11255 North Torrey Pines Road, La Jolla, CA 92037-1011*

After attending this presentation, attendees will understand the problems involved with identifying fingerprints from unidentified human remains (UHR). A fact unknown to many forensic professionals tasked with the identification of unknown UHR, all fingerprint databases are not linked to one another and many of them are unable to perform complete searches of all fingerprints available.

This presentation will impact the forensic community and/or humanity by augmenting UHR identification efforts through the presentation of the resources available for unidentified deceased fingerprint identification. As a direct result, utilization of these fingerprint databases may help identify the tens of thousands of UHR that are currently being held within medical examiner/coroner's (ME/C) offices throughout the United States. More importantly, families of these deceased individuals will no longer wonder what happened to their loved ones and struggle with the agony of possibly never having the ability of laying their loved ones to rest.

Current fingerprint databases utilized by medical examiner/coroner (ME/C) offices and law enforcement (LE) agencies exist at federal, state, and local levels and do not always overlap with the information they contain. In addition, not all ME/C offices and LE agencies possess the ability to search every one of these databases—a fact often unfamiliar to many forensic professionals who lack expertise in fingerprint searching and analysis techniques. Moreover, many agencies tasked with the identification of UHR continue to be unaware of the Department of Homeland Security (DHS) Biometric Support Center (BSC) West and the Federal Bureau of Investigation (FBI) Criminal Justice Information Services (CJIS) Special Processing Center (SPC)—both databases that are capable of performing broader searches and containing more fingerprint records than local databases. This study was conducted to acknowledge the significance and shortfalls of various fingerprint databases currently available to assist forensic experts in identifying UHR.

Statistical data from UHR cases at the San Diego County Medical Examiner's Office (SDMEO) will be presented to demonstrate the effectiveness of utilizing all of these fingerprint databases. UHR fingerprints were submitted to three different fingerprint databases to determine of the same results would occur. Prior to this study, fingerprints from UHR at the SDMEO were generally only submitted to be searched through a local fingerprint database, yielding no hits. During the study, UHR fingerprints were resubmitted to the DHS BSC West and the FBI CJIS SPC. A multitude of the submissions received multiple hits

from both agencies, resulting in identifications—many that were cold cases dating back as far as 1987. Therefore, the results of this study indicate that to ensure all UHR fingerprint files are being searched thoroughly through multiple databases, copies of fingerprints should be submitted to both DHS BSC West and FBI CJIS SPC agencies, as well as local databases. This would allow maximum exhaustion of all resources in attempt at identifying the decedent's fingerprints. An obvious decline in the number of unidentified persons was yielded, which correlated to the utilization of these fingerprint databases.

Specific resources and supporting data will be provided for utilization of federal fingerprint databases currently available to the forensic community. It is recommended that ME/C offices and agencies tasked with the identification of UHR become familiar with the various fingerprint databases which can assist in the identification of current and "cold case" UHR and linking them to missing person cases.

Unidentified Human Remains, Fingerprint, Fingerprint Database

A202 Characterization and Analysis of Blackhorn 209: A New Black Powder Substitute

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After attending this presentation, attendees will have learned about the physical and chemical properties of Blackhorn 209 and the analytical methods for analyzing the intact powder and the post-burn/post-blast residues of this new black powder substitute.

This presentation will impact the forensic community by providing a comprehensive description of this newest black powder substitute on the market.

For many years, black powder has been one of the most commonly used propellants in improvised explosive devices (IEDs) in the United States. Black powder contains 75% potassium nitrate (KNO_3), 10% sulfur (S) and 15% charcoal. However, there are drawbacks with black powder, such as the presence of sulfur in its composition. Sulfur generates the solid combustion products sulfate and sulfide, which can corrode the barrel of a muzzle loading firearm over time. This led to the development of alternative formulations by various companies, replacing sulfur with organic compounds such as carboxylic acid or its derivatives. These modified black powders are known as black powder substitutes (BPS). BPS have been designed to have a more controlled burn rate, generate less smoke upon firing, and improve the safety of storage. They are also classified as flammable solids by the United States Department of Transportation, so they do not have the same restrictive storage requirements as traditional black powder, making them more appealing to retailers. There are currently two main groups of black powder substitutes on the market. One group, which includes Jim Shockey's GoldÔ and Goex Pinnacle Replica black powder, utilizes ascorbic acid as a replacement fuel for sulfur. Another group, containing Pyrodex^{Ò} and Triple Seven^{Ò} manufactured by the Hodgdon Powder Company, uses the sodium salt of benzoic acid and dicyandiamide (DCDA) as fuels. Sulfur is absent in the composition of Triple Seven®, but still present in Pyrodex®.

Blackhorn 209 is the newest BPS on the market. The preliminary results from this study show that Blackhorn 209 is very different from other BPS on the market. The intact powder sample has morphology similar to tube-shaped smokeless powder, but the data collected from analytical techniques such as X-ray Powder Diffraction (XRD), Gas Chromatography-Mass Spectrometry (GC-MS), and Ion Chromatography-Mass Spectrometry (IC-MS) show that Blackhorn 209 contains ingredients from both black powder (potassium nitrate and sulfur) and double-base smokeless powder (nitrocellulose, nitroglycerine, and ethyl centralite). In addition, a special compound, acetyl triethyl citrate (or citroflex A), was identified by GC-MS and trace levels of perchlorate were identified by IC-MS in the de-ionized (DI) water extract of the intact powder. The analysis of the post-burn residues shows that Blackhorn 209 generates inorganic combustion products similar to black powder, including potassium sulfate, potassium carbonate, and thiocyanate. Trace levels of perchlorate were also identified in the post-burn DI water residue extract. The original organic ingredients - nitrocellulose, nitroglycerine, ethyl centralite, and citroflex A - were also detected in the dichloromethane (DCM) extract of post-burn residues. This presentation will also report on the analytical results obtained for Blackhorn 209 post-blast residues from pipe bomb fragments.

Explosive, Black Powder Substitute, Blackhorn 209

A203 Monitoring Air Quality Using Gas Chromatography/Mass Spectrometry

Dina Justes, PhD, 3000 Kent Avenue, West Lafayette, IN 47906; and Garth E. Patterson, PhD, Cynthia Liu, PhD, and James M. Wells, PhD, ICx Technologies, Inc., 3000 Kent Avenue, West Lafayette, IN 47906*

After attending this presentation, attendees will recognize the benefits of utilizing gas chromatography/mass spectrometry (GC-MS) for continuous air analysis and the ease with which a mass spectrometer may alert a user to the presence of chemicals of interest.

This presentation will impact the forensic science community by demonstrating the benefits of laboratory-caliber and on-site analysis. Performing on-site analysis eliminates the need for the transport and storage of chemicals and eases the burden of the chemical analysis laboratory allowing them to focus on samples not amenable to field analysis.

A cylindrical ion trap (CIT) enables the manufacture of a smaller mass spectrometer. The smaller mass analyzer is housed in a smaller vacuum manifold and can be used at higher pressure, requiring less stringent vacuum pumping. These characteristics make a fieldable MS system a reality. The Griffin GC-MS system was recently updated to enable continuous air sampling while maintaining standard liquid injection capability.

Detection and identification of drugs of abuse and explosives in the field is important for the forensics market to be able to acquire actionable information quickly. Mass spectrometry is capable of providing analyses of both types of analytes with potentially court-actionable information. By producing a laboratory quality mass spectrometer that has been ruggedized for field use, the forensic scientist can collect the needed information while maintaining a higher level of safety.

In another study, internal and external air was monitored and characteristic signatures for isolated chemicals were obtained. The internal air analysis plotted the relative signal intensities of hexane, cyclohexane, D5 (decamethylcyclopentasiloxane), and limonene. Over the course of twenty four hours, these chemicals provided a chemical map of the staff's activity. The relative signal intensity of D5, a common ingredient in personal care products, began to rise at approximately 6:19 a.m. and ebbed at around 6:32 p.m. Additionally, a limonene signature was present due to a staff member eating an orange prior to entering the laboratory, demonstrating the ability of a GC-MS monitoring human

activity in the area. An external air analysis was also conducted, demonstrating the presence of naphthalene, methyl naphthalene, and acenaphthalene. One week prior to this analysis, the parking lot was resurfaced and this activity is likely responsible for the chemicals detected by the GC-MS.

This presentation will show the applicability of this proof-of-principle study to work conducted by forensic scientists, including detecting toxic chemicals, narcotics, explosives, and chemical warfare agents in the field.

Mass Spectrometry, Gas Chromatography, Air Analysis

A204 New Sampling Methods for the Simultaneous Analysis of Trace Particle Evidence by Optical and Scanning Electron Microscopy

Daniel M. Baxter, BA, Envionmental Analysis Associates, Inc., 5290 Soledad Road, San Diego, CA 92109*

After attending this presentation, attendees will be able to more effectively collect and microscopically evaluate particle evidence by streamlining the collection, preparation, and analysis processes.

The presentation will impact the forensic science community by providing attendees with knowledge of new sampling tools and ways to combine and simplify the sample collection and comprehensive microscopic analysis (both Optical and SEM) of trace particle evidence. The advantages of combining these analytical methods will be illustrated.

Until recently, a major roadblock to both practical and comprehensive analysis of trace particle evidence was the different sample mounting procedures required for analysis by Optical Microscopy and Scanning Electron Microscopy. Typically, particles or fibers analyzed by Polarized Light Microscopy had to be removed from adhesive tape, mounted on a separate glass slide, and appropriate stains or refractive index oils applied. If SEM and X-ray analysis was then required, the particle would need to be cleaned and mounted on a separate specimen stub for SEM analysis. These preparation procedures are often impractical, time consuming, and run a high risk of evidence loss. Furthermore, analyzing intact distributions of particle evidence cannot be simultaneously examined by both PLM and SEM. Over the past three years, extensive research has resulted in the development of a universal adhesive sampling media suitable for both optical and electron microscopy. This media has now been incorporated into practical field sampling devices.

This presentation focuses on using the new media in two types of commercially available sampling devices. Both devices were originally researched and developed for use in indoor air quality dust analysis, but also solve the same problems encountered for forensic particle evidence analysis. The new media is unique as it is very tacky, has high optical clarity, is resistant to alcohol, and stable in refractive index oils. At the same time, it provides a smooth background and high stability under vacuum and resistance to electron beam damage. Simplified preparation procedures allow Polarized Light Microscopy analysis, and then direct analysis by Scanning Electron Microscopy without any complex sample preparation.

Microscopy, Particle, Sampling

A205 Standardized Chemical Characterization of Glass by Laser Induced Breakdown Spectroscopy (LIBS)

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After attending this presentation, attendees will have learned how chemical analysis and comparison of glass evidence by using commercially available LIBS instrumentation can provide information useful to forensic scientists.

This presentation will impact the forensic science community by demonstrating that LIBS is a viable alternative to the forensic examination of glass.

Glass is a commonly encountered type of trace evidence found at many crime scenes. Glass fragments can provide forensic investigators valuable information of association between items of evidence and potentially link a suspect to the scene of a crime. Much of the population of glass made for the same end use exhibits a similar elemental composition and therefore the value of information derived from chemical analysis will depend on the discrimination (or informing) power of the techniques used for its characterization. There is a range of techniques available for the forensic examination of glass with Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) considered as the "gold standard" for the elemental analysis of glass. This method; however, requires very expensive instrumentation, elaborate facilities to house the equipment and a high level of operator sophistication, therefore less than 10 such instrumental setups are installed in forensic laboratories in the U.S. The use of micro X-ray Fluorescence (μ-XRF) for forensic analysis of materials is more popular in forensic laboratories but this technique suffers from disadvantages such as dependence on sample geometry, time required for analysis and the limitation of qualitative analysis (vs true quantitative analysis for LA-ICP-MS). Laser induced breakdown spectroscopy (LIBS) has emerged as a viable atomic spectroscopy alternative to both LA-ICP-MS and μ-XRF. LIBS has been shown to provide for fast multi-element chemical analyses that provides very similar informing power (discrimination) to LA-ICP-MS and μ-XRF, for a fraction of the cost while offering many advantages over these methods. With a sensitivity of approximately 10-100 mg/Kg (ppm) for most elements of interest in the glass matrix, LIBS is able to chemically characterize the sample quickly and provides the potential for straightforward data analysis.

To date, researchers who have reported good discrimination power and type I and type II errors have used LIBS instrumentation built for the research environment, making the technique not yet practical for the operational forensic laboratory. This presentation describes, for the first time, an approach that incorporates a robust commercial LIBS instrument that can be used for the chemical characterization of glass in the forensic laboratory. The results presented were acquired using an RT100-HP LIBS system using a Q-switched Nd:YAG laser operating at the fundamental wavelength and equipped with a high resolution spectrometer coupled to an ICCD detector. Parameters such as the acquisition gate delay, gate width, and number of laser pulses were varied to optimize the signal-to-noise and signal-to-continuum performance of the instrument. The spectra were optimally collected as a result of 100 laser shots with the accumulation of the last 50 shots used to generate the spectra for analysis. Each glass sampled was analyzed at five locations to

account for any heterogeneity. NIST glass standards 614, 610, 612, 1831 and Bundeskriminalamt (BKA) glass reference standards FGS 01 and FGS 02 were used for the development of the analytical protocols and to determine the precision, accuracy and repeatability of the LIBS analysis. A set of 41 vehicle glass samples and 32 container glass samples from different sources were analyzed with the optimized method and all samples were compared to each other to determine discrimination power, type I and type II error rates. The discriminating elemental emission lines used were Sr, Fe, Ca, Mg, Ti, Ba, K, Al, and Na. The presentation will also report how this instrumentation can find use in other areas of trace evidence characterization within the forensic laboratory.

LIBS, Glass, Chemical Characterization

A206 An Evaluation of Volatile Organic Compounds From Biological Specimens Over Time

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After attending this presentation, attendees can expect to have a better understanding of the chemical composition of biological specimens and the persistence of these compounds over time. In turn, the viewer will become better acquainted with human scent and its role in the forensic science arena.

This presentation will impact the forensic science community by providing the essential scientific foundation that is required for the use of human scent evidence in the court of law.

The concept that every individual has an odor that is specific to him/her has lead to the utilization of human scent as a novel method of identification. Human scent is defined as the most abundant, identifiable volatile organic compounds (VOCs) in the headspace of a collected scent sample. Continuous research into human scent identification has explored the various types of VOCs that can be found in collected body odor as well as determine if these chemical profiles will allow for the individualization of people within a population. Recently, human scent has been employed with human scent discriminating canines. In function, this works by presenting a canine with odor that has been collected from a person of interest (traditionally from the palms of the hands) and in turn the canine will begin to trail the odor path if that corresponding odor is in the area.

Using human scent as evidence in criminal investigations has demanded that further research be conducted to ensure that it can hold up to legal scrutiny. Within the United States, a newly developed investigative technique can only be admissible into a court of law if it satisfies the *Frye* or *Daubert* standard (depending upon the state) which is put into place to evaluate the validity of the technique. Thus, for the continued use of human scent in forensic work it is imperative that many crucial concepts are explored and that there is a foundation of scientific research supporting it. Important assessments need to be made regarding human odor, such as the best location/bodily specimen to detect human odor from and is human odor consistent over time. The purpose of this study was to monitor the volatile organic compounds that are detected in the headspace of various biological specimens (such as hand odor, head hair, fingernail clippings, and saliva) for a period of six months and to evaluate the consistency in which these VOCs appear over time.

The importance of this investigation was to gauge whether the primary odor remains consistent over time for hair, fingernails, and saliva in addition to hand odor, in such that the influences from secondary and tertiary odor sources did not significantly alter the chemical profile being detected. For this study, biological specimens were collected from both male and female subjects once a month for six months. The volatile organic compounds found in the headspace of these samples were extracted utilizing the solvent-free technique of solid-phase microextraction (SPME) and VOC detection was performed using gas chromatography-mass spectrometry (GC/MS). The results from the month-to-month collection of biological specimens from each of the subjects will include: intra-subject comparison of chemical profiles collected monthly and inter- & intra-subject trends will also be noted. Briefly, the outcome of these experiments revealed that saliva possessed the most distinguishable chemical composition of all the specimens with a large number of compounds being acidic, which were unlike hand odor, hair and fingernails. The three remaining biological specimen types had many compounds in common with functional groups ranging from alcohols, aldehydes and hydrocarbons. However, when using a multivariate statistical evaluation (i.e., Principal Component Analysis and cluster analysis) it appears that chemical compounds detected in hair and fingernails are the most similar and form very tight groupings.

Human Scent, Biological Specimens, Solid-Phase Microextraction (SPME)

A207 The Investigation of Adamantanes in Various Petroleum Distillates

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After attending this presentation, attendees will be familiar with the results of the examination of adamantanes in petroleum distillates for the potential use in fire debris analysis by GC/MS.

This presentation will impact the forensic science community by describing a gas chromatographic-mass spectrometric method that could potentially add to the ASTM standard test method for ignitable liquid residues in extracts from fire debris samples. The addition of a new class of compounds, adamantanes, to the standard test method may lead to greater differentiation between petroleum products found at arson scenes.

In suspicious fires where a petroleum distillate has been used as an accelerant, it may become difficult to identify said petroleum distillate because of matrix and pyrolysis products. This type of analysis is challenging in that the matrix and/or pyrolysis products may contain compounds that co-elute or produce similar chromatographic patterns. It has been proposed that using diamondoids, specifically adamantanes, may aid in the ability to differentiate the distillates. Adamantane is a molecule consisting of three fused cyclohexane rings in chair formations. The cage structure of this molecule adds to its stability with a boiling point of 269˚C.

A number of petroleum distillates with varying amounts of weathering were examined using GC/MS for the presence of eleven (11) adamantanes with different functional groups: adamantane, 1-methyladamantane, 1,3-dimethyladamantane, 1,3,5-trimethyladamantane, 2-mehtyladamantane, cis-1,4-dimethyladamantane, trans-1,4-dimethyladamantane, 1,2-dimethyladamantane, 1-ethyladamantane, 1-

ethyl-3-methyladamantane, and 2-ethyladamantane. Extracted ion profiles (EIPs) of the standard adamantanes were utilized for comparisons to the EIPs of various petroleum distillates including gasoline, diesel #2, kerosene, mineral spirits and jet fuel A. Mass to charge (m/z) ratios specific for the adamantanes (136, 135, 149, 150, 163, and 107), were used to screen various different petroleum products from all three ASTM classes of accelerants (light, medium and heavy petroleum distillates). All samples were analyzed as liquids (diluted with pentane as needed), static headspace (SHS) samples, and passive headspace (PHS) extracts using carbon disulfide as the extracting solvent.

It was determined that at least one adamantane was found in all samples except 50% weathered and 75% weathered diesel fuel. Gasoline samples, consisting of unweathered, 25%, 50%, 75% and 99% weathered samples, showed inconsistent results across three trials. They also showed the most "interference" from non-adamantane ions in the EIP. Diesel fuel, kerosene, and mineral spirits showed peaks consistent with those found in the EIP of the adamantane standards. The mineral spirits sample was allowed to weather to 25% and 50%. Again, these consumer samples showed peaks consistent with the adamantane standards. The mineral spirits samples proved to be the most consistent across the three trials showing the least amount of interference ion peaks from non-adamantane ions.

Seven other consumer products found on the ASTM E1618-06 table of flammable liquids, four of which were non-petroleum products, were purchased. Static headspace analysis was performed on these samples and it was determined that only the products made from petroleum distillates showed the adamantane ion peaks on the EIP. Samples that were not made from petroleum products had no adamantane ion peaks present.

Using this information, it is believed that the ASTM E1618-06 standard for fire debris analysis could be amended to include the ions for adamantane. With this amendment, it may be possible to improve the identification of petroleum distillates found in fire debris using ASTM E1618-06.

Petroleum Distillates, Adamantane, GC/MS

B1 Using Reports, Peer Review, and Administrative Reviews to Teach and Maintain Quality in Digital Forensics

Mark Pollitt, MS, University of Central Florida, PO Box 162367, Orlando, FL 32816-2367*

After attending this presentation, attendees will understand how to integrate a functional and managerial approach to teaching and implementing forensic report writing, peer review, and administrative reviews for digital forensic examiners in both traditional and non-traditional settings.

This presentation will impact the forensic science community by providing digital forensic examiners, their managers, and educators with a model that can be adapted to provide training, education, and process improvement in forensic report writing.

Arguably, forensic reports are the single most important document created in forensic science. These documents represent the culmination of the examiner's work and are the foundation for the legal use of the results of the examination. The quality of the written report is critical for the examiner's testimony and her professional reputation. The examiner's organization is likewise heavily invested in the report, as it "represents" the quality of the entire laboratory and the work of all examiners employed by the organization.

One of the traditional approaches to maintaining the quality of the forensic reports is to conduct reviews of the finished products by both peers and administrators. This process has long been accepted as a best practice by forensics managers and accrediting bodies. It is a process that has been followed for years.

It is therefore ironic that managers and examiners are often frustrated with the report writing and review process. Many managers will complain about the writing abilities of their examiners, but are seemingly unable to teach report writing skills effectively. Further, forensic customers such as investigators, lawyers, and jurists are sometimes critical of the reports provided by examiners. In the digital forensic discipline, this is especially difficult, as the methodologies are complex, the results are often voluminous, and the border between the investigative and the forensic can be fuzzy.

This paper will describe a methodology that has been developed in training both students of forensic science and practicing forensic examiners. The approach will combine a functional and a management approach. The former is focused on defining the structure of the forensic report based upon the forensic objectives and the requirements of the Federal Rules of Evidence. Since an effective peer or administrative review must have an objective standard or "measuring stick" against which to evaluate the report, the development of metrics for this purpose will be discussed. Since there are a great number of digital forensic practitioners who do not operate in traditional laboratories with the ready availability of peers and knowledgeable administrators, this presentation will discuss how reviews can be implemented in non-traditional settings.

Since the goals of peer and administrative reviews are a continuous process improvement, these approaches have application in academic,as well as, initial and recurrent examiner training. The author will discuss his observations of the effectiveness of this approach in training examiners as well as educating students.

Forensic Reports, Quality Management, Peer Review

B2 Quantifying Error Rates of File Type Classification Methods

Vassil Roussev, PhD, University of New Orleans, Computer Science, 2000 Lakeshore Drive, 311 Mathematics Building, New Orleans, LA 70148*

After attending this presentation, attendees will gain an appreciation of the limitations of current file type classification techniques. Attendees will also gain a methodological insight on how to critically examine published work and will learn of new techniques and tools that aid their work.

This presentation will impact the forensic science community by demonstrating how to practically approach the problem of "examining validation and expelling incompetence" for an important area in the field. It is believed that this basic approach readily extends beyond the specific area and has much wider methodological implications.

The problem of identifying the file type of a sample of data arises as part of basic digital forensic processing, such as data recovery and reconstruction, as well as network forensics. Looking ahead, its importance is expected to grow further with the adoption of forensics triage and statistical sampling techniques, which will be increasingly needed to deal (in part) with the rapid growth of target data.

This presentation will discuss both methodological issues not addressed by current work and provide a case study to illustrate the points. Specifically, it will be argued that the current formulation of the file type classification problem is inherently flawed for large classes of file types, such as *pdf* and *doc/docx*, and cannot possibly yield informative error rate estimates. Therefore, the problem is re-formulated as two separate problems—primary data format classification and compound data format classification that are independent of each other.

It is also argued that existing studies have been flawed both methodologically and statistically, as the volume of data studied is woefully inadequate to draw any reliable conclusions. This presentation will demonstrate that for some popular storage formats, such as *deflate*-coded data, the problem of classifying it cannot be based on current statistical approaches and a deeper, specialized analysis, including expectations of the content of the uncompressed data, is a hard requirement.

Finally, a case study will be discussed in which classification techniques were evaluated for some popular primary data formats, such as *jpeg* and *mp3*, and quantify their reliability as a function of the sample size. The reliability of compound format detection for *pdf* and *zip/docx* formats will be evaluated and a new analytic technique will be demonstrated that can distinguish *deflate*-compressed data from other types of high-entropy data.

Digital Forensics, Error Rate Estimation, File Type Classification

B3 Psychological Assessments and Attitudes Toward Deviant Computer Behaviors

Marc Rogers, PhD, 401 North Grant Street, West Lafayette, IN 47907; and Kathryn C. Seigfried-Spellar, MA*, 401 North Grant Street, Knoy Hall of Technology, West Lafayette, IN 47907*

The goals of this presentation are to explore whether deviant computer behavior is part of a larger syndrome of deviance. This presentation will examine whether the personality profiles of those

committing deviant computer behaviors are similar to the profiles obtained from those who engage in more general deviance; will examine a potentially unique correlation of deviant computer behavior — Asperger's syndrome; will validate psychometric instruments for use with the "hacker" sub-culture, and to assist digital evidence investigators

This presentation will impact the forensic science community by providing information related those individuals who are involved in criminal computer behavior.

Surveys indicate that there is an increasing risk of computer intrusion, computer crime and attacks on personal and business information. Computer criminality is a serious problem that affects individuals, businesses, and our nation's security. In 2008, the Computer Security Institute (CSI) released the findings from their Computer Crime and Security Survey. The survey consisted of 521 respondents, who reported an average cost per financial fraud incident of $500,000[2]. Forty four percent of the respondents also reported that they were victims of insider abuse and twenty-seven percent reported being the victim of targeted attacks[2]. Despite these figures, most work in this area is aimed at devising approaches to protect computer information; very little research has been aimed at understanding why and who commits these criminal acts. The current research adds to this small body of knowledge by examining the motives and characteristics and those involved in deviant computer behavior.

The current study has four specific goals. The first goal is to explore whether deviant computer behavior is part of a larger syndrome of deviance. Much research has shown that non-computer-related delinquent/criminal activities, substance use, and early/risky sexual behavior are typically seen in the same individuals and can be considered part of a larger syndrome of deviance. The first goal of the present project is to ascertain how strongly related deviant computer behavior is to these other markers of deviance. This is achieved by examining the interrelations among measures of delinquency/crime, substance use, early/risky sexual behavior, and deviant computer behavior.

Second, personality profiles are examined to determine whether those committing deviant computer behaviors are similar to the profiles obtained from those who engage in more general deviance. Several meta-analyses have demonstrated that interpersonal antagonism (i.e., lack of empathy, oppositionality, grandiosity, and selfishness) and problems with impulse control are the most consistent personality correlation of a variety of antisocial and deviant behavior. Thus, the second goal of the present study is to compare the personality correlation of deviant computer behavior to what is known about the personality correlations of crime/delinquency, substance use, and early/risky sexual behavior. This goal is achieved by correlating the degree of deviant computer behavior with indicators of five broad-band personality factors derived from basic research on personality and widely-used in studies of deviant behavior. The five factor model employed consists of five broad traits: Neuroticism (vs. emotional stability), Extraversion (vs. introversion), Openness (vs. closedness) to experience, Agreeableness (vs. antagonism), and Conscientiousness/Constraint (vs. lack of constraint).

The third goal is to examine a potentially unique correlation of deviant computer behavior—Asperger's syndrome. Within the past decade, questions are emerging regarding the possibility of there being a link between computer criminality and a disorder known as Asperger syndrome. Unfortunately, this question has not received the attention from empirical and scientific research that it deserves and demands; no research has been conducted on whether or not there is a relationship between hacking and Asperger syndrome[1,6,7]. As computer criminals begin to face our judicial system, the possibility of a link between criminal behavior and this disorder is extremely important, for it could become a legal defense or mitigating factor in a criminal case. In addition, "a diagnosis could alter sentencing . . . [by] assessing the degree of criminal intent[1]." Due to the lack of research, understanding the true relationship between computer criminals and Asperger syndrome needs to be addressed. Therefore, the goal of the current study is to conduct an extensive comparison and exploration of the relation between computer criminality and Asperger syndrome. This comparison will involve examining relations between a self-reported measure of symptoms of Asperger's syndrome and measures of computer-related deviance.

The fourth objective is to further validate certain psychometric instruments for use with the "hacker" sub-culture. These instruments have been developed and/or used in previous studies[3,4,5].

Results and future implications of the study's findings will be discussed.

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Computer Deviance, Psychological Assessments, Digital Evidence Investigations

B4 Cloud Computing and Electronic Discovery: Challenges in Collection of Large Scale Digital Evidence With Internet-Based Storage, Applications, and Infrastructure

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After attending this presentation, attendees will understand how the evolution of information processing from traditional storage systems to distributed cloud computing has impacted electronic discovery. Many organizations have transitioned from storing data on its premises to so-called "cloud computing" environments in which data, applications or infrastructure is in remotely dedicated or shared locations accessed through the internet. The increasing reliance on cloud computing has a significant impact on planning and performing electronic discovery in civil actions.

This presentation will impact the forensic science community by reviewing the increasing challenges to the collection of large-scale digital evidence in civil cases caused by the evolving use of internet-based remote computation, storage and infrastructure - commonly known as "Cloud Computing" services.

As more and more organizations make use of various forms of so-called cloud computing (Software as a Service, Internet-based storage, Infrastructure on Demand, etc.) traditional approaches to the collection of information subject to discovery in civil cases will present challenges of increasing complexity to the forensic science community. Ready or not, this is happening, and this presentation will help with an understanding of the challenge and approaches to evolving solutions.

In the United States, the Federal Rules of Civil Procedure and similar rules in other countries recognize that various forms of electronically stored information can be vital in civil litigation. But as the technology of the internet has evolved, organizations are processing and storing data not only in their own data centers, but in shared facilities, virtual systems, and increasingly, in storage and processing facilities accessed over the internet.

This presentation will show how these so-called "cloud computing" services affect the process of electronic discovery, from identifying where and how information relevant to the litigation is stored, to how it can be collected from remote sources in a forensically acceptable manner.

Electronic discovery can involve thousands – or even millions of documents. Such volumes, particularly where the data may be in many places and in many forms represents an evolving threat to the ability of the forensic science to keep up with the evolution of information processing.

Electronic Discovery, Cloud Computing, Civil Litigation

B5 Lessons Learned From Teaching a Distance-Delivered Incident Response Course

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The goals of this presentation are to: a) discuss the specific incident response knowledge and skills students are expected to demonstrate; b) compare and contrast the two modes of access, discussing advantages and disadvantages of both methods; and c) discuss a third method under investigation that involves virtualization software running on a server that is accessible over the internet.

This presentation will impact the forensic science community by providing educators and trainers with alternative methods of delivering hands-on, computer-based forensic projects and assignments that require a deal of realism.

Universities are increasing the number of online (distance) courses offered in order to reduce space requirements while allowing increased enrollment, both of which generate more revenue. Experience has taught us that there are courses that do not easily translate into an online format, particularly those that require students to complete hands-on assignments under quasi-realistic conditions in a physical computer lab. Over the last several years the authors have taught graduate and undergraduate versions of a course in Incident Response that requires students to assimilate concepts from the fields computer/network forensics and computer/network security. In this course students learn to identify and address factors related to computer incidents, such as: malware, hacker reconnaissance and exploits, insider access, social engineering, log file interpretation, and combining digital "evidence" to draw conclusions and make recommendations. The capstone project for this course requires students to manage a quasi-realistic 'live computer incident' where an external unauthorized user (hacker) has gained access to a 'privileged account' and attempts to control the server. Students must investigate the incident on a live, running server, which runs contrary to the "traditional" computer forensics process (pull-the-plug, create a forensic duplicate of the media, perform a forensic examination on the duplicate), but is a situation they may encounter under real-world circumstances.

This is a fairly simple assignment to create and manage provided it is run within a computer lab where a professor can supervise students as they are sitting at a computer terminal working on the problem. The same assignment run under an online class, however, creates issues for both professor and students, including: a) ensuring students can access the server from a distance; b) ensuring students do not cheat; c) ensuring students have sufficient knowledge for the assignment, and; d) providing students sufficient access rights to conduct the investigation, while ensuring they cannot change or delete any important assignment or system files on the server.

Over the years two modes of student access to the 'victimized' server were used for the capstone assignment. In the first two class runs a Linux server was created that was 'self hacked,' leaving both obvious and non-obvious signs of unauthorized access and behavior. Each student was provided with an account, and students accessed the server over the Internet using SSH (a secure tunneling protocol). In the second two class runs virtualization software was used to create a Linux virtual machine that was again 'self hacked.' The running virtual machine was then 'suspended,' which wrote the state of the running system (i.e., contents of memory, running processes, etc.) to disk. The suspended virtual machine was compressed (zipped) and the compressed file uploaded to the course website. Students could then download the file, uncompress, and run it within the virtualization software running on their own computer.

Incident Response, Online Learning, Distance-Based Learning

B6 Recovering Deleted Evidence From Mobile Devices

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After attending this presentation, attendees will gain an understanding of how to recover deleted evidence from mobile devices and will learn how this evidence has been used in actual cases. Practitioners will learn about the forensic challenges and advantages associated with mobile devices. Researchers will learn about areas that require further exploration to advance the field of mobile device forensics.

This presentation will impact the forensic science community by expressing how the growing number of mobile devices can contain digital evidence, including cell phones, smart phones, and satellite navigation systems. Although some deleted data may be recoverable from these devices, the process can be technically difficult and physically destructive. This presentation presents various approaches to extracting and interpreting deleted data from non-volatile memory on mobile devices and discusses the forensic implications of each approach.

Mobile devices present significant forensic opportunities and challenges. Their ever-increasing prevalence, functionality, and storage capacity make them valuable sources of evidence. Evidence on these devices can include incriminating communications, illegal materials, location-based information, passwords, and other personal data. However, the complexity and variety of mobile devices make it difficult to develop standardized forensic methods for recovering deleted data from non-volatile memory of these systems. Current tools and techniques available to forensic practitioners and researchers for acquiring and examining data from embedded systems are limited to specific model devices and, under most circumstances, not all of the data can be retrieved due to proprietary hardware and software.

To ensure that important evidence on mobile devices is not overlooked, it is important for practitioners in digital forensics to be aware of the potential for recovering deleted data from mobile devices and how this evidence can be useful in an investigation. Digital forensic researchers also need to be aware of the unsolved challenges relating to extraction and interpretation of deleted data from non-volatile memory on mobile devices. This presentation covers various approaches to obtaining and analyzing deleted data from mobile devices, including file system examination and chip extraction. The forensic implications of each approach are discussed, and case examples and research are presented to demonstrate and emphasize key points.

Mobile Device Forensics, Cell Phone Forensics, Digital Evidence

B7 Kernel-Independent Tools for Deep, Live Digital Forensic Investigation

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After attending this presentation, attendees will understand the importance of developing kernel-independent, deep analysis tools to support live digital forensic investigations. Existing live forensics tools either perform shallow analysis, relying on the target's operating system to retrieve data of evidentiary value, or target specific operating system and kernel versions. This limits their usefulness for investigating machines in the wild. This presentation discusses ongoing research in developing deep analysis tools for live forensics, which automatically adapt to different operating system and kernel versions.

This presentation will impact the forensic science community by discussing methods for designing portable live forensics tools that are applicable to a wide range of forensic targets. This work is important because manually developing support for the large number of operating system and kernel versions now widely deployed is impractical.

A number of factors have contributed to an increasing interest in live forensics, where the machine under investigation continues to run while forensic evidence is collected. These factors include a huge increase in the size of forensic targets, increasing case backlogs as more criminal activity involves the use of computer systems, and the need to turn around cases very rapidly to counter acts of terrorism or other criminal activity where lives or property may be in imminent danger. In addition, a live investigation may reveal a substantial amount of volatile evidence that would be lost if only a traditional "pull the plug" investigation were performed. This volatile evidence includes lists of running processes, network connections, data fragments such as chat or email messages, and keying material for drive encryption. All of this volatile information can be crucial in expediting processing of a case, by providing critical contextual information that supplements traditional analysis, such as processing disk images.

Early live forensics efforts typically involved running a number of statically linked binaries on the forensic target (e.g., *ls, ps, lsmod, lsof*, etc. under Linux) and capturing the output of these commands for later analysis. A physical memory dump might also be captured, but analysis of the physical memory dump was often limited to simple string searches. Recently, research into deeper, advanced techniques has substantially increased the capabilities of live investigation. Physical memory dumps can now be analyzed to reconstruct models of the current and historical states of a live system under investigation. This kind of analysis relies on deep understanding of data structures in the running operating system kernel to extract evidence pertinent to an investigation.

A key problem in developing tools for deeply analyzing live systems is that the format of key kernel structures changes across versions of the installed operating system. This is a problem for both Microsoft Windows and for Linux. For Microsoft operating systems, support is required for Windows NT, 2000, XP, Vista, Windows 7, and the various server offerings, with patch levels (e.g., XP with SP2) introducing even more diversity. For Linux, the problem is much more severe, because official kernel versions are released much more frequently and a large installed base of each version may be present. Furthermore, different distributions, such as Ubuntu, Red Hat, SUSE, etc. may introduce distribution-specific modifications to the kernel. Finally, since the Linux kernel is open source, individual users can modify and install custom versions of the kernel. Linux kernel structures that must be analyzed for deep, live forensics therefore change quite frequently and constantly *manually* updating tools to support new kernel variants is essentially an impossible task.

Automatic model key kernel data structures, such as process descriptors and process memory maps, regardless of kernel version will be presented. The techniques rely on on-the-spot disassembly of important kernel routines, with pattern matching applied to the resulting disassemblies, to discern the structure of kernel data. This is basically an automatic, on-the-spot reverse engineering effort against important kernel components. A description of the techniques and the live forensics tools built using these techniques will be provided in the presentation. The tools use both list-walking approaches as well as data carving techniques to discover both current (e.g., processes now running, currently open network connections) and historical (e.g., terminated processes, closed network connections) volatile evidence.

Digital Forensics, Live Forensics, Linux

B8 Solid State Drive Technology and Applied Digital Forensics

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After attending this presentation, attendees will understand some principles of digital forensic methodologies when solid state drives are examined; will understand what the differences are compared to traditional rotating media; and will understand what new concepts may be put into operation and which old ones still work.

Solid state drives are becoming more commonplace. This new "old" technology is finding its way into the notebook computer market as well as enterprise systems, and it is important for forensic practitioners to be ready when they first encounter such a drive. This presentation will impact the forensic science community by preparing practitioners for when the first solid state drive hits a forensic lab.

The purpose of this presentation is to learn about the newest solid state drives and the forensic methodologies that may be applied to these technologies and to specifically answer the question: "What unique issues and challenges do solid state drives present to digital forensics?" A solid-state drive (SSD) is a data storage device that uses solid-state memory to store persistent data. Data on the SSD is interpreted by the installed Operating System (OS) and File System (FS) which presents the data to the user. High Proficiency SATA SSDs are being built in both a 2.5" and 1.8" form factors in capacities from 64-300GB. There are two different types of SSD technologies; the SLC (single level cell), and the MLC (multi-level cell) design. MLC doubles the capacity of flash memory by interpreting four digital states in the signal stored in a single cell – instead of the traditional (binary) two digital states. The forensic techniques for the SSDs may differ from those for traditional rotating media. Areas that will be discussed are: forensic tools for working with SSDs, the Flash File System (FSD), the translation and magic that occurs within the chip sets on the SSD to provide the data to the OS and FS for operations, the Host Protected Area (HBA), residual data, wear leveling rules, data streams, data carving, and recovering deleted file data.

Solid State, Digital Forensics, Computers

B9 Mobile Device (Cell Phone/PDA/GPS) Data Extraction Tool Classification System

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After attending this presentation, attendees will be able to categorize any mobile device acquisition tool in a systematic classification system. In addition, an overview of all currently available commercial tools for cell phone data extraction will be discussed.

This presentation will impact the forensic science community by providing a common framework for a digital device data extraction tool classification system for the entire digital forensics community.

Our world today has been saturated with inexpensive digital devices. These digital devices are used to stay in contact with friends, (e.g., phone calls and text messages) and to help find our way (e.g., GPS devices). These digital devices have become ubiquitous in our society.

Criminals use these devices to aid them in committing crimes, including the use of GPS devices for human and narcotics smuggling to the use of cell phone text messaging to coordinate attacks and communicate orders in organized crime. These devices contain a wealth of information and intelligence for investigators of crimes.

The field of digital device forensics is in its infancy at this time. The digital forensics community needs a framework (common baseline of understanding) for the classification and understanding of the plethora of tools released into the commercial marketplace in the last five years. A lot of false advertising has occurred, and many practitioners in this field are yearning for an understanding of how these tools work.

It is also critical that the practitioners understand how these tools will impact their evidence collection process. This presentation will "peel back the curtain" to allow attendees to see what is going on "behind the scenes" of these tools. Also presented is a framework and classification system for these tools to provide a better understanding for digital forensics practitioners.

Digital, Forensics, Classification

B10 Exploiting Metadata to Recover Multimedia From 3GP Fragment

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After attending this presentation, attendees will gain an understanding of how 3GP multimedia files, commonly used in cell phones, are structured and how that structure can be exploited to recover the audio and video contents of fragmented files.

This presentation will impact the forensic science community by bridging the gap between computer forensics and multimedia forensics within the digital and multimedia sciences by demonstrating a methodology for recovering the multimedia payload within a damaged or partially recovered 3GP file.

Cell phone forensics examinations are performed every day to recover existing and deleted data. Reviewing file fragments can be problematic depending on the type of data in the file and the scheme used to encode it. ASCII text characters have a direct representation in digital data and can be interpreted easily. Multimedia information (audio and video) is more complex. Audio and video encoders have evolved to exploit research into human perception with that from data redundancy reduction. This results in algorithms that are highly complex and have many variable options. Knowing the state of these variables distinguishes streaming multimedia from gibberish.

In this case study, a cell phone was recovered from a crime scene. A computer forensic analyst recovered one intact audio/video recording in the 3GP file format[1,2] (K1) and another fragment of a 3GP file (Q1). Attempts to play the fragment directly were not successful, but did suggest that information relevant to the crime was present. The two files were evaluated to recover the complete recording. This was done using the following steps: (1) examine the intact file to understand how this particular phone implements the 3GP standard; (2) examine the fragment to determine which 3GP structures are present and which are missing; and (3) use the structure of the intact file to infer or compute the missing Q1 metadata. Analysis of the fragment revealed that the "Media Data Box", the audio/video payload of the file, was completely intact, but the "Movie Box", the metadata describing the payload's format and structure, was truncated.

Successful recovery was dependent upon three assumptions: (1) The Q1 audio and video data are interleaved within the Media Box, as in K1; (2) the Q1 audio data is encoded using adaptive multi-rate compression (AMR)[3], as in K1; and (3) the audio data in Q1 is structured similarly to that in K1. Since some of the metadata concerning the video payload of Q1 survived the truncation, these assumptions about the remaining audio structure were all that was required to recalculate the missing metadata to play the audio/video payload. Even though the image sizes were different between the intact file and the fragment, the process successfully recovered all of the audio/video data. The consistency of the 3GP implementation and the available redundancy of formatting information within the metadata were exploited to fill in the gaps. By successfully reconstructing the metadata, a standard multimedia viewer could be used to play the recording.

References:

1 3GPP TS 26.244 V7.2.0 (2007-06).

2 ISO-14496-12:2005/ISO-14496-12:2005.

3 3GPP TS 26.090 V7.0.0 (2007-06).

Multimedia, Metadata, Cell Phone

B11 Video File Recovery and Playback of Partly Erased Videofiles

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After attending this presentation, attendees will have an understanding of methods of repairing video files in forensic casework.

This presentation will impact the forensic science community by presenting an open source approach for the analysis of image and video files.

The use of in digital video is rapidly increasing. Analog CCTV systems are replaced by digital systems, digital cameras are increasingly popular and affordable, many mobile phones now come equipped with a camera, and high-bandwidth internet allows home users to share their recordings and download video material in larger quantities than ever before. When digital video content is an important part of case evidence, such as in cases of recorded child pornography or other recordable crimes, finding every last bit of video data and making it viewable can be crucial to the investigation.

This is not always as easy as simply searching the data carriers using regular operating system functionality. Deleted files can usually be found with typical forensic software, if they are not yet overwritten and still reside intact on an undamaged data carrier. In some cases, however, the deleted video files may be partly overwritten or file systems may be damaged, leaving the investigator only with fragments of files. Recognizing such fragments and rebuilding them to valid files that can be viewed using video playback software requires thorough knowledge of file format specifications and laborious manual data editing. Many digital forensic investigators lack the time to get into such details.

Netherlands Forensic Institute developed Defraser (Digital Evidence Fragment Search & Rescue), an open source software tool to help the investigator by searching for video file fragments and analyzing their integrity. It allows drag-and-drop combining of video file elements to create playable video files. The tool is plug-in-based, allowing users to store and share their knowledge of particular file formats by programming their own plug-ins.

The product can be downloaded including sourcecode from http://sourceforge.net/projects/defraser. This tool was developed open source, so that other people can write plug-ins, and also if other software engineers would like to review the code, this possibility exists, since it is not a black box approach. It can also be implemented in other products, since it is written under BSD license. Also other users with proposals for changes can submit these changes, and they will be implemented.

Within defraser, plug-ins for MPEG-1, 2 & 4,3GPP/QuickTime/MP4 and AVI are implemented, and new plug-ins

developed based on casework. The user can also develop their own plug-ins with .net and C#. Examples are provided as reference.

The defraser tool could be developed further, with more plug-ins for other image and video file formats such as JPEG, ASF, FLV and Matroska. Forensic logging: trace results to source evidence files (using hash), and tools to automate the analysis. The tool can be used on large images of unkown data, to extract relevant video data. Since the tools also tries to visualize partly erased video, false hits might occur, and further analysis is necessary. In this presentation some examples will be presented in casework where repair was necessary, and this tool was useful for analysis.

Defraser, Video Streams, Recovery

B12 Calibration and Validation of Videographic Visibility Presentations

Thomas Ayres, PhD, 101 Kensington Road, Kensington, CA 94707; and Paul Kayfetz, JD, PO Box 310, Bolinas, CA, 94924*

The goal of this presentation is to review the history and current status of calibration and validation techniques for forensic visibility presentations. Attendees will learn what steps can be taken to ensure a technically defensible approach to capturing and presenting scene visibility tests, as well as, the results of a study that can support the use of such tests.

This presentation will impact the forensic science community by presenting details of the findings as well as recommendations for forensic applications of videographic visibility tests. These results add to the technical foundation for introduction of such images in courtroom settings.

In order to capture and demonstrate visibility of crucial aspects of an accident scene or reenactment for forensic purposes, there must be some means of ensuring that the final image corresponds in a known way to the original viewing conditions. Careful photographic or videographic capture, e.g., from a known position of interest and with lighting similar to the time of the incident, is an essential first step, but it is also necessary to have a procedure for calibrating and validating the image.

Throughout the past several decades, there have been two primary approaches used for such calibration and validation. One involves direct comparison of an image with the scene itself; the use of Polaroid® photos for this purpose has largely given way to viewing static video images on a monitor. In this approach, one or more viewers compare what they see in the scene ahead to what is visible in the photos or monitor, and select photos or adjust the images to match crucial aspects of scene visibility. The other common approach involves the use of stimuli introduced into the scene, generally contrast charts; viewers record their observations of the charts at the scene, and then later select or adjust final images to provide the same level of chart visibility as at the scene.

Further validation of the final images can be obtained by comparing what a group of viewers detect and notice in the scene to what they detect and notice in the images. In forensic applications, it is usually not practical to have more than a few people involved in a site visibility test. This presentation will describe a study conducted specifically to determine the success of current videographic calibration and validation techniques. Test subjects were brought to view a night roadway scene (not as part of any collision investigation), and were interviewed in order to determine what aspects of the scene they found visible. Later, subjects viewed an HD videographic presentation of the scene that had been calibrated by adjustment of the monitor at the scene and validated based on observations of a contrast test chart. Comparison of scene and videographic visibility results demonstrated the utility of the techniques.

Details of the findings as well as recommendations for forensic applications of videographic visibility tests will be presented. These results add to the technical foundation for introduction of such images in courtroom settings.

Visibility, Videography, Contrast Detection

B13 Utility of Quantization Tables for Digital Image Authentication

Amanda E. Broyles, MAM, Federal Bureau of Investigaion, Building 27958A, Quantico, VA 22135; and Richard W. Vorder Bruegge, PhD, Federal Bureau of Investigaion, OTD-FAVIAU, Building 27958A, Pod E, Quantico, VA 22135*

After attending this presentation, attendees will understand what a JPEG quantization table is, how they differ among manufacturers, and how this information can be used in image authentication examinations.

This presentation will impact the forensic science community by reinforcing the value of metadata analysis in digital image authentication and providing another avenue through which claims of image manipulation can be addressed.

The process of digital image authentication usually incorporates an assessment of the metadata contained within the digital image file. This can include information on the make and model of the camera used to take a picture, as well as other information such as date and time or camera settings like shutter speed, aperture, or image size (in pixels). This type of metadata often serves to provide circumstantial evidence regarding the source of a questioned image. For example, if image files depicting child pornography are found on a suspect's computer and the files contain metadata indicating the same make and model as the camera found next to the computer, then this provides compelling evidence that the camera was used to record those image files. Likewise, if the time and date indicated in the metadata correspond to a time when the suspect had access to the camera and victim, this provides additional circumstantial evidence. The mere presence of camera metadata in a digital image file is often cited as support for the authenticity of the file and the scene depicted therein.

However, because there is the potential that such metadata can be falsified (or "spoofed"), the value of such analysis in these cases may be limited, depending upon the specific type of metadata in question. For example, it is a relatively straightforward process to manually modify the time and date metadata using a hex editor, while leaving no trace of this modification. On the other hand, other types of metadata may be very difficult to falsify. This paper addresses one such type of metadata – JPEG quantization tables.

Quantization tables are used to define the amount of compression an image file will undergo when subjected to JPEG compression. A quantization table includes a total of 192 values, broken out into three sets of 64 values. The first set affects the luminance of the image, while the second and third sets affect the chrominance. When a digital camera user selects an image quality setting such as "Fine," "Normal," or "Basic," they are typically selecting a specific quantization table that has been predefined by the camera manufacturer. In some cases, the manufacturer will also use a different quantization table for images of different size (or resolution). Based on an analysis of approximately 200 cameras, Farid[1] suggested that the quantization table could be used to narrow the source of an image to a small subset of camera makes and models. Subsequently, after examining 1,000,000 images, Farid[2] identified a total of 10,153 combinations ("classes") of camera make, model, resolution, and quantization table. The fact that a given camera make and model can generate files of the same size with different quantization tables typically reflects variations in the quality setting. Therefore, in order to completely spoof a digital camera image, the manipulated file must also include the correct quantization table.

The work described in this paper extends the analysis of quantization tables contained in digital images to the "thumbnail"

images included within many digital image files. "Thumbnail" images are reduced size versions of images that are used for ease of display either on a camera monitor or within a computer browser. They are complete digital image files in and of themselves, so they can have their own quantization tables. As a result, digital camera image files can have more than one set of quantization tables – one for the thumbnail and one for the full size image. The quantization tables for the full size image and the thumbnail image usually are different, which means that any spoofing attempt must utilize two quantization tables, making it more difficult.

Further complicating spoofing attempts is the fact that one cannot simply modify the quantization tables using a hex editor, since this can result in dramatic modifications to the image quality. Likewise, commercially available image processing applications such Adobe® Photoshop® will typically utilize a small set of quantization tables that differ from those of camera manufacturers, meaning that any manipulated image will have to be reprocessed outside of Photoshop® to create a falsified quantization table if the proper quantization tables are to be generated. Finally, additional properties of thumbnail images generated by digital cameras as opposed to image processing will be described, such as size, orientation, and framing.

References:

1 Farid, H. Digital Image Ballistics from JPEG Quantization, Technical Report TR2006-583, Dartmouth College, Computer Science, 6 pp, 2006. Accessed July 27, 2009. (www.cs.dartmouth.edu/farid/publications/tr06a.html)

2 Farid, H. Digital Image Ballistics from JPEG Quantization: A Followup Study, Technical Report TR2008-638, Dartmouth College, Computer Science, 28 pp, 2008. Accessed July 27, 2009. (www.cs.dartmouth.edu/farid/publications/tr08.html)

Digital Image Authentication, Digital & Multimedia Sciences, Image Manipulation Detection

B14 Identification of Cameras With Photo Response Non-Uniformity (PRNU) in Large Databases

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After attending this presentation, attendees will be aware of the possibilities of linking a certain image to a specific camera in larger databases.

This presesntation will impact the forensic science community by discussing validation of techniques in large scale databases.

Photo Response Non-Uniformity pattern is a unique sensor noise pattern that is present in all the images and videos produced by a camera, as it originates from intrinsic sensor properties.

This sensor noise pattern acts as a fingerprint, and this fingerprint essentially represents the deviation of each pixel with respect to the average pixel response at uniform illumination. This noise pattern is a stable pattern, which makes it a good candidate for linking a certain image to a certain camera. In each case validation is needed to determine if the patterns are really random, which means the creation of flat field images from at least ten cameras of the same make and model. Flat field images are images taken from a gray surface where no edges are visible.

Indeed, large scale testing on photo cameras has shown that it is possible (with low false acceptance and false rejection rates, or a high likelihood ratio) to identify the source camera based on the patterns that were extracted from images. In general, the amount of compression present in photos is much less severe than what is encountered in videos, especially if they originate from webcams or mobile phones.

The compression effectively acts as a low-pass filter, thus removing or attenuating the PRNU pattern. Another problem is that these devices have in general a much lower resolution and visual inspection already signifies the high amount of compression artifacts present. On the other hand, multiple frames are available from which an average noise pattern can be calculated, which alleviates some of these problems.

Also, these low-cost devices may have a stronger PRNU pattern compared to full size digital cameras, which adds to the feasibility of identification. Previously seen in small scale tests that under certain conditions it is also possible to correctly identify the source video camera, even for heavily compressed webcam videos obtained from YouTube. It is expected that these low quality webcam videos behave similar to videos shot with mobile phones, and hence may also be very useful in a forensic context.

For testing PRNU on larger databases a framework for comparison has been developed, which is open source and can be downloaded from http://sourceforge.net/projects/prnucompare/ .

One of the problems encountered with these low quality cameras is that these compression artifacts (seen as square DCT blocks in the extracted patterns) cause high correlations to occur between unrelated cameras. This stresses the need for large scale testing. However, large scale tests are tedious to perform, mainly due to the long calculation times needed for extracting the noise pattern from the videos, and the lack of online video databases with known source (similar to Flickr for photos). With the advent of an online pattern database, there is hope to overcome both these problems. This allows larger scale testing, and hopefully the ability to make predictions about the reliability of the method applied to these low resolution cameras in practice.

In forensic reports, the error rates of the method are also considered, and will conclude within the Bayesian approach.

Photo Response Non Uniformity, Likelihood Ratio, Camera Identification

B15 An Alternative Method for ENF Data Analysis

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After attending this presentation, attendees will understand current ENF (Electric Network Frequency) analysis techniques for use in the area of digital and multimedia evidence (DME). ENF analysis attempts to detect, analyze, and evaluate embedded power line information that occasionally is recorded on analog and digital recordings. An alternative method to record ENF data will be presented and assessed for accuracy and suitability.

This presentation will impact the forensic science community, especially the sub-disciplines of forensic audio, video, and image analysis, by showing an alternative method available for ENF analysis. Cautions concerning the resolution and accuracy of ENF analysis will provide the DME practitioner with important *Daubert* and *Frye* testimony information.

Hypothesis: An alternative method to evaluate ENF (Electric Network Frequency) data can be accomplished using single-purpose power logger instruments.

Synopsis: Single-purpose power logger instruments were used to compile archive ENF data in the Eastern Interconnect grid of the United States. Comparison of simultaneous power logger and audio recordings showed that pattern matches depend on the resolution selected of the data.

Forensic audio examiners are evaluating the suitability of using ENF information that is occasionally embedded on analog and digital recordings. The goal of the analysis is to match the ENF pattern of

embedded power line information found on evidence recordings to the ENF patterns archived from electric power grids. Potential shortcomings in data resolution, database collection and custody, and the searchability of ENF databases have not yet been resolved. This paper presents an alternative method to collect, store and evaluate ENF data in the eastern grid of the United States.

In the past, power line information (50/60 Hz hum and harmonics) on evidence recordings has been used in audio signal analysis and authenticity examinations. This information can assist audio examiners to correct the speed of recordings and to indicate areas of possible recording alterations when an interruption in the power line hum is detected. The analysis of ENF information using pattern matching is a recent focus in forensic audio research. ENF analysis attempts to match the power line hum pattern on evidence recordings to a hum pattern archived in databases of previously recorded electric grid information. This paper describes the results of test recordings to collect ENF data in Virginia (the eastern interconnect grid of the United States) using stand-alone, single-purpose instruments, AEMC Power Quality Loggers, Model PQL 120. This type of instrument measures and stores the electric power information directly with a frequency resolution of 0.01 Hertz. Power Loggers are plugged directly into wall sockets and sample electric grid parameters, including voltage, current, frequency, and power.

This paper describes the characteristics of Power Loggers and their suitability for analyzing ENF grid information. Test data indicates that there is a distinct trade-off between data accuracy and pattern matching. At the highest resolution of test data gathered, the data from multiple loggers in the same building indicates differences in simultaneous recordings. This result is contrary to previous ENF test results which claim that simultaneous ENF recordings on the same electric grid always match. Data was recorded simultaneously on three power loggers during an audio recording on which ENF power line hum was intentionally recorded. The first comparison analysis evaluated the power logger data resolution needed to uniquely identify a known recorded interval with the same pattern in the power logger database. The test results indicate that multiple pattern matches can occur as the data quality is reduced.

Tests were then conducted with simultaneous power logger recordings and known audio recordings that have 60 Hz induced interference coupled into the audio recording. Comparison analysis was made of the power logger data with the known audio recording. Additional tests were conducted which compared the Logger data with intentionally altered known audio recordings. The results indicate that a trade-off must be made between desired resolution and successful matches of ENF patterns. This evaluation to detect known interruptions in audio recordings is an ultimate goal of ENF analysis. Test results indicate that power line interruptions can be made without detection. In addition, the power logger data will be used to calculate this method's 'error rate' for *Daubert* hearing purposes.

These results indicate data incompatibility can exist between power line hum information derived from audio evidence and that archived using data collection methods not designed for the analysis of power line hum information. Another result of this analysis is highlighting the importance of conditioning the data. Successful ENF analysis to date has used traditional data conditioning techniques (resampling and filtering) in order to have compatible data patterns for analysis. This data conditioning can have unknown effects for ENF data analysis.

Audio, ENF, Data Analysis

B16 Building a Database of Electric Network Frequency Variations for Use in Digital Media Authenticity

Jeffrey M. Smith, MSc, National Center for Media Forensics, 1800 Grant Street, Suite 230, Denver, CO 80210*

After attending this presentation, attendees will become familiar with the fundamental principles behind utilizing the variations in the Electric Network Frequency to authenticate digital recordings and the approach the National Center for Media Forensics has taken to create a database of ENF variations for the Western United States.

This presentation will impact the forensic science community by providing an overview of a new technique in authenticating digital audio and discussing the current research on this subject underway at the National Center for Media Forensics.

There is great need for research in the area of forensic media authentication with regards to digital audio. Tools used in authenticating analog tapes do not apply in the digital domain where sophisticated criminals are capable of seamlessly editing evidence. One proposed tool that is currently undergoing a fair amount of research and has been presented in European courts is the extraction of the Electric Network Frequency (ENF) component of a digital recording in order to authenticate it and perhaps even obtain a time-stamp. When this tool is successful, a forensic investigator is capable of locating edits, identifying the broad geographical area in which a recording was made, accurately assessing the date and time a recording was made, whether the recording is an original or copy, or if it is the result of two audio files being combined or mixed together.

However, for this application to reach its potential, a database of Electric Network Frequency variations for each grid must be available. For the United States, these grids include one for the Western United States, one for the Eastern United States, and one for Texas. It is possible for one to obtain this information from the local power company but for this data to be readily available and easily analyzed, a custom database must be recording ENF variations twenty four hours a day, seven days a week, three hundred and sixty five days a year. The National Center for Media Forensics is currently maintaining a database covering ENF variations for the Western United States and has plans to implement databases in other parts of the country as well. The analysis of this database involves generating a low sample rate waveform from data collected directly from a power outlet. This waveform can then be spectrally analyzed for pseudo-random variations and compared to field recordings exhibiting a strong ENF component.

In this presentation examples will be shown to demonstrate the application as well as proposed methods regarding its use. Following this brief introduction, elaboration on current research trends including those at the National Center for Media Forensics where a database of the distributed power grid covering the western United States is collecting data twenty four hours a day for potential use in media authentication and time stamping recordings of unknown origin. A review of relevant literature that relates to this topic will be given in addition to proposed areas in need of research. A scenario in which recordings originating in either the continental United States or Canada can be authenticated and/or time stamped for use in forensic applications will be described. This involves at least one database in each of the three grids covering these countries. In addition to establishing these databases, refinement in techniques regarding ENF extraction, analysis, and comparison must be undertaken in order for this tool to reach its full potential.

Audio Forensics, Digital Media Authentication, Electric Network Frequency

B17 The Digital Forensics Certification Board: Its History and Future

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After attending the presentation, attendees will understand the evolution of the Digital Forensic Certification Board (DFCB), become aware of the application process, will understand the value of professional certification, and will understand it is community driven.

This presentation will impact the forensic science community by discussing how the Digital Forensic Certification Board was able to respond immediately to one area that the National Sciences Academy February 2009 Report's found lacking, which was the need for certification programs. The DFCB launched their certification program for digital forensics practitioners and managers on March 2, 2009.

Professional certifications in digital forensics are something the community has needed for years and it is now a reality. The Digital Forensics Certification Board (DFCB) professional certifications are truly independent and community driven. The DFCB certification program was developed with National Institute of Justice (NIJ) funding. The terms for the development of this certification program by consensus were followed. The DFCB will eventually be applying for recognition by the Forensic Specialties Accreditation Board (FSAB), which is currently recognized by the American Academy of Forensic Sciences.

There are (2) types of forensic certifications offered: Digital Forensic Certified Practitioner (DFCP) and the Digital Forensic Certified Associate (DFCA). The Founders process offers those, who have been active for years in the digital forensic discipline the opportunity to become certified by demonstrating expertise and experience. Once the Founders process concludes, those seeking certification will be required to sit for a comprehensive exam.

DFCB, Professional, Certification

B18 Changes in Approach for Scalability in Digital Forensic Analysis Emphasizing Distributed, Collaborative, and Automated Techniques

Brian Roux, MS, 701 Poydras Street, Suite 150P, New Orleans, LA 70065*

After attending this presentation, attendees will understand the difficulties currently faced in digital forensics, the mounting problem increasing storage capacities pose for the field, the failings inherent in current generation digital forensic tools' approach to analysis, the necessity of adopting a collaborative and staged approach to analysis, and see an example of how a new such approach can be implemented to address these problems.

This presentation will impact the forensic science community by proposing a more scalable architecture for digital forensic analysis and exposing failings in current generation practices as they relate to time constrained scenarios.

Digital forensics is traditionally performed using "dead" analysis where storage devices are imaged for later processing while the device is in an off state. Modern digital forensics is moving toward the employment of "live" analysis techniques for memory capture, among other things, prior to power off or solely live techniques in cases where systems cannot be powered down. The former approach requires extensive time for thorough analysis and the later requires highly skilled individuals able to deal with unexpected situations arising from live analysis where malicious content could be triggered. Both practices require finite resources: time and expertise.

In a criminal setting the expanding need for immediate triaging of devices is beginning to be articulated as backlogs expand. In England, for example, the Association of Chief Police Officers is searching for a system to act as a "digital breathalyser" to deal with evidence backlogs approaching two years in some areas. The United States has had a number of high profile cases dealing with laptop searches at border crossings with the methodologies exposed painting a haphazard picture of their practices.

Modern digital forensic tools, both commercial and open source, employ a single user paradigm wherein the evidence, once acquired, is worked on in an individual workstation context. The prevailing approaches are also pointed toward analysis in the lab rather than in the field. This design fails to apply modern advances in distributed and high performance computing to speed analysis, and is overly reliant on static features rather than allowing for dynamic insertion of automated processes into the analysis.

Reconstruction of the forensic process is proposed as a staged approach using a pipelined system for the automated portion of analysis. The proposed process treats forensic data as a server centered, rather than workstation centered, resource. By centralizing control over the forensic data, information can be used by multiple systems in tandem. In the example presented, a triage stage takes files from the loaded disk image and distributes them to processing nodes which push the read data through an expandable pipeline of automated processes including file hashing, text extraction, indexing, file type identification, etc. Experimental results show a significant decrease in processing time versus the traditional single station approach.

This distributed approach also allows for node specialization for dealing with proprietary data types requiring specialized or in-depth second pass processing such as extracting individual emails from email stores or performing cross analysis of multiple systems for similarities. Post-triage stages can continue using automated processing while making previous stage data available for one or more analysts to examine allowing preliminary reports to be generated before the data is completely processed. Likewise, limited preliminary analysis can be performed in the field during acquisition or initial inspection with that information integrated with the triage stage.

An initial overview will be presented of the prototype "Black Friar" framework which implements the staged approach to forensic analysis with performance results. Results will be followed by examination of the future development road map as an implementation of the staged forensic approach with special emphasis placed on the flexibility open source frameworks for forensics provide for analysts to integrate new tools into the process. After becoming "production ready" Black Friar will be available as an open source digital forensic tool.

It is recommended attendees be familiar with current generation digital forensic practices, have a working knowledge of file systems and common file types, and some understanding of distributed computing, distributed file systems, and general concepts in high performance computing.

Digital Forensic Analysis, Distributed Processing, Digital Forensic Frameworks

B19 Forensic Data Extraction in Computer Child Pornography Investigations

Sigurd Murphy, BA, Defense Computer Forensic Laboratory, Linthicum, MD; Donald P. Flynn, JD, Defense Cyber Crime Center, DC3, Linthicum, MD; Thomas J. McAleer, Defense Computer Forensic Laboratory, Linthicum, MD; Andrew Medico, BS, Defense Cyber Crime Institute, Linthicum, MD; Daniel Raygoza, Defense Computer Forensic Laboratory, Linthicum, MD ; and Michael J. Salyards, PhD*, U.S. Army Crminal Investigations Laboratory, 4930 North 31st Street, Forest Park, GA 30297*

After attending this presentation, attendees will understand the unique technical, legal, and investigative challenges in child pornography investigations, learn about the key forensic steps in conducting an automated examination, and understand the importance of a user-friendly display.

This presentation will impact the forensic science community by explaining how forensic data extraction is a powerful tool that could revolutionize the way digital evidence is examined primarily in child pornography investigations and possibly in other types of offenses.

This presentation will describe a new and powerful model for examining digital evidence in child pornography examinations. Child pornography introduces three challenges. First, anecdotal reports from local, state, and federal laboratories show that the sheer numbers of cases and volume of media associated with child pornography overwhelms most digital evidence laboratories. Second, computer forensic examiners are often asked to make determinations outside of their expertise like medical determinations (especially about the age of children in digital images) and legal determinations about whether the content of a picture of document contains pornographic material. Finally, examiners are burdened with lab requests that ask for "all information about all files." These types of examinations can take 3-9 months to complete, and often contain detail that is neither understood nor used by customers in the investigative and legal communities.

Forensic Data Extraction (FDE) was designed to meet these challenges and consists of four key elements. First, a robust extraction tool uses commercially available forensic software tool to search cases for images, videos, Peer-to-Peer file sharing logs, email messages, internet chat logs, and web browser history. The tool searches both allocated files and unallocated space, and automatically looks inside compressed files. Operating system and application files are eliminated using the NIST NSRL. This step is performed in a highly efficient machine-driven manner that was designed to be run in a massively parallel operation.

Second, all of the recovered files are stored in a database with their associated metadata (original path, size, last modified time, etc). MD5 hashes are computed for each recovered file so that files can be matched against lists of known child pornography files. Images and videos not found in the known files list are ranked by an algorithm that judges human (flesh) content. In addition, thumbnails of videos are generated after skipping past opening title/credit screens so the investigator can easily see a preview of the content of the video.

Third, a highly robust and user-friendly front end allows for easy viewing, sorting, and classification of the files by the investigative, medical, and legal communities. Known child pornography files and files that are known to be transferred via peer-to-peer (P2P) software are grouped together and highlighted. The remaining images are sorted by human content rating so that the investigator can view more likely files first. This front is delivered inside of a mini virtual machine to facilitate support for the largest possible set of customer machine configurations.

Finally, a follow-up mechanism allows the customer to quickly and securely request that a follow-on examination be conducted in a manner that they control. This technique marries files selected by customers with the back-end database to allow for timely follow-up examinations on files of interest.

This model results in dramatic increases in productivity and timeliness while simultaneously allowing the customer to maintain an increased amount of control over their casework. Unexpected benefits include increased guilty pleas, identification of additional victims and acceptance of the customer front end by the judicial community. Details will be presented about how FDE works, statistics showing the effects on productivity and some noteworthy case examples.

Digital Evidence, Computer Forensics, Child Pornography

B20 Challenges for Digital Forensic Acquisition on Virtualization and Cloud Computing Platforms

Christopher W. Day, BS, Terremark Worldwide, Incorporated, 2 South Biscayne Boulevard, Suite 2800, Miami, FL 33131*

After attending this presentation, attendees will understand the issues involved with acquiring digital evidence from virtualization systems such as VMware and Xen-based systems, as well as so-called "cloud computing" platforms that rely on these technologies to provide organizations and users with highly-scalable and distributed computing capabilities. Attendees will learn how virtualization systems work and the particular challenges they pose to the forensic investigator. In addition attendees will learn about the most common types of cloud computing platforms and how each introduces additional challenges for the investigator above and beyond those presented by virtualization technologies.

This presentation will impact the forensic science community by providing practitioners with a primer for these increasingly common but to many practitioners, still mysterious, technologies and platforms that they will likely be asked to perform forensics acquisitions and investigations on in the near future. This presentation will also present some practical techniques and procedures practitioners can utilize in their work with these systems.

Given the theme of this year's conference, it seems fitting to examine the technology of virtualization and one of the primary emerging applications of this technology, cloud computing, and the challenges these will present to digital forensic investigators now and in the near future. Various estimates and projections point to an increasing use of cloud computing platforms now and in the near future, some indicating as much as 30% of corporate information processing will take place on some form of cloud platform by 2011. In any case, forensic investigators will need to have an understanding of the technologies involved, the different types of cloud platforms likely to be encountered and what acquisition and investigation challenges they are likely to encounter. Most importantly, investigators must have an established, tested, and accepted methodology for performing evidence acquisitions and investigations on these platforms. One methodology the author is working on in conjunction with the FBI will be presented as an example.

Digital Forensics, Virtualization, Cloud Computing

B21 Virtualizing the Computer Forensic Examination Platform

Brian D. Nunamaker, BS, Drug Enforcement Administration, 10555 Furnace Road, Lorton, VA 22405*

After attending this presentation, attendees will learn how to implement a virtualized examination platform to conduct computer forensic examinations. Attendees will also have a greater knowledge of the advantages and disadvantages of this configuration.

This presentation will impact the forensic science community by showing how a computer forensics laboratory implemented a virtualized

examination platform integrated with a Storage Area Network (SAN) to improve performance.

Most computer forensic laboratories suffer from the same problems, too many exhibits to process, with too little time to complete the task. Virtualization with SAN storage may help reduce preparation time between cases. Overall examination time can also be reduced. Virtualization allows for the standardization of examination platforms, a template for updates and deployments, and multiple isolated examination platforms to exist on a single physical server. By using virtualization and a fiber channel SAN, multiple examination platforms can take advantage of shared hardware between the servers and the SAN. This allows for a higher density of examination platforms on the same physical hardware. The virtualized examination platforms can take advantage of the increased disk performance of the SAN while still sharing a single fiber connection to reduce networking costs and complexity.

Examination platforms, such as server operating systems (OS) (Windows NT 2000 2003 2008, SQL Server, MySQL, Linux, BSD, SCO, etc.), can be rapidly rolled out from templates. These templates contain operating systems stored on wiped virtual drives. The fully configured examination platforms are ready for case processing in a matter of minutes, as opposed to the hours needed to wipe a hard drive and install a new OS. Redundant Array of Independent Disks (RAID) volumes located on the SAN containing evidence can be moved from one virtual examination platform to another with a few clicks of a mouse. The centralization of the evidence allows for less handling of physical hard drives and equipment. This should allow for an increase in the longevity of equipment.

An additional advantage to virtualization is the isolation of the examination platforms on a single physical server. This isolation allows examiners to work multiple cases at the same time without the concern for cross contamination of the evidence. The isolation of the examination platforms on the network is achieved through strong security polices and the use of a stand-alone network. This allows examiners to log into their local desktop computer and remote into their examination platform. The examiner can switch between multiple remote examination platforms containing different case materials. Multiple examination platforms can reside on a single server and share the hardware resources.

Due to the network infrastructure of this configuration, the network of computers can be exploited for other purposes. The laboratory can now take advantage of distributed password breaking applications. These applications will distribute attacks against a single password protected file across multiple servers (nodes) and act as a collective password breaker. Resources can be controlled to balance the performance of the examination platforms running processes overnight versus the resources for password breaking.

Virtualization, SAN, Examination Platform

B22 A Baseline for XP Boot Changes

Benjamin R. Livelsberger, BA, National Institute of Standards & Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 20899-8970*

After attending this presentation, attendees will become familiar with a baseline of what changes take place to the volumes of a Windows XP system on boot.

This presentation will impact the forensic science community by discussing how an accidental boot to a computer's host operating system is a serious error for a forensic investigator, but understanding the changes that occur when a system boots can mitigate resulting damage.

The behavior of the Windows XP SP2 operating system installed to a FAT32 volume was studied. The operating system was installed and the research was done in an isolated environment. No additional programs were installed, but "user files" were copied to two secondary volumes. Over the course of five boot cycles, before and after images were made of the system. The images were then compared for differing sectors and differences were analyzed using the Sleuth Kit digital investigation tools.

Over the course of five boots and shutdowns of a generic Windows XP system little or no change was made to the secondary volumes, but an average of close to 13,900 sectors changed on the system's boot volume. Changes occurred in each of the boot volume's reserved, FAT, and data areas. On each cycle the reserved area's FS Info sector changed and for each cycle between two and five sectors of the FAT 0 table and between two and five sectors of the FAT1 table changed.

Between 12,501 and 14,827 sectors changed in the data area on each boot. Most of these sectors represented changes to allocated file content. On average, the content of 34 system files changed with the range being 32 - 36 files. A core set of 31 files had content change in each of the five boot cycles. 96% of the changes to file content were to the PAGEFILE.SYS and SYSTEM files (the page file size was 2GB). In general, sectors weren't de-allocated, but on each boot a small number of previously unallocated sectors (averaging around 170, but ranging from 20 to 633) did become allocated.

In the boot volume's data area, in addition to changes to file content and to allocation status, a small number of sectors containing directory entries (file metadata) differed after each boot cycle. For one of the boot cycles, the access times for 497 entries changed, but for the remaining four cycles no access times were altered. Changes to write date and time values were more consistent. On average 54 directory entries had their write date and time values updated with a range of 52 to 55 directory entries. A core set of 51 of those directory entries changed consistently in each of the five boot cycles. Four to seven entries consistently had their size values changed. A set of four of these entries had their size values altered in every cycle and on each cycle eight new directory entries were created.

Having an understanding of the nature of how a system changes on boot and having a baseline for those changes allows the investigator to begin and to defend the examination of an inadvertently booted system.

Boot, Filesystem, FAT32

B23 Tips & Tricks for the Analysis and Harvesting of Data From Macintosh Computers

Jessica J. Reust Smith, MFS, Stroz Friedberg, LLC, 1150 Connecticut Avenue, Northwest, Suite 200, Washington, DC 20036*

The goal of this presentation is to show attendees what they can do to avoid some of the forensic pitfalls caused by the occasional foray into the forensic analysis of Macintosh computers. In addition, attendees will learn forensic examination techniques for extracting valuable evidence from Macintosh computers, drawn from both applied research and actual investigations.

This presentation will impact the forensic science community by describing tips and tricks for digital forensic examiners when approaching both the forensic analysis of Macintosh computers in investigations and the harvesting of data for counsel review and discovery obligations.

As the market share of Macintosh computers rises, they are turning up in increasing numbers in forensic investigations of both civil and criminal manners. However, when compared to their PC counterparts, Macintosh computers usually present additional challenges to the digital forensic examiner due to the nature of their file system and operating system and the analysis tools available.

There are a number of different software programs available to facilitate the examination of Macintosh computers, and it is important for the examiner to understand the strengths and weaknesses of the tools

they use so as not to overlook important evidence or data. This presentation will show attendees what they can do to avoid some of the forensic pitfalls caused by the occasional foray into the forensic analysis of Macintosh computers. In addition, attendees will learn forensic examination techniques for extracting valuable evidence from Macintosh computers, drawn from both applied research and actual investigations.

Macintosh Computers, E-Discovery, Digital Forensics

B24 A Forensic Analysis of a Vista 64 Hard Drive

Marc Rogers, PhD, 401 North Grant Street, West Lafayette, IN 47907; Katie Strzempka, BS, 3708 Sweet Valley Lane, Apartment A1, Lafayette, IN 47909; and Eric Katz, BS*, 2099 Malibu Drive, West Lafayette, IN 47906*

After attending this presentation, attendees will have the tools and knowledge necessary to view evidence and other data stored in Microsoft Vista's Shadow Volumes.

This presentation will impact the forensic science community by communicating one potential way of analyzing Vista Shadow copies and viewing a Vista 64-bit hard drive using a virtual machine.

Sixty-four bit processing may be revolutionary for computing, but can create a hassle for computer investigators. This is especially true in departments without the funding to afford a new 64 bit PC. Criminals rarely face the same limitations. Vista tries to help its users by offering a function called Shadow Copy that creates restore points to recover files as they were. Shadow Copy is a wonderful tool, but in some Vista versions, such as Home Premium, the user has no access to the Shadow Copy. For investigators this means that the Shadow Copy is there and files may be present in it, but there is no easy way to access or restore from it. What happens when an investigator must look at a Vista 64 bit machine and restore the Shadow Copy volume and all that is available are 32 bit computers?

The case discussed in this paper addresses these exact issues. Illegal images were known to be on the suspect's hard drive, but were inaccessible. Several methods were utilized to access the files within the shadow volume and the combination of some of these methods proved to be successful and forensically sound.

Vista, Shadow Copy, 64 Bit

B25 Indication of CD Burning by Detailed Examination of $MFT: A Case Review

Douglas Elrick, BA, Digital Intelligence, 17165 West Glendale Drive, New Berlin, WI 53066*

After attending this presentation, attendees will be able to examine a Windows based computer or evidence that files have been burned to an optical disc.

This presentation will impact the forensic science community by providing new sources of potential evidence in digital investigations.

One of most common case scenarios in civil computer forensics is one in which an employee leaves a company and is suspected of taking intellectual property to a competitor. Examiners are routinely asked to analyze the work computer and look for file activity prior to the employee's departure, what external storage devices have been attached, what files have been attached to emails, and if any files have been burned to a CD or DVD disc. The first three requests are fairly straightforward to complete but the detection of files that have been burned to disc has been difficult to determine. Thousands of files and gigabytes of proprietary information can be absconded with few methods for detection.

In a recent case, several hundred documents were found to have been last accessed just prior to the employee leaving. Not all the files in a particular subfolder were accessed which suggests a selective process and not an automated routine. Further examination revealed that the NTFS entry modified date and time was also updated within seconds of the last accessed time. Test burning of files through Windows XP SP2 revealed similar date and time results with the last accessed date and time and the entry modified date and time.

Through a detailed examination of the $MFT, clues are revealed indicating that files have been burned using the Windows operating system. Testing has shown that this detection can be accomplished for Windows XP through Windows 7 beta. A thorough understanding of the $MFT record structure including file attributes, record headers and record slack is needed for recognition of these indicators.

This presentation will demonstrate the artifacts left behind by which the Windows CD Burning process. While the evidence found is not conclusive that particular files and folders have been stored on optical disc, the artifacts found will provide strong indicators.

CD-Burning, MFT, File Attributes

B26 Testing Tools to Erase Hard Drives for Reuse

James R. Lyle, PhD, and Craig Russell, MS, National Institute of Standards & Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD*

After attending this presentation, attendees will be made aware of some of the issues used in testing computer forensic tools used to erase hard drives before reuse of the hard drive.

The presentation will impact the forensic science community by increasing awareness in the community of the tool behaviors and limitations likely to be encountered when using tools to prepare digital media for reuse between cases.

The Computer Forensics Tool Testing (CFTT) project at the National Institute of Standards and Technology develops methodologies for testing computer forensic tools. A methodology for testing tools was developed that erases entire hard drives. Digital media used in the processing and analysis of digital data is often reused between cases. Good practice dictates that the reused media is completely erased between cases so that data from one case does not get mixed in with another case. Test methodologies have been developed to examine the behavior of drive wiping tools. By using this methodology an investigator should have confidence that the tool used to prepare storage disk drives for forensic reuse are in fact wiped of any remnants of earlier investigations.

The core requirement for a tool is the removal of all accessible data on the hard drive. At a minimum all visible sectors should be overwritten with new data that is forensically benign. Some tools may adhere to a policy that ignores hidden sectors (Host Protected Area (HPA) or Device Configuration Overlay (DCO) with the justification that as long as the hidden area is in place it is inaccessible and not likely to cause a problem. Other tools remove hidden areas and then overwrite the formerly hidden data.

An important feature, sometimes overlooked by tools, is the erase instruction built in to recent hard drives. ATA drives that implement the SECURE ERASE instruction can overwrite an entire hard drive with a single command. Our test methodology provides for testing tools that use either multiple WRITE commands or the SECURE ERASE command. There are several advantages to using the SECURE ERASE command; these include faster performance and the erasure of data from failed sectors. Sometimes a hard drive removes a failing sector from normal use and substitutes a new sector from a spare sector pool. The SECURE ERASE command can access the failed sector and remove any data that is present.

There are problems testing two often implemented tool features: multiple overwrites, overwrite verification. To determine if a tool actually completely overwrites a drive multiple times, the overwrite process would need to be intercepted at the end of each pass and the hard drive examined. This would have to be done by guesswork without special purpose equipment such as a bus monitor. For a tool that offers verification of the overwriting, a tester would need to determine that the tool can detect a failure of the overwrite process. This would require detection of the tool finishing the overwrite process and about to begin the verification pass, interruption the execution of the tool, modifying the hard drive being erased and then restarting the tool at the point of interruption. This might be possible by using a virtual machine, but the effort to check the operation of a verification feature may not be the best use of limited resources. The CFTT methodology ignores both features and only considers the basic functionality.

Digital Forensics, Software Testing, Media Erasure

B27 The Application of Known Sample Searching to Digital Forensics

Robert Monsour, BA, Forensics3, PO Box 79134, Corona, CA 92877*

After attending this presentation, attendees will gain an understanding of the potential benefits and challenges of applying known sample searching to the field of digital forensics.

This presentation will impact the forensic science community by discussing how the application of known sample searching to digital forensics can allow examiners to search for and identify thousands of potentially important artifacts, including artifacts which examiners may not otherwise recognize. It will also assist examiners in confirming the origin of artifacts identified during investigations, and in more precisely understanding the activity that led to the creation of specific artifacts. Finally, the presentation may aid in generating interest, debate, and additional work in the application of known sample search techniques to digital forensics.

The forensic sciences have long used databases of known samples to assist in the identification of a wide range of physical evidence items. In this methodology, items such as paint chips or shoe prints are digitally quantified and searched against a database of known samples in order to identify the origin of an evidence item.

Surprisingly, the field of digital forensics has yet to generate a government or commercial solution for comparing digital evidence against a large collection of known samples in order to pinpoint artifacts that might be of evidentiary significance.

Forensic examiners typically learn to recognize and understand common digital artifacts through training, research, and experience. It can take several years for a forensic examiner to be able to recognize and understand even a few hundred common artifacts. The development of an automated system for screening evidence for thousands of known artifacts has the potential to allow examiners to identify many more digital artifacts than is currently possible through traditional training methods.

A year-long research effort aimed at developing the first comprehensive solution for screening digital evidence for known artifacts was started. The resulting solution allows forensic examiners to search digital evidence for over 2,000 artifacts left by popular websites and applications. This product is currently being tested by law enforcement and corporate digital forensic examiners in the United States.

Using this research effort as a case study, the potential benefits and practical issues involved in applying known sample searching to digital forensics will be discussed. Many artifacts not generally known in the forensic community were identified through the effort to develop this solution, indicating a known sample methodology may have the potential to allow investigators to locate artifacts that might otherwise go unnoticed. The benefits of using a keyword-based approach to known sample screening versus relying on more complex scripting will be discussed, which can allow development of known sample search solutions to keep pace with the constant changes associated with website and application artifacts. Finally, potential pitfalls and challenges of applying known sample search methods to digital forensics will be discussed.

Digital Artifacts, Keyword Searches, Known Sample Searching

B28 Reliability of Computer Forensic Tools: Application of Chain of Custody Principles

Daniel Ayers, MSc, and Ricard Kelly, forensic-validation.com, PO Box 97651, Manukau City, Auckland, 2241, NEW ZEALAND*

After attending this presentation, attendees will understand limitations of the reliability of current computer forensic tools, protocols, and results. Attendees will then be able to consider what modifications to their computer forensic analysis protocols may be required, and will be better informed as to the types of validation tests that should be carried out on computer forensic tools and results.

This presentation will impact the forensic science community by encouraging the forensic community to require that tool vendors improve their products to better account for how data is handled and how computations are performed. These factors will in turn improve the reliability of computer forensic evidence presented in court.

"Chain of Custody" protocols are widely used to establish that a physical exhibit uplifted from a crime scene is the same exhibit produced in court and that the exhibit has not been tampered with in any way. The chain of custody comprises every person responsible for handling the exhibit, from the person who collected it through to the person producing the exhibit in court. Each person must be able to give evidence as to from whom (or where) they obtained the exhibit, to whom the exhibit was relinquished, what happened to the exhibit whilst in their custody, and what steps were taken to ensure the integrity of the exhibit was preserved.

Computers, hard drives, and other electronic media are physical exhibits for which the chain of custody must be maintained in the usual way. However, when computer forensic analysis tools are used to examine electronic evidence the traditional chain of custody protocols may not be adequate to establish that analysis results presented in court are reliable and have not been subject to tampering.

This presentation demonstrates how inadvertent errors and deliberate tampering can adversely affect the reliability of widely used computer forensic tools in ways that may not be easily detected. The problem is illustrated using a recent case study involving multiple flaws in a widely used computer forensic tool.

Current practice and tools do not effectively address the problem are illustrated. It is argued that, with current tools and practices, the chain of custody in respect of computer forensic analysis results is often broken. It will be proposed that the issue could be addressed by adapting traditional chain of custody protocols to provide assurance over the internal processes employed by tools to read, interpret and display data.

The concept of judicial notice, the *Daubert* test and statutory provisions as to reliability of evidence are briefly discussed in the context of computer forensic tools.

Computer, Reliability, Validation

C1 Pickup Rear Bumper Damage Patterns and Force-Deflection Characteristics

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The goal of this presentation is to present a method for full scale force-deflection bumper testing for accident reconstruction. The specific results will be set forth and their utility will be demonstrated through a case study.

This presentation will impact the forensic science community by providing specific information that is useful in accident reconstruction and in replicating the characteristic damage sustained by pickup rear bumpers.

The results of force-deflection testing of the rear bumper installed on a pickup are presented. The usefulness of the characteristic bumper behavior is demonstrated using a specific example of a rear-end impact, in which it was suspected that the damage was deliberately enhanced. By replicating the damage it was demonstrated how the characteristic pattern of damage could appear suspicious in post-accident photographs, and the associated impact magnitude was derived.

A small pickup was rear-ended by a small SUV. The driver of the SUV described accelerating to about 10 mph and then skidding into the pickup after it abruptly stopped ahead. The SUV driver insisted that the post-accident photographs depicted a pickup from an older year range with greater downward bumper deflection than was observed at the accident scene.

Figure 1, Post Collision Photograph of the Pickup.

Post-repair inspection of the pickup revealed the absence of the side braces between the bumper ends and the brackets. In post-collision photographs, before repair, the side braces were not visible, as seen in figure 1 above.

Given the apparent absence of side braces, it was theorized that the loosening or removal of the bolts that connect the bumper to the bumper brackets could result in the enhanced downward appearance of the pickup rear bumper, thereby exaggerating the appearance of the damage as was alleged by the SUV driver. Indeed, as shown in Figure 2, the photographs of the SUV fail to reveal the type of under-ride damage that would ordinarily be associated with the pickup's rear bumper deflection.

Figure 2, Post Collision Photograph of the SUV.

However, inspection of the SUV revealed that there was damage above the front bumper to the left head light and grille areas. In addition, a horizontal rectangular imprint was found on the central front bumper. Thus, the SUV's damage was consistent with a direct contact between its central front bumper and the pickup's rear bumper step. As the pickup's bumper rolled under, the SUV's head light and grille areas sustained damage as they directly contacted the top of the pickup's rear bumper.

The SUV's bumper presumably pocketed the pickup's rear bumper step. This pocketing may have been enhanced by the SUV's license mounting hardware. As a result, the SUV did not fully under-ride as would normally be expected for the amount of downward deflection of the pickup's rear bumper. As such, a unique combination of vehicle damage patterns was produced.

By capturing the pickup's rear bumper step, contact forces continued to be applied to the lower portion of the rear bumper, even after the bumper began to roll under. This loading pattern lends itself to analysis by generating force vs. deflection curves to determine the amount of work required to cause the damage pattern exhibited on the pickup.

For the demonstration, an exemplar pickup and four sets of rear bumper assemblies were acquired. The vehicle was mounted on jack stands to make room for equipment and enhance visualization of the bumper during the testing. Bumper defection was produced using a 12,000 pound capacity winch attached to the under-side of the pickup. The tests were instrumented with a 10,000 pound Interface load cell, and an Ametek 50 inch high tension linear motion transducer. The data was collected at 10,000 Hz using a Diversified Technical System's TDAS Pro.

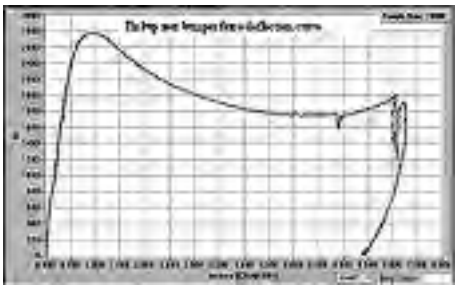

Figure 3, Force-deflection of the Pickup's Rear Bumper.

Shown above is the force deflection collected on the fourth test. The first three tests were halted due to winch mounting, chain slipping, or instrumentation interference issues. Test numbers two and three resulted in similar initial curves before the tests were halted. Between tests the damaged brackets, etc. were replaced. Integrating the above force-deflection curve for the work required to cause this damage resulted in a velocity change of nearly 3½ mph.

Post-test examination of the bumper brackets revealed that the presence of the side braces forced the bumper brackets to bend just ahead

of the brace attachment in a characteristic manner. As viewed from above and behind the bumper, only the narrow bent portion of the bumper bracket was visible between the bumper and the cargo bed, as depicted in figure 1 above. Therefore, the post-collision bumper damage was replicated with an intact bumper assembly.

As such, it can only be concluded that the post-collision appearance of the pickup did not depict a bumper position that was exaggerated by removal or loosening of bumper to bracket mounting bolts and side braces. Indeed, the SUV's head light and grille area damage confirms that it forced the pickup's rear bumper to roll under to the extent depicted in post-collision photographs. However, the pocketing of the pickup's rear bumper step prevented the under-ride type damage that would ordinarily result.

Pickup, Bumper, Testing

C2 Minivan, School Bus, and Pickup Crash Analysis: A Case Study

Donn N. Peterson, MSME, Peterson Engineering, Inc., PO Box 664, Brainerd, MN 56401-0664*

After attending this presentation, attendees will learn how post collision spin in yaw affects calculations of dynamics of vehicles and of occupants. They will also follow calculations for force-velocity-displacement during impact with short time duration.

Overly simplified and incomplete analyses can lead to significant errors in an accident reconstruction. This presentation will impact the forensic science community by demonstrating how some, if not most, accident reconstruction software either does not include effects of spin at all or they do so with questionable accuracy of the polar moment of inertia. Slow spins might be satisfactorily handled by applying an appropriate averaging method to calculate an effective drag factor. Fast spins are better handled by calculations based on numerical integrations with short time steps.

An eastbound minivan "blew" through a stop sign and crashed into the right side of a southwest bound school bus in an intersection with unrestricted visibility. The school bus went out of control, continued moving southwest while rotating clockwise such that its rear end occupied most of the opposite lane. A northeast bound pickup crashed into the rear left side of the school bus. The school bus came to rest on its left side in the northeast bound lane southwest from the intersection facing southwest. Its rear axle was separated, and it came to rest near the rear end of the school bus. The pickup came to rest upright on the northeast bound shoulder facing northwest with its front end beneath the school bus left side. The minivan came to rest upright in the southwest bound lane facing northeast about 1½ car lengths southwest from the intersection. The movements of the minivan and of unbelted front seat occupants during collision are desired in order to determine who was the driver.

As in most crash analyses, the first interval of motion to be analyzed is the last interval in time to occur. This is from the instant of separation between the minivan and the school bus until the minivan reached its final rest. The initial conditions are determined for this interval which are equated to the final conditions for the preceding interval. The collision becomes the next interval of motion to be analyzed which is from the instant of initial contact to the instant of separation. The vehicles are assumed to be approximately following their respective roadways before collision, but the speeds are initially unknown and must be determined. Unbelted occupants will travel in the same direction at the same speed as that of the minivan at the instant of initial contact with the school bus. The minivan c.m. (center of mass) velocity will abruptly decelerate in its original travel direction while it accelerates in the original travel direction of the school bus; the relative angle between which is called the PDOF (principal direction of force). Coincidentally, the minivan orientation will undergo an abrupt acceleration in a clockwise spin in yaw. This means that initially all points forward from the c.m. will move to the right relative to the c.m. while the c.m. itself moves to the right from its original travel direction. Unbelted occupants will thus strike deploying airbags and parts of the dash or firewall that had been to their left prior to the collision. Deployed airbags will restrict the occupant's torso motion toward the dash in front of them, but only slightly affect motion toward the left side of the vehicle. Legs and lower abdomen motion will experience only little effect from the airbags until stretching is induced between body parts.

Spin in yaw during the collision and post-collision both acted to make unbelted front seat occupants move to the left relative to their positions prior to the collision. The unbelted passenger moved toward the driver's seat, and the unbelted driver moved toward the driver's door which according to witnesses flew open during the collision.

Engineering analyses also show that the second crash with the pickup was several times more severe than the first crash with the minivan. Thus, the second crash with the pickup most probably caused the severe injuries and fatalities to the students on the school bus. Post-collision spinning in yaw by the minivan accounted for about 2.5 times as much kinetic energy as that due to linear translation. Thus, any analyses that do not account for the spinning effects are subject to significant errors in the post collision dynamics.

Accident Reconstruction, Post Collision Spin, Relative Motion of Vehicle Occupants

C3 Train Versus Train Collision Resulting in a Train Yard Fatality

Kurt D. Weiss, MS, Automotive Safety Research, 5350 Hollister Avenue, Suite D, Santa Barbara, CA 93111-2326*

After attending this presentation, attendees will be shown how a sequence of events and the actions of several railroad employees lead to a yardman being killed while on the job.

This presentation will impact the forensic science community by illustrating how the analysis of an event data recorder, voice recorder, and video were used to demonstrate the proper behavior of a railroad employee prior to a collision between two train cars.

Introduction: Train yards are intricate networks of parallel railroad tracks that provide temporary storage and passage of train cars. Linked train cars are called a "cut of cars." These cuts are moved about the yard in order to fulfill space and delivery requirements. Crossovers are manually operated track assemblies that allow movement of cars from one track to an adjacent track. The cuts on storage tracks subsequently do not block the main lines on which trains continually pass.

The cut of cars are moved within the yard by a remotely operated locomotive. A trainman uses a belt pack to control the locomotive's throttle and braking system. A belt pack is a radio frequency transmitter with a built-in safeguard. If the trainman tilts the belt pack for an extended length of time, that is the pack is not held level during the operation, it signals a tilt fault. A tilt fault causes the locomotive's brakes to be applied automatically.

Case Study: In the early morning hours of August 30, 2007, a trainman was remotely controlling a locomotive within a northern California train yard. The trainmaster in the tower overlooking the yard gave the trainman verbal instructions to move two hopper cars from one track to an adjacent track. To do so, the trainman used a crossover.

However, prior to the trainmaster's instructions, another trainman had positioned a second cut of cars on the adjacent track in a foul condition of the crossover. A foul condition occurs if any portion of a

train car is positioned such that it will interact with another passing car. The car's position on the adjacent track within proximity of the crossover guaranteed a collision would occur.

The locomotive's operator was on the right front corner of the hopper car as it approached the tanker car in foul. The right front corner of the hopper sideswiped the left side of the tanker, and the operator was wedged between the impacting cars. He died as a result of his injuries.

Injuries: The coroner's report reveals the trainman suffered blunt force trauma injuries to the head, neck and chest. He also sustained lacerations, fractures, and abrasions to his extremities.

Locomotive Event Data: The remotely controlled locomotive contained an event driven data recorder that only records an event it is received from an operator. The event data retrieved from the locomotive was produced as a nine-page spreadsheet with 27 columns and 249 rows, containing a total of 6,723 data entries. The spreadsheet identifies the locomotive, date and time, as well as numerous event names like locomotive throttle position, track location and speed, among others. Each event name has an associated time stamp. The corresponding 28 minutes and 10 seconds of data captured the event during which the trainman was killed.

Physical Evidence: The hopper car sustained collision damage to a side platform and a ladder-like structure on which the decedent was riding. Additionally, the right side of the hopper reveals a large, longitudinal dent with an associated heavy black paint transfer from the tank car. Scaling photographs of the hopper taken at the scene indicates the cars were in contact for approximately 26 feet until the locomotive came to a stop.

Videotape and Voice Recorder Analysis: A fixed-position video camera is located near the tower in the train yard. This wide-angle camera has a fixed focal length and cannot pan side to side. From its location, the events leading up to the train collision are recorded; however the point of contact between the cars occurs to the right and out of the camera's field of view.

All radio communication within the train yard is continuously recorded by a voice recorder. The time stamp of the voice recorder is heard on tape followed by the corresponding verbal transmission from any trainman, trainmaster, or railroad employee. This voice recorder also records any audio transmission from the locomotive event data recorder, such as the announcement of a tilt fault.

The event data recorder and videotape time stamp are set to Pacific Standard Time, whereas the voice recorder time stamp is set to Central Standard Time. Not surprising is the fact that all time stamps do not match, despite the 2-hour time zone adjustment. However, the offset between the event data recorder and the voice recorder time steps can be calculated. By locating an entry on the event data recorder spreadsheet and its corresponding entry on the voice recorder, the offset between them was determined to be 2 hours, 5 minutes and 2 seconds, or 02:05:02. With this time offset, the time of specific voice recordings can be compared with what commands were sent to the locomotive by the trainman remotely operating it with his belt pack.

Analysis: An analysis of the recordings on the voice recorder reveal the sound of the impact was captured by the radio of the trainman remotely operating the locomotive. Therefore, the time stamp of the impact was determined. Comparing this time stamp with the event data spreadsheet shows the locomotive was commanded to slow approximately 25 feet before impact, in the area corresponding to entering the crossover. Three seconds later, the locomotive's brakes were applied and the locomotive transmission direction was changed from forward to reverse. These two commands were sent after contact between the two train cars had already occurred. Finally, a tilt warning transmitted from the trainman's belt pack corresponds to the time when he began to fall from the train car, and a tilt fault transmission corresponds to the time when he struck the ground.

In their defense, the train company stated that the trainman's actions were the cause of his own death, stating he failed to comply with General Code of Operating Rules (GCOR) section 6.28. Section 6.28 states:

Except when moving on a main track or on a track where a block system is in effect, trains or engines must move at a speed that allows them to stop within half the range of vision short of 1) Train, 2) Engine, 3) Railroad car, 4) Men or equipment fouling the track, 5) Stop signal, or 6) Derail or switch lined improperly.

Conclusion: The plaintiff's argued successfully that:

1) The dark conditions of his early morning shift and the proximity to the tank car restricted the trainman's view of the imminent danger of collision with the car in foul of the crossover.

2) The cut of cars previously placed in foul of the crossover by another trainman was in violation of GCOR section 7.1 stating;

Do not leave cars or engines where they will foul equipment on adjacent tracks or cause injury to employees riding on the side of a car or engine.

3) The trainmaster on duty gave the other trainman permission to position the cars in foul of the crossover.

4) The trainmaster gave oral instructions to the decedent to use the crossover that eventually lead to the collision that resulted in fatal injuries.

5) The event data recorder and the trainman's operations of the locomotive indicate he was not aware of the car in foul. He simply began to slow the locomotive prior to entering the crossover.

Train Yard, Belt Pack, Locomotive Event Data Recorder

C4 Excessive Seat Belt Webbing Slack in a Low Speed Frontal Collision Resulting in Orbital Blow-Out Fracture

Robert D. Anderson, MS, Biomechanics Analysis, PO Box 7669, Tempe, AZ 85281-0023*

The goal of this presentation is to demonstrate seat belt inspection techniques and methodology and relate them to a case study in which a mechanism for introducing excessive seat belt slack into the restraints

This presentation will impact the forensic science community by presenting a potential mechanism for seat belt failure by which excessive slack is introduced into the seat belt. This can assist in the explanation of the disparity between the evidence of seat belt use with unrestrained occupant injuries in some instances.

A mechanism for the inadvertent introduction of excessive slack into the seatbelt webbing is presented. As a result of the additional slack, a face-to-steering wheel strike was allowed to occur in spite of seat belt use in a low speed frontal collision. This facial strike produced an orbital fracture with blindness from a direct blow to the eye from the steering wheel.

Figure 1, Frontal Under-ride Damage.

The extent of frontal damage is shown in figure 1 above. The sedan under-rode a full-sized pickup in a rear-end type collision orientation. It

sustained a little more than six inches crush across approximately 80% of its front, which is generally consistent with a Delta V as high as the 13 to 14 mph range. The airbags did not deploy presumably due to the "soft" contact with a longer than usual crash pulse.

The driver would have ordinarily had sufficient clearance for the lap and shoulder belt to prevent any face to steering wheel strikes during the collision. However, the extra lap belt webbing slack that passed through the latch plate compromised the seat belt's effectiveness. This allowed the driver to travel forward with little restraint so that they suffered a facial strike on the steering wheel. The direct blow to the eye from the steering wheel rim caused an orbital blow out fracture with blindness.

Inspection of the driver seat belt revealed scratching on the latch plate consistent with habitual use. Loading marks consistent with seat belt use were found on the driver's latch plate and D-ring. Transfers on the seat belt webbing revealed evidence that a little more than half a foot of webbing (excess slack) had been pulled through the latch plate.

Near the seat belt anchor, there was a plastic cover for the belt fuse, which is also known as a webbing tuck, energy loop or rip stitch,. As seen in figure 2, the plastic cover had a tendency to become caught beneath the seat. Unlike other fuse covers which are integral with the anchor bolt cover, this cover had a gap of exposed webbing that allowed it to twist relative to the anchor thereby allowing it to catch under the seat when

Since only modest seat belt forces consistent with restraining an occupant in a low speed frontal collision were sufficient to free the belt fuse cover, this served to introduce excessive webbing slack.

Figure 2, Belt Fuse Caught Beneath Seat

In addition, as seen above, because catching of the belt fuse cover effectively moved the anchor point forward, it also increased the likelihood of creating even more slack when the lap belt gets inadvertently caught on the recliner lever. This is consistent with the webbing transfers which showed more than half a foot of webbing forcefully passed through the latch plate in the collision.

Certainly, this seat belt configuration is dangerous since it introduces excessive slack into the seat belt, which directly undermines the seat belt's efficacy in a collision. In addition it is problematic and dangerous as it also provides a mechanism to inadvertently recline the seat back, which could cause a loss of vehicle control while driving.

Interestingly, review of NHTSA consumer complaints revealed descriptions of the seat belt catching the reclining lever and/or inadvertent reclining of the seat back, while driving in some cases. There were also complaints of the seat belt getting caught under the seat, on the reclining lever and/or extra slack, as well as complaints that the seat belts did not restrain in frontal impacts. These complaints are consistent with a pattern of the catching of the seat belt fuse cover under the seat, as occurred in the described collision.

Seatbelt, Slack, Ocular Injury

C5 Relationship Between Vehicular Rear Impact With Seat Back Failure, Delta V, and Occupant Compartment Intrusion

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After attending this presentation, attendees will understand how moderate-to-severe rear-impact motor vehicle accidents can result in debilitating cervical spine injuries when seatbacks fail. The forces involved can cause the front passengers' seatbacks to deform to such a degree that the bodies of the passengers are no longer restrained. The bodies continue to move rearward until they contact structures in the vehicle's rear compartment, causing severe injuries. This presentation addresses the frequent misconceptions in the analysis of such impacts. Following the presentation, the audience will have a better understanding of the important parameters in a rear impact setback collapse.

This presentation will impact the forensic science community by discussing how to protect against cervical injuries, it is important to identify and understand the risk factors.

Moderate-to-severe rear-impact motor vehicle accidents can result in debilitating cervical spine injuries when seatbacks fail. The forces involved can cause the front passengers' seatbacks to deform to such a degree that the bodies of the passengers are no longer restrained. The bodies continue to move rearward until they contact structures in the vehicle's rear compartment, causing severe injuries. This presentation addresses the frequent misconceptions in the analysis of such impacts. Following the presentation the audience will have a better understanding of the important parameters in a rear impact seatback collapse.

To protect against cervical injuries, it is important to identify and understand the risk factors. Unfortunately, misunderstandings related to the kinematics and biomechanics of such events has greatly hindered injury prevention efforts. Without adequate analysis, unproductive arguments regarding seat strength typically result. This presentation will address the following misconceptions: a) delta V of the struck vehicle is the primary risk factor, b) intrusion and or deformation of the rear compartment is a critical factor in the injury causation, and c) protection provided by the occupant's seat back in a moderate-to-severe rear impact is equivalent to protection provided in frontal or side impact at the same delta V.

A new analysis technique will be used, where the motion of the occupant's change of velocity is divided into the five phases. Although there will be some overlap between phases, the separation greatly assists analysis and understanding of the event. The five phases are:

1. Occupant is restrained by the seat back
2. Seat begins to fail and deforms
3. Lap belt friction with the lower extremities slows the body
4. Body moves freely rearward and impacts the rear seat back or other structures in the rear of the vehicle
5. Occupant experiences a ride down with the vehicle.

Since it is the change in velocity in phase four that is causing the injury, not the Delta V of the vehicle, it is this phase that needs to be minimized. The only important velocity is that of the head relative to structures struck once moving freely rearward and released from the seat. Depending on the seat back angle, a change in velocity of seven to ten mph in phase four can produce a serious cervical spine injury. Vehicle rear crush intrusion that limits the seatback excursion can reduce the injury risk. Also, such intrusion can reduce the distance traveled by the occupant and, thus, reduce the change of velocity experienced by the occupant in the impact with rear structures. These phenomena will be demonstrated using a MADYMO simulation of an actual event and comparisons between injured and uninjured occupants in the same rear impact crashes.

The government has no crash criteria for the protection of occupants in rear impacts; the only requirement is that the fuel tank is protected. This Federal Motor Vehicle Safety Standard (FMVSS) is 301. In this test, the rear of the vehicle is impacted by a moving barrier traveling at 30 mph. Depending on the weight of the vehicle, the change of velocity imparted to the vehicle is typically much less than 20 mph. Also, the Anthropomorphic Test Devices (ATD/Dummies) in the vehicle are not instrumented and no ATD measurement criteria have to be met. Frequently, the seat backs deform rearward significantly in the FMVSS 301 test. Even if the seatback fails entirely and the ATD is flat on its back the vehicle passes this Federal standard. In a frontal impact the Federal standard known as FMVSS 208 specifies that the vehicle crash into a fixed barrier at 30 mph and that injury measures in the ATD not be exceeded. Clearly, the protection afforded an occupant is far less in a rear impact than in a frontal impact.

Several case studies will be presented. In these cases, there were varying Delta Vs of the struck vehicle, varying stiffnesses of the occupants' seat backs, and varying degrees of intrusion into the occupant compartment.

Rear-End Impact, Seatback Collapse, MADYMO

C6 Retro-Reflective Efficiency of Conspicuity Tape at Entrance Angles Greater Than 45 Degrees: Application to Nighttime Automobile/Semi-Trailer Collisions

James B. Hyzer, PhD, Hyzer Research, 1 Parker Place, Suite 330, Janesville, WI 53545-4077*

The goal of this presentation is to show that the retro reflective efficiency of conspicuity tape falls off dramatically at entrance angles greater than 45 degrees.

This presentation will impact the forensic science community by demonstrating to the audience how semi-trailers that may be highly conspicuous to oncoming drivers when approached on a perpendicular path can be nearly inconspicuous under conditions where the semi-trailer blocks the lane of travel at an angle greater than 45 degrees from perpendicular, and that the situation then significantly worsened in the presence of disability glare.

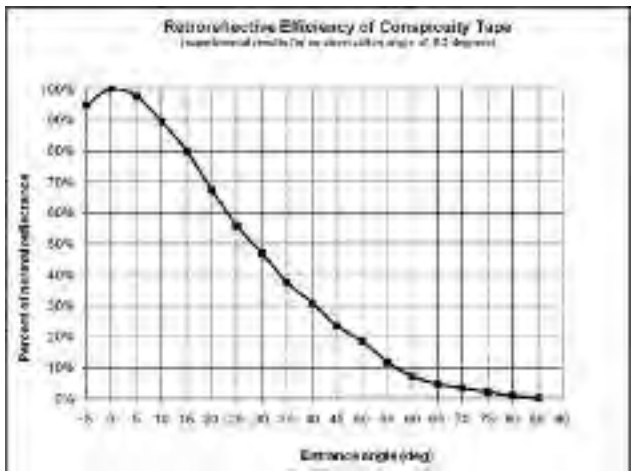
Background: In driving situations, conspicuity is defined as the ability of an object, such as a hazard, to visually draw the attention of a driver. Hazards which are more conspicuous are first detected and recognized (visually perceived) at greater distances than hazards that are less conspicuous. Conspicuity tape is intended to make semi-trailers more conspicuous and identifiable as a hazard to an oncoming driver at night. Tape brightness for the approaching driver/observer depends on several factors: (1) the level of illumination from the headlamps that shine onto it; (2) the angle at which the light from the headlamps strike the tape (entrance angle); and, (3) the subtended angle between the drivers eyes, the tape, and the headlamps (observation angle). Additionally, conspicuity tape that is older (weathered), dirty, and/or physically degraded (partially missing or scratched) is less efficient and therefore will be less conspicuous to oncoming drivers.

Disability Glare: Bright headlamps on vehicles in the opposing lane is a well known cause of visual disability glare for drivers at night. The degree to which glare disables the ability of a driver to visually detect and recognize hazards in the road ahead is dependent on a number of factors, including: (1) the luminous intensity of the glare source; (2) the angular position of the glare source relative to the hazard that requires detection and recognition; (3) the duration of glare exposure in relation to the time of impact, and, (4) the degree to which a particular driver is affected by glare (middle-aged to older drivers are generally more affected by glare than younger drivers, for example). It will be shown that the presence of disability glare, an approaching driver's ability to visually perceive conspicuity tape is significantly worse than if glare were not present.

Geometric Considerations: The geometry of the 53 foot long semi-trailer is such that it can easily block two 12-foot lanes of a roadway, at angles greater than 45 degrees from perpendicular to the centerline, as the tractor-trailer pulls onto the roadway from a drive.

Experimental Study/Results: A photometric study was undertaken to quantify the retroreflective efficiency of conspicuity tape under typical driving conditions. Two inch by four inch wide rectangles of both red and white retroreflective tape were mounted into a gonimeter and illuminated by tungsten halogen headlamps. The observation angle was controlled to 0.2 degrees as the entrance angle was varied from -90 to 90 degrees in 5 degree increments. Relative retroreflective efficiency was then determined as a percent of maximum and is plotted as shown.

The experimental results demonstrate that, all else being equal, conspicuity tape on a semi-trailer that is blocking a lane of travel at 45 degrees will be less than one quarter as bright as it would be if the semi-trailer were perpendicular to the lane of travel. As the entrance angle becomes greater than 45 degrees the reflectance efficiency of the tape, and therefore its brightness and conspicuity to oncoming drivers, decreases rapidly with angle with values less than 5% at 65 degrees and then effectively zero as the angle approaches 90 degrees.



Conspicuity Tape, Visibility, Accident Reconstruction

C7 Directional Control of a Vehicle Towing a Small Trailer Related to the Overturn Parameters of Tow Vehicle

Robert L. Anderson, MS, Applied Research and Investigations, PO Box 1208, Scottsdale, AZ 85252*

After attending this presentation, attendees will be aware of test results that show that under some circumstances the ability of a vehicle to successfully tow a small trailer can be reduced if the tow vehicle has a susceptibility to overturning.

This presentation will impact the forensic science community by making attendees aware how the loss of control of a vehicle towing a trailer can be influenced by overturn stability characteristics.

The determination of whether a vehicle can adequately tow a trailer is usually determined by things like engine size, suspension, tire ratings, and weight ratios between the tow vehicle and trailer. Testing that has demonstrated that the Static Stability Factor (SSF) can also play a role in the tow vehicle's ability to control trailer sway, even for a small trailer, is presented.

The accident that prompted this testing involved a Sport Utility Vehicle (SUV) towing a small trailer with an All Terrain Vehicle (ATV). The reconstruction showed the vehicle combination swayed with increasing amplitude until it went into a grassy median and rolled.

The tow vehicle weighed approximately 4,400 lbs. and the loaded trailer weighed approximately 1,100 lbs. for a weight ratio of approximately 4 to 1. Normally that would mean that the tow vehicle could easily withstand a swaying trailer.

The propensity of the SUV tow vehicle to rollover without a trailer was also evaluated for the stock vehicle and again with the tow vehicle modified so that the SSF was higher. The stability testing presented consists of testing that utilizes turns in one direction, like the J turn as well as several reverse steer tests.

It is well known that trailers sway for a variety of reasons, but those reasons are not always readily identified. The directional control tests consisted of a rapid double lane change to consistently and predictably produce significant trailer sway at a predetermined time and location. Combination vehicle testing was performed with the stock tow vehicle as well as with the modified tow vehicle.

The tow vehicle modifications merely consisted of changing the wheels. The modified wheels had a smaller diameter, lower profile and a larger lateral offset. This effectively lowered the axle by approximately 1¾ inches and widened the track width by approximately 6.7 inches, thereby increasing the SSF.

The modified SUV tow vehicle, with a higher SSF, was sufficiently stable to not go up on the outriggers, even when subjected to more severe testing maneuvers than had previously caused rollovers with the stock tow vehicle.

During the directional control testing it was observed that the trailer had a tendency to pull the rear end of the stock tow vehicle out of alignment more easily as compared to the modified vehicle.

Between the modified and unmodified conditions there were two runs that were the most comparable with essentially the same steering inputs for the first two turns. The directional divergence between the vehicles was apparent during the second turn, where the measured heading angle was approximately 25% higher for the stock vehicle. This indicates that the slip angle for the stock vehicle was significantly higher due to the trailer pulling it's rear-end towards the outside of the turn.

Correspondingly, the stock vehicle's lateral acceleration, which was corrected for roll angle, was significantly lower during the second turn, particularly the initial part. This also indicates that the stock vehicle's rear end was being pulled out of alignment. Finally, the stock vehicle's roll angle was twice as great as the modified vehicle's during the second turn. The increased roll angle probably contributed to allowing a higher heading angle and a lower lateral acceleration.

An even greater directional divergence was observed in the third turn of the directional control tests and in one instance the trailer rolled over.

The conclusion is that in spite of a favorable weight ratio, engine size, etc, a tow vehicle with a low SSF can also be inadequate to resist sway for even small trailers.

Trailer Towing, Trailer Controllability, Overturn Stability

C8 Teaching Forensic Engineering Concepts to Non-Engineering Graduate Students

Alexis N. Sommers, PhD, Tagliatela School of Engineering, University of New Haven, 300 Boston Post Road, West Haven, CT 06516*

After attending this presentation, attendees will have reviewed a successful attempt to educate non-engineering graduate students in forensic engineering basics, applications, and methodology, thereby gaining insight into how to provide an effective orientation to forensic engineering for lawyers, scientists, insurance investigators, manufacturers, and quality assurance professionals.

This presentation will impact the forensic science community by providing a better understanding of forensic engineering will advance the profession and expand its role in the broad economy.

Given that forensic engineers tend to enter the field by a variety of random routes following opportunity and a fondness for detective work, formal instruction is rarely seen in higher education. Yet there is an increasing amount of litigation which demands some forensic engineering input, and hence a need on the part of non-engineers, including forensic scientists, to be familiar enough with forensic engineering to identify characteristic problems, choose suitable consultants, and manage findings as they apply to a particular case. The presentation audience will review a successful attempt to educate non-engineering graduate students in forensic engineering basics, applications, and methodology, thereby gaining insight into how to provide an effective orientation to forensic engineering for lawyers, scientists, insurance investigators, manufacturers, and quality assurance professionals. The assumption is that a better understanding of forensic engineering will advance the profession and expand its role in the broad economy.

Experience at the University of New Haven suggests that forensic engineering needs to have more exposure and utilization in the developing problems of product counterfeiting, system failure, quality breaches, shoddy manufacturing, complex accidents, supply chain malfunctions, and inadequate life cycle performance, all of which tend to culminate in litigation or arbitration. Wider knowledge of forensic engineering may result in faster, more equitable, and more effective case resolution and product improvement. A side effect may be the encouragement of engineers to specialize in forensic work.

Contemporary high levels of accident litigation, increasingly serious quality issues in manufacturing, product counterfeiting in global supply chains, and difficulties in resolving insurance claims due to natural disasters have all focused on a need for more forensic engineering talent and the ability to put it to use in resolving civil lawsuits, both real and threatened. Efforts at the University of New Haven are described which attempt to make forensic science and other non-engineering graduate students familiar with forensic engineering techniques and practitioners. The goal is to expand their employment options to include law firms, insurance companies, and management and quality consultants. The goal was not to train forensic engineers but to give non-engineers a feel of what forensic engineers do and how to select and work with one to serve a particular client or project. Specific coursework was designed and implemented, with some success, which is delineated. A four-course concentration is described, half of which is offered annually. Enrollments, issues, and instructional problems are described, together with an assessment of the effort and its likely future path. The courses are a joint effort of the Department of Forensic Science and the Tagliatela College of Engineering.

Forensic, Engineering, Courses

C9 Environmental Forensics: A Repository for Junk Science

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After attending this presentation, attendees will understand the importance of thoroughly researching an opposing expert's publications.

This presentation will impact the forensic science community by helping experts identify junk science and defend good forensic science.

The inconvenient truth about environmental forensics is that the U.S. Supreme Court rulings of *Daubert*,[1] *Joiner*,[2] and *Khumho Tire*[3] backfired. The groundwork laid in these cases was intended to provide a series of tests for a judge, as the "gatekeeper," to discern and allow appropriate science to be heard by the trier of fact, and to keep "junk

science" out of the courtroom. But instead, it has led to the promotion of junk science. The U.S. Supreme Court's rulings are being used to advance the specific junk science needed to aid the "expert's" client and not the good science needed to inform the trier of fact. This so-called expert publishes the pertinent method and case studies in a peer-reviewed journal, which immediately addresses and satisfies *Daubert's* peer-reviewed test and implies complete acceptance by the scientific community.

This is wrong because: (1) they are purportedly publishing a scientific method (one they know little about in many instances) when in fact they are using the article as a vehicle to solidify or validate their position in a particular litigation case, (2) the "science" and its application that they espouse is seriously flawed and not worthy of publication, and (3) publication of information from an ongoing litigation matter is professionally and ethically wrong and potentially prejudicial when offered to the court as evidence of the validity of their approach. These published papers have several attributes in common that should caution the reader and a judge about the objectivity of the interpretation of the environmental forensics used to form the so-called expert's conclusions.

The author or authors have little or no formal training concerning some of the disciplines in the article or case. For instance, in *Cornell-Dubilier Electronics, Inc. v. Home Insurance Company*,[4] in which the scientific disciplines were chemistry and hydrogeology, an expert was accepted by the court as an environmental scientist even though this "expert" testified that he had no expertise in either chemistry or hydrogeology.

The author uses a case study that is in litigation. The litigants are not given but the data maps, and case description are included in the article. The fact that the author's interpretation of the data has been accepted for publication has made it at least iron-clad, most likely gold-plated, for use in the trial.

The publication will contain numerous general references. For instance, a ten-page article might have 50 references, which gives the article the illusion that the article is of a very scholarly work.

The interpretation of the data in the article is rarely accompanied by any actual data. There are tables of general or average results, with little, if any, backup sampling and analytical information.

Age-dating releases is a favorite topic in these publications. In each article there are many variables given, which are basically "fudge factors," used to determine the date of a release of a substance. A favorite tactic is the use of numerous methodologies that provide the same result. These methodologies are accepted as good science, with lots of general references and very little data and quality control. Numerous avenues filled with fog give the impression of a clear and definitive picture.

The development of the *Daubert* hearing for experts has the inconvenient consequence of promoting peer-reviewed junk science publications. What should have created rigorous hurdles that good science could easily clear has, instead, become a pole vault. No wonder the "gate keepers" are in Never Never Land.

References:

1 Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993).

2 General Electric Co. v. Joiner. 522 U.S. 136 (1997).

3 Kumho Tire Co. v. Carmichael, 526 U.S. 137 (1999).

4 Home Insurance Comapany v. Cornell-Dubilier Electronics, Inc. Superior Court of New Jersey Law Division: Mercer County, Civil Action No. MER-L-5192-96.

Environmental Forensics, Junk Science, Age-Dating

C10 Tools of the Environmental Forensic Microscopist

Richard S. Brown, MS, MVA Scientific Consultants, 3300 Breckinridge Boulevard, Suite 400, Duluth, GA 30096-893*

After attending this presentation, attendees will have a basic understanding of how Polarized Light Microscopy (PLM), Scanning Electron Microscopy-energy Dispersive X-ray Spectrometry (SEM-EDS), Fourier Transform Infrared Microspectroscopy (FTIR)) and transmission electron microscopy-energy dispersive x-ray spectrometry with selected Area Electron Diffraction (AEM) can be applied to the characterization of nuisance dusts, airborne and waterborne particulate, and other materials that contain fine particulate.

This presentation will impact the forensic science community by reinforcing the procedures used to characterize and study some of the most challenging samples in a logical and systematic manner.

Dust and debris samples can be intimidating to the inexperienced analyst as can the instrumentation used by the microscopist! Knowing the capabilities and limitations of the various microscopes used in the environmental forensic laboratory is essential to guide the analysis and collect the data needed to characterize the most complicated samples in a timely manner.

Basic concepts of sample preparation, sample study and advanced techniques for preparation of some of the more challenging samples will be presented through case studies. The types of materials and particles present in an "unknown" sample dictate how the analysis progresses. Having a basic procedure to record observations, collect information and use the information collected allows the microscopist to guide his analysis procedure and proceed in a logical, reproducible and confident manner. The initial examination of the sample using gross visual examination and low power stereomicroscopy coupled with the microscopist's experience and knowledge of microscopy allows the characterization of a complex particulate sample to progress in a logical and flexible manner. The process of studying a sample using the tools available to the microscopist cannot be overemphasized especially when results are needed yesterday. The time spent in guiding an ongoing investigation through the careful study of a microscopic sample can result in a huge savings in time, labor and costs.

Microscopy, Environmental, Dust

C11 Characterization of Coal Ash From TVA Spill and Other Investigations

James Millette, PhD, MVA Scientific Consultants, 3300 Breckinridge Boulevard, Suite 400, Duluth, GA 30096*

After attending this presentation, attendees will understand how microscopy plays a part in tracking coal ash/fly ash particles from its source to various locations in waterways and inside homes.

This presentation will impact the forensic science community by increasing the general knowledge of how coal particles and coal ash can be identified in samples of dust, water, and sludge.

In December of 2008, a dam of a landfill holding flyash at the Tennessee Valley Authority Kingston power plant broke, releasing about 5.4 million cubic yards of ash into the surrounding area. It is estimated that the spill will cost up to $975 million to clean up. Questions about how the flyash particles might disperse into local waterways and adjacent properties led to the need for environmental forensic microscopy to identify the flyash particles in samples of water, sludge, and household dust.

Fly Ash, Cenosphere, Microscopy

C12 Asbestos and Environmental Crimes

Peggy J. Forney, BS, U.S. Environmental Protection Agency National Enforcement Investigations Center Laboratory, Building 25, Box 25227, Denver Federal Center, Denver, CO 80225*

After attending this presentation, attendees will see how an environmental crime can impact an entire community. This presentation will show some of the interesting challenges faced by an environmental forensic chemist.

This presentation will impact the forensic science community by showing how the crime put the community in turmoil, and why the school was described as a war zone.

EPA regulations come into play when specific amounts of Asbestos Containing Material (ACM) are removed from a school building and/or released into the environment. Often when the investigation starts, much of the material has already been removed. Calculations from photographs or evidence found after the removal may be used to help determine if a violation exists.

A small town contracted asbestos abatement at the local high school during the summer break. The school library was torn apart; the walls and ceilings of the halls were "power washed" with high pressure water to clean asbestos containing material off the surfaces. The material migrated down pipe chases, inside the classrooms and into lockers. In mid August, the work was reported as completed. Teachers complained about dust coming out of the vents. They were told that the dust was from cement and non-toxic. Due to the complaints, air monitors were placed in the school. Fiber counts varied from non-detect to over 4000 structures/mm^2. The legal limit is 70 structures/ mm^2.

Contaminated water was washed down storm drains. The pipes drained into an irrigation canal, which went into the reservoir that provided drinking water to the town. Debris was also washed down floor drains. Floor drains in the school emptied into the sanitary sewer system. The treatment plant composted the solids and sold the residue to farmers, who spread it on the fields surrounding the town.

These are common types of requests asking the chemists at the U.S. EPA to use not only chemistry, but logic to help assist in determining if violations of an environmental regulation act have occurred. Not only is polarized light microscopy used to determine the amount of asbestos in samples, but other documentary evidence, such as photos, are used to piece together information for case development.

Asbestos, School, Community

C13 The Role and Challenges of the Microscope in a Mobile Analytical Setting

Kelly M. Brinsko, MS, McCrone Research Institute, 2820 South Michigan Avenue, Chicago, IL 60616*

After attending this presentation, attendees will have an awareness of the advantages and shortcomings of the microscope in a mobile lab, especially in the context of the analysis of chemical and biological warfare agents.

This presentation will impact the forensic science community by illustrating how various complementary techniques can be used to make an identification of an unknown substance in the most challenging circumstances.

The microscope is an intrinsic component of any forensic, environmental, or analytical laboratory, and as such it plays a significant role in the mobile analytical lab setting. A microscopical visual examination of an unknown substance will often yield enough information for an identification to be made, or conversely, it could provide an indication of the absence of certain hazardous materials. One particular mobile lab setting where the microscope plays such a role is used by the National Guard's Weapons of Mass Destruction – Civil Support Teams (WMD-CSTs). These analysts provide support to civil authorities as first responders during incidents that may involve weapons of mass destruction. Each state and U.S. territory has at least one WMD-CST and a mobile lab equipped with a polarized light microscope capable of epifluorescence microscopy and infrared microspectroscopy. These tools are used in order to establish the presence or absence of chemical and biological agents. Because these analysts are working with potentially life-threatening substances, certain precautionary measures must be taken before, during, and after an examination with the sample. These procedures include the use of sealed slides or permanent mounting media, preparing samples in a contained glove box, and decontamination steps. Such methods, though necessary for the protection of the analyst, are not always conducive to microscopical analyses. As such, there are some challenges and limitations to the capabilities of the microscope in these settings.

This presentation will discuss the use of the polarized light microscope, fluorescence microscopy, and infrared microspectroscopy in the detection of chemical and biological substances. These various techniques frequently complement each other and together may form the basis for the identification of an unknown substance. Special attention will be given to the important role of the microscope, which includes its advantages as well as its shortcomings in the mobile analytical lab.

Microscopy, Mobile Laboratory, CBRNE

C14 Identification of Cocaine Using Hand-Held Raman Spectrometer for Use in Roadside Drug Tests: Surface-Enhanced Raman Spectroscopy (SERS) is Used Along With a Commercially Available Raman Instrument

Nathan Greeneltch, BS, Northwestern University, 2145 Sheridan Road, Tech k157, Evanston, IL 60611*

The goal of this presentation is to introduce the forensic community to the field of SERS, highlight a promising direction for this spectroscopy, promote analytical/reproducible science in a forensic setting, and set the groundwork for other researchers to use SERS to identify different drugs such as marijuana and methamphetamine.

This presentation will impact the forensic science community by introducing a new technique to the forensic field that will no doubt be a major force in the future of drug screening, and to continue moving the forensic science field toward its rightful respected place among the analytical sciences.

Surface-enhanced Raman Spectroscopy (SERS) is a general analytical detection methodology that has application in a number of fields including biomedical detection chemical/biological warfare agent detection. Here, the technique has been chosen for the screening of cocaine. 10^{-7} M drops of cocaine have produced a unique Raman signal sufficient for positive identification. Emphasis is put on the challenges in using Raman spectroscopy to distinguish between cocaine and its metabolites. The spectrometer used for all measurements is a commercially-available hand-held Raman spectrometer. The SERS-active sensing substrate is a 200 nm thick silver film over nanosphere deposited using vapor deposition. Fabrication of the SERS substrate will be demonstrated in easy-to-understand figures.

Surface-Enhanced Raman Spectroscopy, Cocaine, Roadside

C15 Semi-Quantitative Mapping and Identification of Dispersed Chemicals Using an Ambient-Air Ion Source/ Mass Spectrometer

Andrew H. Grange, PhD, United States Environmental Protection Agency, Environmental Sciences Division, PO Box 93478, Las Vegas, NV 89119*

The goal of this presentation is to inform attendees about a new, high throughput, highly specific analytical technique for identifying and mapping dispersed chemicals.

This presentation will impact the forensic science community by leading to more thorough characterization of contaminated sites, real-time monitoring of remediation, and documentation of thorough clean-ups.

The research focus is to develop high throughput analyses to semi-quantitatively map with high spatial resolution polar chemicals dispersed accidentally, deliberately, or by weather-related events or present in Superfund or Brownsfield sites. Recently developed ambient-air ion sources provide highly specific, mass spectral analysis of compounds adsorbed on surfaces in several seconds. Development of an autosampler and field sample collection system could provide 10-100 times faster analyses than conventional mass spectrometric methods, thereby greatly reducing analysis costs and enabling more rapid and thorough characterization of contaminated areas. A Direct Analysis in Real Time (DART®) ion source directs a heated and energized helium stream onto surfaces to desorb and ionize analytes absorbed on surfaces. The ions are analyzed by a Time-of-Flight Mass Spectrometer (TOFMS), which measures exact masses and relative isotopic abundances that provide the elemental compositions of ions and a compound's identity. Because time-consuming chemical separation techniques are not used, software was written to deconvolute composite mass spectra based on the exact masses and relative isotopic abundances of the ions from multiple compounds. An autosampler was designed, built, and tested that incorporated N-scale model railroad flatcars, track, and a transformer (±15 VDC power supply); a 3-feet-long, 1/4-inch-square bar; fish line; a small 7-rpm motor; and other easily procured and inexpensive parts. Cotton swab wipe samples were inserted through holes in the bar spaced ½ inch apart. In 7.5 minutes, 76 cotton swab wipe samples were analyzed. To provide wipe samples to the lab nearly ready for analysis and to simplify sample collection, a field sample carrier was built around the aluminum bar. Only five minutes was required for sample preparation for each set of samples. The cost of materials for the two devices was about $350. To determine the feasibility of plotting a semi-quantitation map for an analyte, ten NoDoz® (45% caffeine) tablets were ground to powder and dispersed across a concrete driveway using a shop vacuum operated as a blower. A four-color, semi-quantitation map for high, moderate, low, and non-detect levels of caffeine was plotted from the abundances for the m/z 195 $[M+H]^+$ ion from the analyte. The wipe samples were collected from a 7 x 12 sampling grid by dipping the cotton head of a 6-inch swab into water and then rolling it back and forth from side to side and from top to bottom within a 10-cm square template. Palliatives for analyte carryover between swabs during the analyses were use of water-soaked swabs interspersed between the analyte swabs to generate hot water vapor that washed condensed analyte from the inlet orifice cone into the mass spectrometer and signal integrating software that accounted for the remaining carryover. Other sampling techniques are being developed to sample soil, sand, and grass surfaces that will provide an aqueous extract within a few minutes into which a cotton swab will be dipped. Successful development of additional sampling techniques will provide a high throughput analytical technique for rapidly mapping contaminated areas, for locating "hot spots" in Superfund and Brownfields sites, for guiding remediation in real time, and for documenting thorough clean up of contaminated sites. Rapid mapping of contaminated sites with high spatial resolution will provide better risk assessments for humans and ecosystems and better delineate contaminated areas in need of remediation.

Dispersed Chemical, Rapid Analysis, Mass Spectrometry

C16 Tool Mark Creation and Transfer Issues in Firearms

John R. Nixon, MBA, Athena Research & Consulting, PO Box 66, Bippus, IN 46713*

After attending this presentation, attendees will gain knowledge in the mechanisms and mechanical processes behind tool mark creation on firearms components during manufacture. Tool mark analysis practitioners will gain knowledge of component manufacture processes, the mechanical production and transfer of tool marks, and an appreciation of the impact of modern manufacturing processes on tool mark formation and individuality. It is anticipated that this presentation will be of particular interest and benefit to attorneys and investigators.

The presentation will impact the forensic science community in the way that firearm tool mark analyses are viewed in terms of tool mark creation, and their potential for individuality & variability within the context of the manufacturing techniques employed in firearms component production.

The paper will discuss the production of tool marks in firearm components that are manufactured through the use of machine tools, hand tools, and other techniques. The impact of recent manufacturing technological innovations with regard to tool mark creation, and the implications for the discipline of tool mark analysis and comparison, will be discussed.

Firearms consist of numerous components, and several of the components will leave tool marks on ammunition components discharged through the firearm. The most common firearm components that create tool marks on ammunition components are the barrel, breech face, firing pin, extractor, and ejector. There are numerous process alternatives when it comes to the manufacturing of these components, particularly in the rifling of barrels. The tool marks imparted to the ammunition components comprise stria and impressions – stria being generated by tool marks on the firearm components, and impressions being formed by the tool marks on the firearm components.

Linking particular individual firearms to fired ammunition components recovered from crime scenes is a routine activity for most crime labs. Tool mark identifications are performed using tool mark analysis and comparison, with the aid of a comparison microscope. These analyses are performed by individuals with job titles such as "forensic scientist" or "firearms & tool mark examiner". It is almost unheard of for a one of these practitioners to have mechanical engineering qualifications, or any experience in the use of machine tools & hand tools in a commercial manufacturing environment.

In recent years use of the tool mark identification process, and the qualifications of its practitioners, have came under intense scrutiny from the legal community, and some forensic scientists. The process has been disputed via *Daubert* and *Frye* challenges in state and federal courts across the United States. The discipline was a subject of discussion in the February 2009 National Academy of Sciences Report *Strengthening Forensic Science in the United States: A Path Forward*. Some attorneys have noted that tool mark analysis practitioners provide differing court testimony with regard to how tool marks on firearms components are created. The paper will discuss these issues with the aid of case studies.

Mechanical Engineering, Tool Mark, Firearm

C17 Theory of Tool Mark Identifcation

Ronald R. Scott, MA, MS, Arizona Ballistics & Firearms, 37881 North 10th Street, Phoenix, AZ 85086*

The goal of this presentation is to provide an appreciation and explanation of the theory of tool mark identification based on the hypothesis that "sufficient agreement" can lead a qualified firearms examiner to correctly identify tool marks which originate from a common origin; image exemplars will provide insight into the physical factors of general, sub-class, and individual characteristics which can lead to conclusions of identification, elimination, or inconclusive.

This presentation will impact the forensic science community by raising awareness of the underlying principles, methods, and procedures which must be applied by forensic examiners to interpret the comparison of tool marks on various items of evidence within the parameter of guidelines for reliability and validity as determined by the courts under *Daubert* and similar standards, the AFTE Theory of Identification, and will address the impact that external influences play in reported opinions.

Hypothetical Propositions:

1) Tool marks imparted to objects by different tools will rarely, if ever, display agreement sufficiently to lead a qualified examiner to conclude they were created by a single tool.

2) Most manufacturing processes involve the transfer of rapidly changing or random marks onto work pieces such as barrel bores, breechfaces, firing pins, and working surfaces of other common tools. Caused principally by the phenomena of tool wear and chip formation. Microscopic marks on tools continue to change from further wear or abuse.

Summary: Debate continues on the issue of tool mark identification and its impact in the legal arena. Decisions made by the courts in cases such as *Daubert* and *Frye* have brought the discipline under immense scrutiny. Supporters and foes have both put forth arguments which address reliability and validity of the physical tool mark and the issue of subjectivity in reaching conclusions.

The Association of Firearms and Tool Mark Examiners (AFTE) is widely recognized as the leading organization in this discipline and courts will reference the theory when making rulings.

The Theory of Tool Mark Identification is comprised of three main components:

1) Opinions of common origin can be made based on the principle of "sufficient agreement".

2) "Sufficient agreement" is defined by the pattern or combination of patterns of surface contours and that significance is determined by comparative examination of physical attributes which can indicate that agreement is significant when it exceeds the best agreement demonstrated between tool marks known to have been produced by different tools and is consistent with the agreement demonstrated by tool marks known to have been produced by the same tool and that the likelihood that another tool could have made the tool mark is so remote that it should be considered a practical impossibility.

3) Currently the interpretation of individualization/identification is subjective in nature, founded on scientific principles and based on the examiner's training and experience.

Numerous studies have been published which purport to show that the qualified tool mark examiner can identify marks of a single origin. These are based mostly on studies of "consecutively manufactured" firearms, or parts of firearms. However, not all studies provide adequate information indicating that the acquisition of these items was accomplished by monitoring the manufacturing process to ensure consecutiveness. Other studies involve the comparison of projectiles and/or cartridge cases fired in one firearm with conclusions being drawn after pre-determined quantities of shots being fired which are then compared for changes from prior shot batches.

The common denominator in all tool mark comparison is the subjectivity of each examiner in how he interprets the evidence and applies the theoretical principles for "sufficient agreement." Unlike DNA or other hard sciences, tool mark identification does not provide an objective standard on which to reach a conclusion.

Providing that the evidentiary item is suitable for comparison, the three conclusions available to examiners are "Identification", "Elimination", and "Inconclusive".

Some crime labs have adopted policies which influence the independence of the examiner. These include policies where the examiner is prohibited from reporting an elimination if the general class characteristics agree regardless of any significant disagreement of individual characteristics.

Another policy which places external influence on the opinions of examiners is when there are differing opinions between the primary examiner and the verifying examiner in the same lab. Protocol calls for them to attempt to rectify their differences before going to court and it is rare that a unified conclusion is not published. Instead, many labs interject a process which requires a board to review the circumstances and issue a decision. This means that the opinions of the examiners are overruled by personnel who may not be qualified to do so.

Subjectivity could result in two examiners comparing tool marks on evidence and reach the same conclusion based on viewing differing areas of the evidence, or differing opinions even when examining the same tool marks. This is because each tool mark examiner is drawing upon his/her own experience and would be influenced by the standards of his/her mentor.

Under current methodology, the ability to determine and initiate a uniform national standard which must be met is under study but this is in its infancy. Until a standard is determined, if ever, the courts will continue to be the gatekeepers to evaluate whether expert testimony meets the prong of whether the expert is qualified to give the testimony, and the two *Daubert* prongs.

The relevancy prong: The relevancy of a testimony refers to whether or not the expert's evidence "fits" the facts of the case.

The reliability prong: The Supreme Court explained that in order for expert testimony to be considered reliable, the expert must have derived his or her conclusions from the scientific method.

- Empirical testing: the theory or technique must be testable.
- Subjected to peer review and publication.
- Known or potential error rate and the existence and maintenance of standards concerning its operation.
- Whether the theory and technique is generally accepted by a relevant scientific community.

The majority of rulings made by the courts when there are opposing expert opinions is that those conclusions are issues for the jury to decide providing that the relevance and reliability prongs have been met.

Tool Mark Orgins, Sufficient Agreement, Subjectivity of Opinions

C18 Use of Supplementary Analytical Techniques in Firearm Tool Mark Analyses: Utilizing Mechanical Engineering Knowledge and Experience, Deductive Reasoning, and Supplemental Analytical Techniques to Minimize the Number of "Inconclusive" Conclusions

John R. Nixon, MBA, Athena Research & Consulting, PO Box 66, Bippus, IN 46713*

After attending this presentation, attendees will gain knowledge in techniques that may be utilized to minimize the number of "inconclusive" conclusions drawn following analysis of tool marks

found on ammunition cartridge cases recovered from shooting crime scenes.

This presentation will impact the forensic science community in the way that cartridge case tool mark analyses are conducted, and will minimize the number of "inconclusive" conclusions published by crime labs.

Fired cartridge cases are frequently recovered from shooting crime scenes. These cartridge cases contain tool marks created by the firearm in which they were discharged. The most common tool marks used for identification purposes are the firing pin impression and the breech face markings. Crime laboratory employees use a comparison microscope to compare marks on the cases recovered at the crime scene to marks left on cases that they personally have test fired in a suspect firearm or firearms.

In many laboratories, the employees must follow prescribed laboratory protocols and/or trade association recommendations with regard to what analyses may be performed and what conclusions are allowed be drawn. The prescribed protocols stipulate that the examiner must first determine that the suspect firearm and the recovered cartridge cases are of the same, or compatible, caliber. Once this is affirmed the examiner may move on to the microscopic comparison analysis. If distinctively individual and unique characteristics are present, then the examiner may declare either an identification, or an exclusion. If insufficient distinctive individual or unique firing pin, breech face, or other markings can be found, then the laboratory protocol typically stipulates that the examiner must declare that the examination is "inconclusive." The "inconclusive" conclusion is relatively common, and it diminishes the overall probative value of the tool mark analysis process. Many defence attorneys believe that juries view the "inconclusive" statement as a weak "identification," and that the implication of this for defendants is negative in nature. Clearly, less "inconclusive" conclusions would benefit the justice system.

The paper will describe and discuss how mechanical engineering knowledge and experience regarding manufacturing techniques and mechanical function, plus the application of logical supplemental analyses and deductive reasoning, can be used to reduce the number of "inconclusive" conclusions. The techniques will be illustrated by case studies.

Mechanical Engineering, Tool Mark, Inconclusive

C19 The Relationship Between the Measured Friction Coefficient and the Safety of a Walkway Surface

Marcus P. Besser, PhD, Thomas Jefferson University, 130 South Ninth Street, Philadelphia, PA 19107-5233; Howard P. Medoff, PhD, Pennsylvania State University, 1600 Woodland Road, Abington, PA 19001; and Mark I. Marpet, PhD, 14 Cowie Road, Chester, NJ 07930-9715*

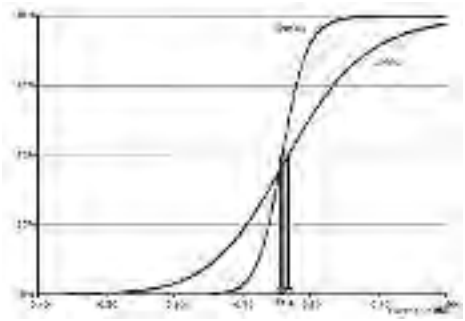
After attending this presentation, attendees will have learned to define a "risk-adjusted friction coefficient", which takes into account what is an acceptable risk of falling.

The presentation will impact the forensic science community by showing that merely using an average friction coefficient to characterize the friction of a walkway surface grossly oversimplifies the safety picture. A quantitative way of understanding the implications of friction variability on safety can allow users to understand better just how safe a surface actually is.

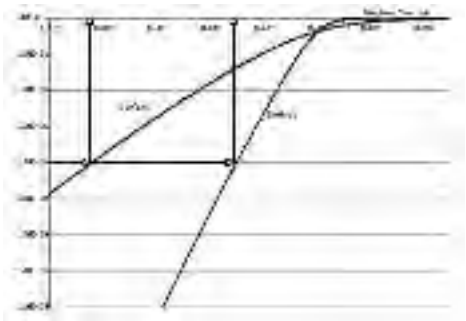
Historically, the average of a set of friction values is used to characterize the coefficient of friction between a shoe bottom (or test foot) and a walkway surface (or test surface). Oftentimes, a standard or practice sets a numeric target, a threshold, above which is considered "slip resistant." For example, ASTM D 2047 Standard Test Method on Floor Polish specifies that if the average of twelve determinations (4 orthogonal tests on each of three test tiles) of the static coefficient of friction, as determined using a James Tribometer and a Standard Leather test foot, is 0.5 or above, that polish can be considered slip resistant.

This approach is potentially inefficient and potentially problematic; inefficient when it requires a floor surface to have more friction than it needs to be safe; problematic when in spite of having an average friction level above a safety threshold (for example, 0.5), a certain proportion of the test results (or pedestrian steps, in real life) fall below the safety threshold.

An example can illustrate this. The following diagram depicts the logistic-regression curves for two real-world flooring materials, call them Surfaces A and B. The typical way to describe a single-point estimate of the friction from a logistic-regression curve would be the value at which the P(Slip) = 50%. We can see, by drawing lines down from the intersection of the logistic regression curves and the horizontal line at P(slip) = 50% that (a) both surfaces have excellent traction and (b) that Surface B has slightly better friction than does Surface A.

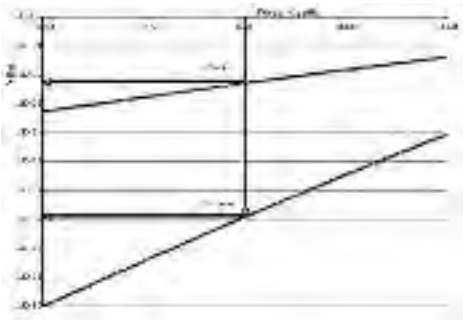


In fact, from a safety standpoint, these statements are misleading. To see this, the question should be framed a bit differently. Instead of asking for a single point estimate, like the average or median (or here, the P(Slip) = 50%) friction value, first (a) recognize that friction is stochastic, varying according to some probability distribution; and (b) pedestrians take many, many steps every day, so to prevent a fall, one must drive the probability of a fall in a single step to be quite low, for example, P(slip) = $^{1}/_{10,000}$. What is the "risk-adjusted friction coefficient?" The graph above does not give enough detail, but by plotting the ordinate on a logarithmic scale, we can see the answer. Drawing a line, not at the 50% level, but at P(slip) = 0.0001 = 10^{-4}, it is shown that the risk-adjusted friction coefficient of surface A is about 0.6, about 0.33 for Surface B:



Thus, because Surface A has a much tighter spread of friction-coefficient values, i.e., a smaller standard deviation, it is ultimately superior to surface B, the one with the slightly higher ordinary friction coefficient.

Looking at this another way, many practitioners traditionally use a friction coefficient of 0.5 as the border between slip-resistant and not-slip-resistant surfaces. At 0.5, what is the imputed probability of slipping at a friction coefficient of 0.5? With surface A, the probability is about $^{1}/_{9,000,000}$; for surface B, it is about $^{1}/_{200}$.



This analysis has been accomplished using a friction-coefficient distribution that was generated using logistic regression, because the tribometer used in collecting the data was of a Slip/No-Slip design. It is clear that the method can be easily extended to tribometers other than dichotomous-outcome instruments (The Slip-Test Mark II and II and the English XL). Specifically, one can take a tribometer that produced a quantitative result, e.g., a James Tribometer or Horizontal-Pull Slipmeter, and repeatedly conduct friction determinations on a properly prepared sample with a properly prepared test foot. One can develop an ordinary histogram of those results and, from that, a cumulative-distribution function. If necessary, curve-fit an appropriate distribution to that cumulative distribution, take the log of the P(slip) and proceed as above. Not directly related to the probability of slipping but also potentially useful, the standard deviation or percentile/quintile/quartile metrics can also be used to intelligently characterize the variability aspects of the friction-coefficient distribution.

In summary, by recognizing that friction-coefficient are stochastic variables, and by utilizing the measure of that variability, one can gain insight into pedestrian safety that goes far beyond what one can discern using only an average, or other central-tendency metric, to characterize the friction coefficient.

Tribometer, Slip and Fall, Slip-Resistant

C20 Progress in Tribometer Characterization Since the Bucknell University/ASTM Workshop

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After attending this presentation, attendees will learn about the progress that has been accomplished since the 1991 Bucknell/ASTM workshop, including the progress in methodology and instrumentation.

This presentation will impact the forensic science community by demonstrating how the use of an instrumented force plate and real-time position sensors can help to better understand the operating characteristics of a walkway-safety tribometer. This data will allow tribometer comparison with biomechanical parameters to assess biofidelity.

Background: The 1991 ASTM F-13/Bucknell University Tribometer workshop tested a number of then-current tribometers against an instrumented force plate, in order to compare the tribometers. In that workshop, the force plate served as a Gold Standard for measuring friction. If this standard is accepted, then the 'best' tribometer would be the one that measured closest to the friction values measured with the force platform. As was reported after the workshop,[1] different tribometers gave different values for the amount of friction between the test shoe and the test surface. In a follow-up paper[2], it was suggested that the "disagreement" between results of different tribometers was less an issue of instrument accuracy than it was a disagreement on exactly what was being measured, i.e., not only the material properties, but the systemic properties of the measuring system.

In addition to the instrumented force plate, similar to the one used at the Bucknell/ASTM workshop, we have equipped the tribometer's test foot with a three-dimensional position sensor. Together, the force plate and the position sensor allow us to track what the tribometer 'foot' is actually doing, and what forces it is exerting on the ground. By using this additional information, we may be better able to evaluate the biofidelity of tribometric testing.

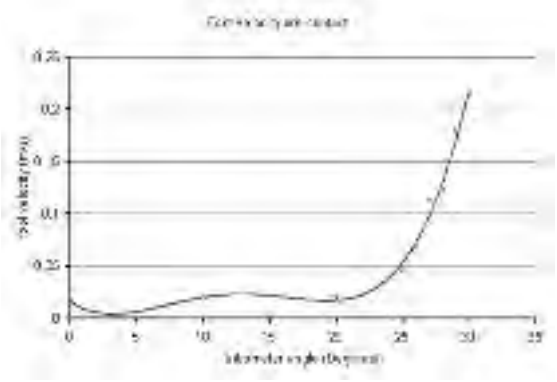
Instrumentation: The testing was conducted using a modified Slip-Test Mark II tribometer, (a portable inclinable articulated strut tribometer) and two test surfaces (Official Vinyl Composition Tile (OVCT) and Porcelanosa Ferroker Ceramic tile). The Mark II tribometer was modified such that the tribometer setting could be varied by very small angular increments (0.01^{o} for angles up to 10°, and 0.1° above 10°). Rather than reading the tangent of the friction angle directly off the instrument scale, the angle of inclination was determined using a SPI-Tronic Pro 3600 Digital Protractor affixed to the inclinable carriage of the tribometer. This allowed us to determine the friction angle with an order of magnitude more precision than one can obtain using an unmodified tribometer.

The tribometer was mounted over (but not on) a biomechanical force platform (AMTI model OR6-5, Newton, MA). This is a six degree-of-freedom (three forces along the X, Y and Z axes and three moments about these axes) platform using strain gage load cells in the four corners of the platform to measure ground reaction forces. The test surfaces were mounted to the surface of the force plate; the tribometer was mounted such that only the test foot of the tribometer would impact the test surface (the frame of the tribometer was supported above the force plate). Thus, all forces measured by the plate were those exerted by the test foot on the test surface. Ground reaction forces were collected at 1000 Hz.

An electromagnetic tracking system (Polhemus Liberty system, Colchester, VT) was used to record the motion of the test foot of the tribometer. A small sensor (1.1 cm on a side; <5 grams) was attached via an 18 cm long 6 mm diameter carbon fiber tube and vertical strut to the front of the test foot (smooth neolite). The tube was kept horizontal to the test surface during testing. The tracking system was used to collect position data at 120 Hz; these data were low-pass filtered at 6 Hz, then differentiated to get test foot's pre-contact velocity.

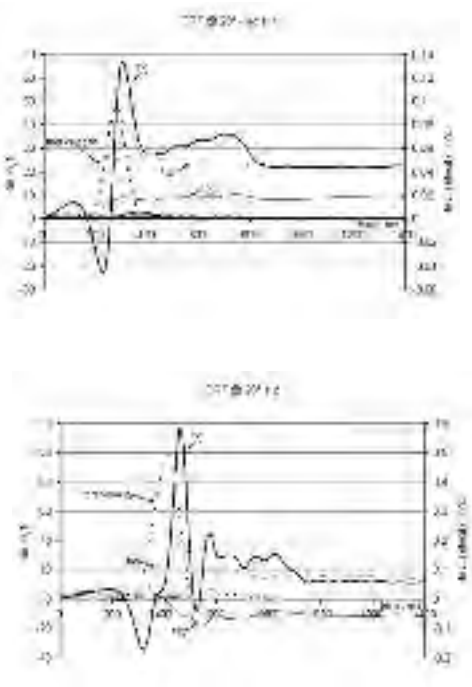
Data were collected with the tribometer in the 0° position (strut vertical), and then the tribometer angle was increased until a slip occurred. The angle was slightly decreased and then multiple trials (usually 10) were collected at small (0.1° to 0.5°) increments. Probability of slip was determined from these multiple trials to be used in other analyses[3]. This paper will concentrate on the motion of the 'foot' just before foot contact, and its possible effect on slip behavior.

Foot velocity at initial contact: One of the characteristics of variable-angle tribometers (including the Slip Test Mark II that is the subject of our tests) is that the test foot is in motion before coming into contact with the test surface, and it is the contact with the surface that decelerates the foot. This is certainly a more 'biofidelic' model than a drag-sled (for example, a Horizontal-Pull Slipmeter) or an articulated-strut tribometer (for example, a James Tribometer). A pedestrian who slips is usually not standing still and being dragged across the floor; rather, s/he slips when his/her foot contacts the ground (dynamically) and lacks sufficient traction (friction) to prevent sliding. The tribometer foot velocity was measured in the direction of motion immediately pre-contact; results are shown in the graph below:



Discussion: In the trials depicted above, slipping first occurred at a friction angle of 27°, and became more likely as the tribometer angle was increased (P(slip| friction angle = 27°) = 0.20); (P(slip| friction angle = 30°) = 0.90)). An increase in the foot velocity was noted as the tribometer angle was increased. The human analog to this would be an increase in walking speed. As such an increase in speed increases the likelihood of a slip in humans, the change in foot speed with change in tribometer angle must be considered when considering if a tribometer measurement is biofidelic.

Ground reaction forces: Ground reaction force curves for a no-slip and a slip trial are shown below:



Discussion: Returning for a moment to the Bucknell workshop, a drag-sled tribometer would exhibit a constant vertical force, with a gradually increasing horizontal force, which would plateau when slip occurred. But considering the "real-world" slip, which usually occurs at initial contact, we can see that the characteristics of the ground reaction force is not the quasi-static, gradual application of a force, but instead is an active impulsive loading, that must be considered when assessing slip.

Conclusion: The kinematics and dynamics of loading when using a tribometer must be considered to assure biofidelity when measuring friction and resistance to slip.

References:

1 Marpet, M. Comparison of walkway-safety tribometers (1996) *Journal of Testing and Evaluation*, 24 (4), pp. 245-254.

2 Marpet, M., Fleischer, D. Comparison of walkway-safety tribometers: Part 2 (1997) *Journal of Testing and Evaluation*, 25 (1), pp. 115-126.

3 See: Medoff, HP., Besser, MP., Marpet, MI. (2007): "The Characterization of the Slip-Test PIAST Tribometer by Characteristic Functions Based Upon Logistic Regression", Conference proceedings of the *59th Annual Meeting of the American Academy of Forensic Sciences*, San Antonio, TX, February, 2007, p. 172.

Tribometer, Slip and Fall, Verification

C21 Visual Characterization of Tribometric Reference Surfaces Using Logistic Regression

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After attending this presentation, attendees will have learned of a visually intuitive method, based upon logistic regression, to characterize the efficacy of a tribometrist's technique in using a Tribometric Reference Surface (TRS) set. TRS's are floor surfaces with specific parameters that are utilized to, calibrate and verify a tribometer (a walkway-friction test instrument), and provide a means of comparing the test results of different tribometers on a given test surface (not a TRS).

This presentation will impact the forensic science community by giving researchers and practitioners knowledge of reliability issues in tribometric testing, and the background needed to understand the strengths and weaknesses of their technique in validating a TRS set.

Background: ASTM Committee F-13 on Pedestrian Walkway Safety and Footwear has been tasked with developing a non-proprietary Standard Test Method for the evaluation of walkway friction. As one important step, Subcommittee F13.1 on Traction is developing a Standard Test Method for measuring the slip properties of the TRS's (generically called Standard Reference Materials (SRMs) by the ASTM). Very briefly, to be considered acceptable, a tribometer must (a) rank the different TRS surfaces in the reference set in the proper, predetermined friction order (low to high) and (b) be able to discriminate (exhibit statistically-significant friction differences) between the different TRS surfaces. Importantly, the specific numeric values obtained in the testing are not in themselves considered an end result. The predetermined friction rank order of the TRS surfaces correlates with the human slip as determined by human-subject experimentation. Thus, biofidelity is inherent in the choice and ranking of the TRS set. It is noted that the official TRS set, i.e., the SRMs that are sold and certified by the ASTM, are not yet available for sale. Although the tests and analysis in this paper use similar (if not identical) TRS surfaces as will be available from ASTM International, it is important not to infer anything vis à vis the SRM set based upon these tests. Rather, the user can repeat these tests using the official SRMs, for test-process verification and quality control.

Logistic Regression: This presentation examines a process by which tribometry-instrument users can gain insight into the efficacy of their techniques using the TRS set and analyzing test results using Logistic regression.

Logistic regression is a mathematical modeling tool that allows one to determine the "best" parameters in a model that predicts a dichotomous (YES/NO) result using continuous independent, predictor

variables. Here, the dichotomous variable is whether there will be a slip or not (the probability of a slip), and one (if not *the*) independent variable is the friction between the shoe (or test foot) and the surface (or test surface or the TRS) as determined by the tribometric instrument. The logistic regression parameter of interest here is the logistic slope of the curve: the larger in magnitude the slope parameter, the finer the discrimination between the slip and no-slip conditions on that TRS. Interestingly, the intercept parameter in the model is of no interest in our application. The logistic-regression equation is:

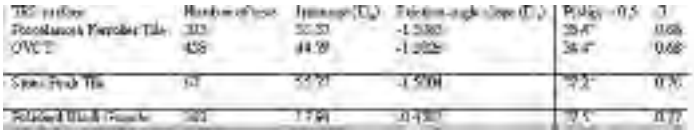
$$P(slip)_i = \frac{1}{1+e^{\beta_0+\beta_1 x_i}}, \text{ where}$$

P(Slip) = Probability of a slip on trial i,

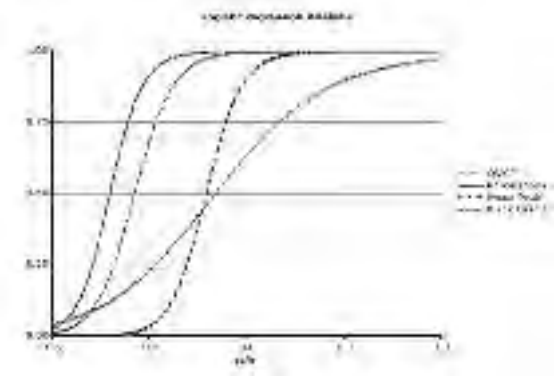
β_0 is the intercept term (not used in this paper),

β_1 is the slope term

TRS Testing: The testing was conducted using a modified Slip-Test Mark II tribometer, (a portable inclinable articulated strut tribometer) and four TRS's (Official Vinyl Composition Tile (OVCT), Porcelanosa Ferroker Ceramic tile, Stone Peak Ceramic Tile, and polished black granite). The Mark II tribometer was modified such that the tribometer setting could be varied by very small angular increments (0.01^o for angles up to 10°, and 0.1° above 10°). The angle of inclination was determined using a SPI-Tronic Pro 3600 Digital Protractor affixed to the inclinable carriage of the tribometer. The tribometer angle was increased until a slip was noted, the tribometer's slip angle was backed off, and sets of successive readings were taken (typically n=10 at each setting) as the tribometer's friction angle was increased, typically by 0.1° in order to generate the logistic regression values for each TRS. Here are the results, again noting that these results should not be considered applicable to the ASTM-certified SRM set:



It was found that the two ceramic tiles and the OVCT had steep and distinctly separated logistic curves. On the other hand, the Polished Black Granite had a shallow logistics curve that crossed over all three of the other TRS curves. This is a clear indication that (a) the experimental technique used in with the Polished Black Granite was wanting or, (b) that the Granite was not the same as the granite used in the ASTM's SRM set.



Conclusion: It is concluded that, beyond the basic Analysis of Variance tools that must be utilized to ensure that the rank-order and statistically-distinct requirements that must be met to ensure TRS-set validation, characterization of the TRS set by logistic regression is a useful technique to enable the researcher or practitioner to determine at a glance whether any problems exist in TRS set and, further, to show where those problems lie.

Tribometer, Slip and Fall, Logistic Regression, Logistic Regression

C22 Comparison of Slip Resistance of Tread Plate and Smooth Steel With Various Finishes Using a Variable Incidence Tribometer (VIT)

Keith E. Vidal, MSME, Vidal Engineering, LC, PO Box 31875, St. Louis, MO 63131*

After attending this presentation, attendees will understand: how the slip resistance of tread plate (aka diamond plate) steel compares to flat plate steel, and how paint coatings can dramatically affect the slip resistance of both tread plate and flat steel products.

This presentation will impact forensic science community by showing that physical design differences of walking surfaces, as well as coatings on those surfaces can dramatically affect the slip resistance of the surface.

This study was the result of a slip and fall accident that took place on a hydraulic lift gate installed on a truck that was used for transporting used tires. The lift gate had been manufactured approximately five months before the incident. Although optional surfaces were available, the lift gate was originally manufactured with a flat plate-steel surface coated with a primer. It was subsequently painted with an acrylic enamel paint and then installed onto the truck. The truck was driven to various automobile tire shops where worn out tires were picked up to be recycled. Many of the tires had varying amounts of rainwater within the carcass, which would splash out when being thrown onto the truck. There were also intermittent rain showers the day of the incident.

At the time of the slip and fall, the lift gate was elevated to the same level as the bed of the truck, several feet high. A man wearing work boots was standing on the surface of the lift gate and was observed by witnesses with his feet above his head and his back parallel to the lift gate surface. As his body fell onto the surface, the back of his head hit the edge of the lift gate resulting in serious injuries. The surface of the lift gate was reportedly wet at the time of the fall.

It was hypothesized that the painted finish of the lift gate contributed significantly to the likelihood of a slip on the lift gate, and that several of the various lift gate options available were more slip resistant and thus safer under foreseeable and expected conditions of use. Since the accident had taken place three years prior to the engineer's involvement, the original surface material and condition were no longer available for testing.

Test Method: Samples of tread plate and flat plate-steel were obtained and prepared for slip resistance testing. A sample of each material was left uncoated; coated with the same primer used on the lift gate; and coated with black acrylic enamel, the same enamel the lift gate was coated with. Each of the surfaces were tested dry and wet using an English XL tribometer (aka Variable Incidence Tribometer (VIT) or a Variable Angle Tribometer (VAT)) to determine the slip resistance properties of the various uncoated and coated materials. Testing was performed in accordance with ASTM Standard F-1679 and the VIT manufacturer's operating instructions and use manual. Each sample was tested at least four times and the tests results were averaged.

Results:

Material description	Avg. Slip resistance (Dry/Wet)	
Smooth Bare Steel	.93	.42
Primed Smooth Steel	.79	.48
Painted Smooth Steel	.89	.26
Bare Tread Plate	.78	.68
Primed Tread Plate	.76	.72
Painted Tread Plate	.76	.60

Discussion: There are at least two consensus standards that put forth guidelines for slip resistance levels on walking/working surfaces. ANSI A1264.2 - Provision of Slip Resistance on Walking/Working Surfaces has published the guideline value of 0.50 as a reasonable level of slip resistance for walking/working surfaces. NFPA 1901 – Standard for Automotive Fire Apparatus sets a minimum level of slip resistance under wet conditions for exterior surfaces as measured with the VIT, as 0.68.

Results of the slip resistance testing showed that the smooth steel surface was marginal to unacceptable (depending on the above test method criteria used), in the bare (.42) and primed (.48) condition under wet conditions but otherwise acceptable dry (.93 and .79 respectively). The acrylic enamel painted smooth steel surface was acceptable dry (.89) but significantly more slippery when wet (.26). All of the diamond plate samples, except the painted (.60), were found to have acceptable slip resistance properties in both the wet and dry condition.

Conclusion: The evaluation of the various surfaces using the VIT tribometer illustrates the utility of this particular tribometer as a tool in assessing the safety of a walking/working surface. The hypothesis that the painted smooth steel surface contributed to cause the slip in this case, and that other options were safer, was supported through test evaluation of the available surfaces under foreseeable conditions.

Slip Resistance, Slip and Fall, Tribometer

C23 Practical Engineering Applied to Aid in Assessing Walkway Slip Resistance

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After attending this presentation, attendees will have both a background and a working knowledge of what is required to avoid the consequences of improperly specified, constructed, or maintained walkway surfaces by learning how to evaluate design alternatives as a function of architectural type of occupancy and conditions of use as slip resistant. Attendees will also understand, how to quantify limits of slip resistance on a scientific basis, how to choose among available slip resistance measurement technologies, and how to best choose and qualify experts to assist both in the choice of a walkway surface and in the prosecution or defense of personal injury claims.

The presentation will impact the forensic science community by helping assure that the constructed environment is built and maintained to a standard related to the type of use and conditions of occupancy that is suitable to the interests of public safety.

The subject of walkways and slip resistance is well known for the breadth of opinion that it attracts. Unfortunately, the state of the art on the subject provides little aid and comfort to walkway design decision makers. Talk (opinion) is cheap in comparison to the responsibility, or what lawyers call duty, that accrues to those who make the decision that determines the quality of a walkway surface. The walkway choice decision makers, "the choosers" for purposes of this discussion, have backgrounds that range from naive property owners or their agents to more sophisticated owners and architectural engineers.

The paper is intended both as an aid to benefit choosers who bear walkway safety decision responsibility and as an aid in the resolution of disputes arising from claims of damage resulting from personal injury. The focus of the discussion is to provide practical guidance, based on existing standards, published research as to what is acceptable and what is defensible regarding the choice of a walkway surface. The goal is to help simplify what can be an overwhelmingly complicated subject by providing pragmatic advice to the choosers and litigators who wish to work in the public interest.

The presentation proposes a common language through definitions on which to base the discussion. It gives historical perspective leading up to the state of the art regarding what is suitably deployed as a walkway surface based on the architectural type of occupancy and conditions of use. It discusses, as an aid to understanding, why statics is appropriate rather than dynamics in the application of mechanics to the description of the physics of not slipping, though a decision on this matter is not actually required for assessing walkway safety issues. It poses and then answers rhetorical questions such as: what is the rationale and practicality for an approach that establishes a single parameter as a measure of walkway safety, what is the nature of the forces that represent slip resistant conditions, how can slip resistance be quantified and evaluated experimentally, how does one choose among the available technology for tribometry, and finally how are experts chosen to who can best perform the testing and analysis related to walkway performance. It divides the walkway system as it metaphorically is and can literally be argued to be that which exists below the walkway solid material interface (excluding porosity), and that over which little or no control is exerted including at the interface, as contamination or non-adhered covering, and that which exists or is happening above the interface.

The conclusions support the use of the force ratio, determined as the highest (limiting) value of a traction force that can be applied to an approximately level surface divided by the simultaneously applied normal force, both before slip occurs which is termed the Coefficient of Slip Resistance (CSR). It also discusses jurisprudence related issues without preference given to either those responsible for the choice of walkway surface, or to those prosecuting on behalf of or those defending against claims of defective conditions of either construction or maintenance resulting in personal injury claims.

Slip Resistance, Walkway Safety, Traction Tribometry

C24 The Role of Lateral Shear Force in the Required Coefficient of Friction for Level Walking

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The goal of this presentation is to help better identify the most critical instants that a slip and fall incident could potentially occur during level walking.

Traditionally, only the longitudinal component of the shear force at the shoe and floor interface has been used in calculating the required coefficient of friction and the lateral component of the shear force at the same interface has been often ignored by most researchers for simplicity. This presentation will impact the forensic science community by showing how the lateral shear component at the shoe and floor interface could play a critical role in determining the instant that a slip and fall incident might occur.

Slips, trips, and falls are a serious problem. Occupational injuries due to slip, trip, and fall incidents remain a leading source of losses in workers' compensation (*Leamon and Murphy, 1995*). The annual direct cost of occupational injuries due to slips, trips, and falls in the United States is estimated to exceed six billion U.S. dollars (*Courtney et al., 2001*). Falls on the same level accounted for 65% of claim cases, and,

consequently, 55% of claim costs in the total direct workers' compensation for the occupational injuries due to slips, trips, and falls (*Leamon and Murphy, 1995*).

Required friction is the minimum friction needed at the shoe and floor interface to support different types of human activities. When the required friction for an activity exceeds the available friction at the shoe and floor interface, a slip may occur (*Redfern et al., 2001*). The available friction represents the maximum frictional force that can be supported without a slip at the shoe and floor interface. The required coefficient of friction (RCOF) is typically measured on dry surfaces with a force plate and is one of the maximum values in the friction coefficient obtained by dividing the component of the measured ground reaction force (GRF) tangent to the floor surface by the normal component during a step (*Redfern et al., 2001*). A mechanical device, known as a slipmeter, is typically used to measure the available coefficient of friction (ACOF) at the contact interfaces (*Chang et al., 2001a; 2001b*). Various models to estimate slip probability based on the comparison of the RCOF and ACOF have been published in the literature.

Traditionally, only the longitudinal component of the shear force at the shoe and floor interface has been used in calculating the RCOF in which the longitudinal component was divided by the normal component at the same instant. The lateral component of the shear force at the same interface has been often ignored by most researchers for simplicity. The argument for this neglect was that the longitudinal component of the shear force is usually much larger than the lateral component. Therefore, the contribution of the lateral component to the total magnitude of the actual shear force which is the vector sum of both the longitudinal and lateral components was negligible.

This general assumption might be true in many of the cases. However, the results from this experiment on level walking show that some walks exhibited very different results with a large lateral component shear force compared with its longitudinal component in the early part of a heel contact. Under these circumstances, the lateral component should not be ignored, and the instantaneous coefficient of friction reached its maximum near the instant when the lateral shear component also reached its maximum. Therefore, it triggered the mechanism for determining the RCOF. In comparison with the cases that the RCOF was triggered by the longitudinal component, those triggered by the lateral component usually happened earlier in a gait cycle than those triggered by the longitudinal component. Perkins (1978) reported that the shoe started slipping forward approximately 0.1 second after a normal landing in a typical severe slip on slippery surfaces in their experiment. Slip at the instant of heel contact was not very common, according to his results, but it usually led to an irrecoverable slip. The lateral shear component might help explain why some slips occurred early in a gait cycle, but some did not.

Lateral Component of Shear Force, Slips and Falls, Required Coefficient of Friction

C25 Utilized Friction During Bathtub Entry/Exit Under Dry and Wet Conditions

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After attending this presentation, attendees will understand how the friction used while entering and exiting a typical bathtub varies under dry and wet conditions between young, middle, and old age individuals.

This presentation will impact the forensic science community by providing forensic slip and fall investigators with baseline information on the friction levels used when entering and exiting a dry or wet bathtub.

Bathtubs and showers are a common source of unintentional slips and falls. Entering and exiting a bathtub requires an individual to step over the tub's apron as they transition between two different and potentially slippery surfaces. The goal of this study was to quantify the friction used by barefoot subjects entering and exiting a typical bathtub/shower enclosure under dry and wet conditions. It is hypothesized that the complexity of simultaneously stepping over the bathtub apron and dealing with a potentially slippery surface would produce lower frictional demands in older subjects than in young and middle-aged subjects, particularly under wet conditions.

Sixty subjects (30F, 30M) distributed equally in three age groups (20-30 yrs, 40-50 yrs, 60-70 yrs), entered and exited a slip-resistant bathtub using six movement patterns simulating actual use (three entering and three exiting the tub). Each subject repeated each movement pattern five times under blocked dry and wet conditions, yielding 60 trials per subject. For bathtub entry, the first movement consisted of a single forward step over the tub's apron starting and ending in a standing position; the second movement consisted of a single forward step combined with a 90º left rotation to stand facing the faucet; and, the third movement consisted of multiple forward steps approaching the tub combined with a 90º left rotation on the last step over the tub apron to stand facing the faucet. The three exiting movements were the reverse of the three entry movements. Force plates (*Bertec 4060, Columbus, OH*) installed in the slip-resistant tub floor and the slip-resistant deck immediately outside the tub measured ground reaction forces, from which utilized friction and double support times were calculated. Force plate data were acquired at 1 kHz and peak utilized friction during heel strike and toe off of each limb was obtained from a 50ms running average of the instantaneous ratio of shear force to normal force.

Subjects completed all trials without tripping, falling, or reaching for either of two grab bars. No obvious slips were observed and no subjects reported slipping. Overall, utilized friction varied from 0.102 to 0.442 (0.235 ± 0.057) and was 0.058 ± 0.040 lower in wet conditions than in dry conditions across all movement patterns ($p<0.0001$). Older subjects used less friction than young subjects during exiting movements only ($p<0.006$). Utilized friction did not vary between genders ($p>0.14$). Double support times were longer in older subjects than in both young and middle-aged subjects for all movement patterns ($p<0.0009$) and longer under wet conditions than under dry conditions for all entry movements ($p<0.0001$).

The combination of lower friction and longer double support times in wet conditions suggests that subjects regard the wet condition as more hazardous than the dry condition and adapt their utilized friction accordingly. The results also suggest that older subjects are more cautious than young subjects when confronted with the dual task of both stepping over the tub's apron and transitioning to a surface perceived to be more slippery.

Slip and Fall, Friction, Bathtub

C26 Deformation Mechanisms of Walk-Off Mats

Anastasia D. Micheals, MS, Forensic Materials Consulting, 1784 Sanchez Street, San Francisco, CA 94131-2741*

After attending this presentation, attendees will understand the deformation mechanisms of contemporary floor mats (also called walk-off mats). Attendees will comprehend the nomenclature used to describe mat deformations. Attendees will also become aware of the various forces present in use, laundering, and delivery, which may contribute to

deformation. In addition, attendees will understand how these principles were applied in defense of a trip and fall injury case.

This presentation will impact the forensic science community by providing a tutorial of failure mechanism of materials as related to walk-off mats.

Floor mats, also called dust mats or walk off mats, are ubiquitous in our society. They may be encountered many times during a day; at the coffee shop, grocery store, office building, and school. Sizes vary; typical dimensions are 2 feet by 3 feet, 4 feet by 6 feet or 4 feet by 10 feet. Frequently placed at the transition from outdoors to indoors, the mats appear as a safety device to prevent tracking water onto surfaces with low coefficients of friction, i.e., floors which are slippery when wet. But, an additonal rationale behind their widespread placement is that they remove and trap dirt, debris, and moisture at the building entryway, reducing building cleaning costs. Mats are typically rented from a company that services the mats periodically, by removing and laundering a soiled mat, and replacing with a clean mat.

Contemporary floor mats are composites made of a rubber base with a fiber carpet pile. While specific material formulations vary, a typical rental mat consists of a nitrile rubber backing and a nylon pile. The pile may be attached to the rubber backing by various mechanisms, depending on manufacturer. For example, individual tufts of the pile may be directly bonded to the rubber by thermomechanical means, or may be bonded by means of a woven or non-woven pile substrate. Due to the nature of the materials they are made of, mats can fail by several mechanisms:

- Delamination – separation of the pile from the substrate;
- Substrate Degradation – changing the properties of the rubber substrate through exposure to chemicals, UV light, or heat; or
- Rippling – permanent deformation of the mat caused by unequal stretching the polymer bonds of the substrate past their limit of plastic deformation.

These mechanisms, which degrade the properties of the mat, occur with time, and depending on the exact conditions of use and care. The floor-mat manufacturing and rental industries recognize that mats have a finite lifetime, and that they must be periodically removed from service and replaced.

During duty, cleaning and placement, the mat is subjected to various forces. The forces can result in elastic or plastic deformation of the mat substrate, depending on their magnitude. During use, frictional forces hold the mat to the floor; tensile and compressive forces are generated by people walking on the mat; and torsional forces are generated if the mat is not lying flat on the floor. These forces are generally small enough to cause only elastic, or non-permanent deformation. During laundering, the mats are agitated with soap and water, rinsed, and spun dry, in industrial washing machines. During water extraction by spinning, the mats experience the largest forces. For a mat lying flat against the wall of the washer barrel, the centripetal spinning force becomes a simple compressive force through the thickness of the mat, similar to that created by placing a weight on it during use. However, if the mat became twisted or rolled over during washing, a bending force is experienced during spinning, which is maximized on the outer surface of the bend. Centripetal force, coupled with the weight of additional wet mats, can exceed the elastic strength of the material, break polymer bonds and cause permanent deformation. Ripples that prevent the mat from lying flat can thus develop over multiple laundering cycles. Standards for laundering are specified by the mat manufacturer. Care is taken to specify parameters such as laundering temperature, soap formulation and amount, the weight of mats to be placed in each pocket of the washing machine, and the spin speed.

In one case, a rental company placed a mat at the doorway of a county museum. An 80-year-old woman tripped on a ripple in the mat, fell, and broke her hip. It was found that although the mat rental company observed the manufacturer instructions regarding laundering of its mats, they failed to have a formal inspection program in place to ensure that rippled mats were removed from service.

Walk-Off Mats, Deformation, Rubber

C27 Exploding Pool Filters That Can Kill

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After attending this presentation, attendees will understand design failures that are present in certain pool filters and their potential for injury. Attendees also will learn of the legal issues involved in presenting such cases.

This presentation will impact the forensic science community by providing insight into a forensic engineering evaluation of swimming pool filters. The major legal issues and case workup will be discussed, as well as, the engineering obligation to notify the Consumer Product Safety Commission of the problems.

During the course of accident evaluation of pool filter failures, it was determined that design flaws existed that did not provide safety protection during routine servicing of the filter. The Consumer Products Safety Commission has had 18 serious injuries and 4 deaths reported. All the injuries have involved the kettle-style filters and the incidents occurred when the persons doing the maintenance had finished cleaning the cartridges inside the filter, put the top back on, and started the pump. For various reasons, the compressible air was not vented, and the band that clamps the top of the filter to the bottom was not tightened properly or failed to clamp. When this occurred, the compressed air forced the top to fly off, resulting in death or serious injury to the person it struck. If the air had been vented, then an incomplete seal of the top to the bottom would only have resulted in a water leak. The failure of pool filters is associated with the following conditions:

- Failure of automatic air venting valves.
- Short and wide kettle-style filters.
- Failure in the case where the top and bottom flanges are held in place by adhesives.
- Body clamp failure due to design or failure to tighten.
- Placing essential controls too close to the pool filter.

Automatic venting valves operate through the means of a float that closes off the vent when the water in the filter rises to the top. If the float is pushed up by the rapid flow of air and becomes stuck to the top of the valve, then it fails to vent the air. Unfortunately, it is not possible to pre-determine if the valve is functioning properly and air has been released.

The short, wide filters are dangerous because as the diameter increases, the area increases as the square of the diameter, and the force on the lid increases accordingly. The safest design is tall, narrow filters.

Adhesive failures are due to quality control where the adhesive is not applied uniformly or the adhesive breaks down due to thermal fatigue and mechanical stress.

The body clamps must be robust so that aggressive tightening does not cause failure. Some designs lack such ruggedness. The clamp tightening mechanism relies on the individual to determine when the clamp is adequately tight. Under-tightening and over-tightening can easily occur. The safest pool filters use bolts to hold the top in place rather than clamps.

The location of switches and timers in close proximity to the pool filter puts the operator at risk and is a factor in causing most of the injuries.

Pool Filters, Explosions, Clamp

C28 Scientific Perspective on *Frye* and *Daubert* With Respect to the NAS Report

Harold E. Franck, MSEE, PE, Advanced Engineering Associates, Inc., 4713 MacCorkle Avenue, Southeast, Charleston, WV 25304*

After attending this presentation, attendees should gain some insight into the necessity for standards in the engineering sciences and the lack of standards in engineering sciences.

This presentation will impact the forensic community by encouraging the development of standards, protocols, and guides.

Engineering and science have a variety of goals, which are readily understood by the general public. Some of the most important goals, such as the protection of life and property, are not so well known or understood. In engineering and in science there are ethical standards to which practitioners adhere. In the context of forensic science, investigations are carried out to determine the events that led to the incident and in many instances, to develop methods of avoidance. At the present time there are two standards that are used by the courts to determine the validity of the expert's testimony.

The *Frye* Standard stems from a 1923 case that established the minimum standard required for the admission of expert testimony in federal cases. This standard requires the expert to use data and methodology "generally accepted" by other experts. In the *Daubert* case in 1993 the evidence that was presented by the plaintiff was considered to be novel scientific evidence or junk science. Therefore, this novel scientific evidence did not qualify under the *Frye* Standard as admissible expert testimony. In the U.S. Supreme Court appeal the lower court rulings were overturned and a new standard was developed where the reliability of the evidence must meet a non-exclusive four part test.

- Can the theory or technique be tested?
- Have they been subjected to peer review and publication?
- Is there a known or potential rate of error?
- Is there general acceptance in the scientific communit similar to the Frye Standard?

On November 22, 2005, the Science, State, Justice, Commerce, and Related Agencies Appropriations Act of 2006 became law. Congress authorized the National Academy of Sciences to conduct a study on forensic sciences. The Senate Report set forth many charges to the forensic sciences community including to disseminate best practices and guidelines concerning the collection and analysis of forensic evidence to help insure quality and consistency in the use of forensic technologies and techniques to solve crimes, investigate deaths, and protect the public. One of the issues covered during the committee's hearings was the fundamental of the scientific method as applied to forensic practice – hypothesis generation and testing, "falsifiability" and replication, and peer review of scientific publications. Another observation was the lack of mandatory standardization, certification, and accreditation. The committee stated that the fragmentation problem is compounded because operational principles and procedures for many forensic science disciplines are not standardized or embraced. Often there are no standard protocols governing forensic practice in a given discipline. One recommendation is to establish a national code of ethics for all forensic science disciplines.

It is clear that standards and protocols must be developed for the forensic sciences. In the engineering sciences there are many recognized standards in certain fields, but they are utterly lacking in others. For example, the fire sciences have a multitude of standards, guides, and protocols that were developed by ASTM and NFPA. In the engineering sciences there are but a handful of standards. Some were developed 25 years ago and a few others were developed five years ago when a major push was made in ASTM to develop such standards. Since then no standards have been developed, and their development has actually been curtailed. The AAFS through its long and close association with ASTM, has an opportunity develop standards, guides, and protocols in forensic engineering sciences.

Standards, Protocols, Guides

C29 An Accident Reconstructionist's View of How the Rules of Evidence Affect Expert Testimony

Peter Alexander, PhD, Raymond Smith & Associates, 4934 Wagontrail Court, Parker, CO 80134*

The goal of this presentation is to inform attendees of the flaws in the judge's gatekeeper role regarding admissibility of scientific testimony.

This presentation will impact the forensic science community by providing case studies of application of *Daubert* ruling in civil litigation involving scientific conclusions.

The National Academy of Sciences (NAS) has recently issued a 254 page draft report stressing the need to strengthen forensic science activities in the United States. Among the areas mentioned were:

- The lack of standardization of procedures;
- The lack of mandatory certification, and accreditation of practitioners;
- The lack of established accuracy limits for procedures;
- The admissibility of forensic evidence in litigation;

This paper deals with the last item, the admissibility of accident reconstruction data and conclusions used at trial which are drawn from that data.

The NAS Report recounted the *Frye* standard developed in 1923 and the 1975 Federal Rules of Evidence – Rule 702 which led up to the 1993 *Daubert* decision. *Daubert* established several standards (cited below) that the trial judge could consider with regard to expert testimony.

1) Whether a theory or method has been tested;
2) Whether it has been subjected to peer review and publication;
3) Whether it has a known rate of error;
4) Whether there are standards controlling the technique;
5) Whether it is accepted in the scientific community;

When one side in a lawsuit challenges the other side's expert based on the *Daubert* decision, the judge is required to act as the "gate keeper" and rule on the admissibility of the presentation in terms of the above criteria, in order to prevent the jury from being exposed to unsound or unscientific conclusions. Often during a *Daubert* challenge the judge is presented with conflicting, rather technical, testimony from experts on each side. One side may contend that the other expert's conclusions are invalid because they rely on junk science or faulty assumptions. This process is an exercise in fairness to ensure that one side in a court case does not influence the jury with testimony that is not sound or accurate. How well this process works for the accident reconstructionist is discussed below.

On occasion the judge shirks his gatekeeper role and decides to let the jury decide the merits of each side's expert conclusions. Sometimes it appears that the judge may feel that he is insufficiently technically astute to render a decision. Unfortunately, a jury is even less qualified to make this judgment than the judge. When the judge fails to fulfill this role, the jury is presented with two experts who each sound very convincing but have contradictory scientific conclusions. In such a situation it is possible for justice to be perverted. Two case studies illustrating this process are detailed below.

Case Study 1: This case involved a rear impact to the stopped plaintiff's 1992 Suzuki Sidekick, by a 1997 Jeep Grand Cherokee. Roughly $1500 in damage was suffered by each vehicle. Physicians attributed cervical and mild brain injuries to the plaintiff resulting from this collision.

The plaintiff's expert placed the Jeep's impact speed at >10 mph, resulting in a 5 mph. speed change of the plaintiff's vehicle. The female plaintiff was restrained and turned when she was hit by surprise from the rear.

The defense expert concluded that the impact speed was <5 mph, resulting in a 4g peak acceleration to the occupant. The expert cited staged rear impact crash tests at this speed, in which the human volunteers were uninjured. The expert also stated that the forces in this collision were no greater than those experienced during normal daily activities. The defense expert's conclusions were based on a numerical model which was used only by that expert and had never been independently tested or validated. The model was capable of producing any result the expert wanted, depending on his choice of key input parameter values.

Previously the State Supreme Court had ruled that comparing forces in a collision to forces related to daily activities was junk science and inadmissible. Likewise the Supreme Court had also ruled that comparison of the lack of injuries incurred in staged crash tests with the likelihood of injury in an actual collision was junk science.

During the hearing, in this case, challenging the defense's right to present this data to the Jury, the judge abdicated his responsibility and decided to let the jury decide which expert was right. The jury decided that the plaintiff could not have been injured in this impact. If the jury had known that the defense expert was relying on "junk science" would the result have been different?

Case Study 2: This case involved a 2000 Toyota Avalon which struck the plaintiff's slowly moving 1989 Cadillac Deville from the rear. The defendant claimed she was only traveling at 5 mph when the plaintiff stopped suddenly. There was $1,000 damage reported to the plaintiff's vehicle and a precision frame measurement showed that the frame had been bent by the force of the collision. Physicians testified to various significant back and neck injuries suffered by the plaintiff in this collision.

The plaintiff's expert testified that this collision's relative impact speed was in excess of 12 mph. and aggravating factors such as a prior asymptomatic injury, being turned at the moment of impact, and being hit by surprise contributed to the likelihood of injury to the plaintiff. The expert also established that the stated impact speed was a minimum value necessary to cause the frame damage noted.

Despite being challenged, the defense expert, a medical doctor, was allowed to testify regarding her reconstruction of this accident. She concluded that the peak acceleration in this collision was less than 2g and it was unlikely that someone would be injured at that acceleration level. The expert also noted that we live with 1g acceleration exerted on our bodies. Despite the defense expert having no credentials in the area of accident reconstruction, she was allowed to testify as to her conclusions in that area. Incredibly, the plaintiff's accident reconstruction expert was not allowed to rebut the defense expert's accident reconstruction testimony because he was not a medical doctor like the defense's expert.

The jury found against the plaintiff, agreeing with the defense expert that acceleration levels of 2g were unlikely to cause the stated injuries. The jury never heard that the 4 mph. that would have produced the 2g acceleration claimed by the defense, never would have bent the plaintiff's vehicle frame. The jury also never heard that, even if the defense was correct about the impact speed, a 1g vertical acceleration applied to one's body is not comparable to a 2g horizontal acceleration applied to the head and neck. In addition, the jury never heard that the peak accelerations experienced by the plaintiff could actually have been as high as 15g. Would the jury verdict have been the same if they had been allowed to hear these arguments during rebuttal?

Conclusion: How can the possible perversions of justice apparent in the above examples be avoided? It appears that some judges are not comfortable deciding issues which are technically based. One option might be to require judges to have some minimal training in science or engineering. Another possibility might involve providing science education to sitting judges. Still another option might involve the appointment of a technical advisor by the judge to help him rule on cases involving complex technical matters. Attorneys and judges might provide different sets of options with regard to this question.

Accident Reconstruction, *Daubert,* Expert Testimony

C30 Biomedical/Biomechanical Analysis of Injury/Trauma Reported for Restrained and Un-Restrained Adult and Pediatric Occupants Involved in Vehicular Rollover Crashes: A Nominal and Statistical Approach

Laura L. Liptai, PhD, and Tia L. Orton, BS, BioMedical Forensics, 1660 School Street, #103, Moraga, CA 94556*

After attending this presentation, attendees will understand the numerous in-depth biomedical analyses of both adults and children involved in rollover crashes illustrate injury causation and related mitigation methods.

This presentation will impact the forensic science community by documenting the importance of a nominal crash-specific biomedical forensic analysis, not simply a reliance on statistical studies, when determining injury causation and related mitigation.

Despite effective improvements in vehicular safety, rollover crashes have continued to pose a significant problem due to their association with high injury trauma rates. As a category, rollover crashes constitute over a third of the trauma-related harm although they represent just over 2% of the crash population. Approximately 84 percent of the harm associated with rollovers occurs to unrestrained occupants.

Numerous in-depth biomedical analyses of both adults and children involved in rollover crashes illustrate injury causation and related mitigation methods. In the majority of cases it was specifically determined that use of the available restraint system would significantly lower the injury risk. In several cases; however, use of the available restraint system did not prevent serious injury/fatality.

This paper documents the importance of a nominal crash-specific biomedical forensic analysis, not simply a reliance on statistical studies, when determining injury causation and related mitigation. This is particularly true with rollover crashes which can be highly variable events with often-erratic parameters.

Rollover, Unbelted, Biomechanical

C31 Occupant Excursion and Restraint System Performance in Rollover Testing

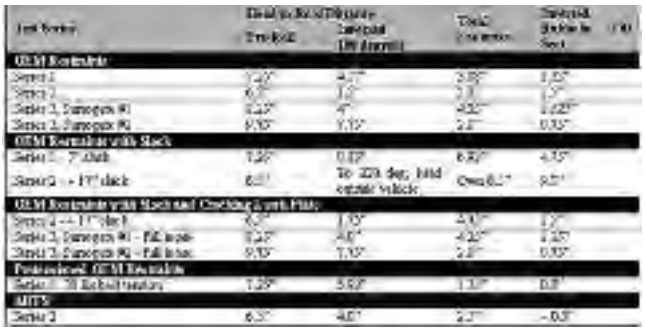
Steven E. Meyer, PE, Arin A. Oliver, BS, and Brian R. Herbst, PE, SAFE Laboratories, 6775 Hollister Avenue, Suite 100, Goleta, CA 93117*

After attending this presentation, attendees will have a better understanding of the effect of seat belt looseness, or slack, and its relationship to occupant excursion during a rollover by evaluating various restraint system designs and configuration in rollover-type test environments.

This presentation will impact the forensic science community by providing effective occupant protection in automotive rollover crashes requires supplying the occupant with a restraint system proven effective in this accident mode. Preventing occupant ejection and providing restraint through the rollover sufficient to prevent potentially injurious contacts with interior vehicle components are paramount for effective occupant protection. Research has shown that the potential for injury can be decreased by closely coupling the occupant to the seat. The presented testing studies the ability of various restraint systems to control occupant excursions out of the seat.

Providing effective occupant protection in automotive rollover crashes requires supplying the occupant with a restraint system proven effective in this accident mode. Preventing occupant ejection and providing restraint through the rollover sufficient to prevent potentially injurious contacts with interior vehicle components are paramount for effective occupant protection. Research has shown that the potential for injury can be decreased by closely coupling the occupant to the seat. The presented testing studies the ability of various restraint systems to control occupant excursions out of the seat. This presentation will give attendees a better understanding of the effect of seat belt looseness, or slack, and its relationship to occupant excursion during a rollover by evaluating various restraint system designs and configuration in rollover-type test environments.

A series of roll spit tests were performed utilizing production sport utility vehicles (SUVs) with a female occupant (5th to 25th percentile) positioned in one of the front seating positions. Measurements were taken of the occupant's initial upright clearances to the surrounding vehicle structure. The vehicle occupant compartment was then rotated to an inverted orientation, 180 degrees of rotation (unless otherwise noted), and the excursions and clearances were recorded. Various restraint systems were considered and subjected to testing, including the original equipment manufacture (OEM) as well as other restraint systems designs seen in production. The observed results of the testing are summarized in the following Table.



The testing demonstrates that occupant excursions in vehicle rollover circumstances are dramatically affected by the chosen restraint system. Slack in an OEM restraint system increases the occupant excursion from that of a normally tight OEM restraint system. This additional excursion can greatly increase the occupant's potential for injurious contacts with the interior of the vehicle during a rollover and/or contribute to the occupant's partial or full ejection. Various restraint system components added to the tested vehicles demonstrate a decrease in the occupant's excursion; and therefore, a decrease in injury potential. Simply adding a cinching latch plate, even allowing slack in the torso belt, is seen to prevent vertical excursions beyond that of a tight belt configuration. A pretensioned belt or all-belts-to-seat (ABTS) restraint system shows a large decrease in the amount of occupant excursion.

Rollover, Restraint, Excursion

C32 Comparison of Hybrid III Dummy Neck Stiffness to Actual Human Neck Injury Tolerance for Axial Compression in Rollovers

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The goal of this presentation is to examine the Hybrid III dummy neck stiffness and compares it to the human neck. After attending this presentation, attendees will understand the difference between dummy and human neck response to axial loading and its significance.

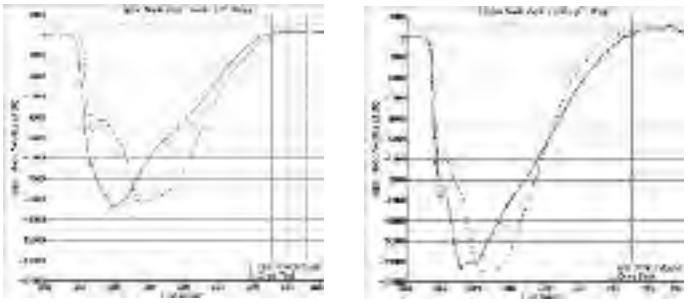
This presentation will impact the forensic science community by showing that a value of at least 10,500 N is an appropriate representation for upper neck axial load in the Hybrid III dummy as a threshold for predicting human cervical spine injury.

Over 10,000 people die annually in the United States from rollover motor vehicle collisions, and more than 16,000 people suffer catastrophic injury. Most of the research on cervical injury potential in rollover accidents has utilized the Hybrid III anthropomorphic test device (ATD), aka, the Hybrid III dummy. This presentation examines the Hybrid III dummy neck stiffness and compares it to the human neck. After attending this presentation, attendees will understand the difference between dummy and human neck response to axial loading and its significance.

Although it is the most advanced ATD currently available, the Hybrid III dummy is not a good surrogate for neck injury investigations during rollover collisions. Inadequacies of the Hybrid III dummy neck have been reported in the literature. The dummy neck geometry is clearly not the same as a human neck. The human neck is articulated with joints while the dummy neck is a non-jointed structure, which leads to dynamic dissimilarity. In fact, the Hybrid III in current use is a scaled-down, cheaper version of the original GM design. The dummy neck is too stiff in the axial direction when compared to the human neck. No one-to-one relationship between the dummy and the human neck with respect to forces experienced and mechanism of injury has been widely accepted. Despite this, extensive use of the Hybrid III dummy in rollover testing has led researchers to infer that the dummy neck response is a close representation to that of a human neck. Some research even uses a dummy axial neck load as low as 2000 N to represent injury potential from roof crush.

In the current study, the MADYMO (MAthmatical DYnamic MOdels) computer simulation program was used to establish a relationship between the dummy and human neck response. A one-directional (translational) joint between the lower neck and upper torso was added to the basic 50th percentile male dummy model to account for the axial compression response of the dummy neck. The axial compression properties were selected from tests on the dummy head-neck system as reported by Herbst (1998) who used loading rates from 4.5 to 17.9 mph.

Dummy drop tests conducted at SAFE in 2005 were used to validate this modified MADYMO dummy model. A 50th percentile Hybrid III male dummy was inverted and placed in a seated position such that the neck was almost vertical (head 7 degrees rearward of vertical). The dummy was then dropped, free fall onto a concrete surface covered with linoleum flooring from heights of 12 inches and 24 inches. The peak upper neck axial load was 8,458 N for the 12-inch drop and 11,344 N for the 24-inch drop. Figure 1 shows good correlation between the MADYMO model and the drop tests.



(a) (b)

Figure 1. Dummy upper neck axial loads from MADYMO model and SAFE drop tests for (a) 12-inch drop and (b) 24-inch drop.

Because neck tolerance data on living humans is limited, the only verified injury measure is from recreational activities such as diving and football accidents. This research indicates that cervical flexion-compression injuries can occur at head impacts as low as 10.2 feet/sec (approximately 7 mph). The results of research utilizing cadavers are also consistent with this number.

The modified MADYMO model was then utilized to simulate a 20-inch drop height to represent a 7 mph impact velocity. The results from this validated MADYMO model showed that the neck compressive force is approximately 10,500 N. When the dummy torso position was changed to represent a more vertical neck condition (5 degree variation), the loads increased to about 11,500 N. Thus, this study shows a range of compressive neck loads between 10,500 to 11,500 N for a 20-inch drop height, which represents an approximate 7 mph impact velocity.

The drop testing and the MADYMO modeling clearly demonstrate that the Hybrid III dummy neck is much stiffer in the axial direction than the human neck. It should be noted that peak force has not been established as a reliable parameter for assessing catastrophic cervical injury in the human. However, if one does use peak axial load, the human neck is roughly 4,000 N in an inverted drop with an impact speed of 7 mph and the equivalent peak load in a Hybrid III dummy neck under similar loading conditions is over 2.5 times that value. The dummy neck inadequacies, as described above, are responsible for this disparity.

The Hybrid III dummy is routinely used for analyzing the forces and injury potential during rollover accidents with various axial neck loads to predict injury outcome from roof crush. This study shows that a value of at least 10,500 N is an appropriate representation for upper neck axial load in the Hybrid III dummy as a threshold for predicting human cervical spine injury.

Rollover, Hybrid III Neck, MADYMO

C33 Containment Potential of Laminated Glazing in High Speed Rollover Testing

Brian R. Herbst, PE, Steven E. Meyer, PE, and Arin A. Oliver, BS, SAFE Laboratories, 6775 Hollister Avenue, Suite 100, Goleta, CA 93117*

After attending this presentation, attendees will recognize the retention capabilities of laminated glass door windows for unrestrained occupants in a dynamic rollover event.

This presentation will impact the forensic science community by discussing how keeping occupants inside the vehicle during a rollover accident event is the first step to reducing occupant injury in this accident mode.

Keeping occupants inside the vehicle during a rollover accident event is the first step to reducing occupant injury in this accident mode. While increased restraint use, restraint performance and vehicle structural integrity have all been identified as being associated with occupant containment, vehicle glazing is known as the structural component that is most likely to fail during this accident mode. Vehicle glazing failure usually creates large portals in the vehicle structure through which occupants can be ejected. In the presented automotive rollover testing, the original tempered door glazing was replaced with laminated glazing and unrestrained Anthropometric Test Devices (ATDs) were subjected to high rates of rotation. Under various configurations, ATD kinematics and glazing performance during rollover were recorded.

The performed study includes seven controlled, multi-revolution tests of a partial sport utility vehicle (SUV) occupant compartment test fixture rotating about a fixed, longitudinal axis. The front doors of the fixture were modified by replacing the original equipment manufacturer (OEM) glazing with a piece of 0.269" thick laminated glass manufactured by American Glass Products containing a 30 mil PVB inner layer. Although slightly thicker (from OEM thickness of 0.152" to 0.269" laminated thickness), the laminated glass was able to fit into the OEM window hardware by slightly expanding the window frame metal flanges. Additionally, the right front door window frame was reinforced with a 1.5 to 2.25" wide piece of sheet metal.

Unrestrained Hybrid III 50th percentile male ATDs were positioned in the driver's and/or passenger's seating positions with dummy kinematics and interaction with the front window glazing observed at roll rates of up to 644 degrees per second. The same driver's and passenger's doors, as well as their associated laminated glazing, were utilized in all of the seven tests conducted. At various points during the testing, the laminated glazing on each door was pre-damaged in order to note the effect of existing fractures. The observed results of the testing are summarized in the following Table.

Test	Description	Max. Roll Rate	Distance of Separation	Occupant Containment	Glazing Status
1	LF & RF ATDs, DGL, Windshield & RD	505 deg/s	10.5 (Not Known Until Test = ATD	Passenger Ejected through Empty Window Opening	Undamaged at initiation of testing & did not fracture during testing
2	RF ATD, PGL, Windshield, RD Divider	556 deg/s	20	Migrated to roof, Fully contained	Undamaged at initiation of testing & did not fracture during testing
3	RF ATD, PGL, Windshield, RD Divider	601 deg/s	36	Placed against door glazing, Fully contained	Undamaged at initiation of testing & did not fracture during testing
4	RF ATD, PGL, Windshield, RD Divider	606 deg/s	40	Placed against door glazing, Fully contained	Fractured, minimal propagation and minimal deformation during testing
5	LF ATD, DGL, Windshield, RD Divider	644 deg/s	40	Placed against door glazing, Fully contained	Undamaged at initiation of testing & did not fracture during testing
6	LF ATD, DGL, Windshield, RD Divider	645 deg/s	42	Placed against door glazing, Fully contained	Fractured, cracked with slight propagation of cracks during testing
7	LF ATD, DGL, Windshield, RD Divider	642 deg/s	42	Placed against door glazing, Fully contained	Fractured, cracked with slight propagation of cracks during testing

No separation of the laminated glazing from the door window surround was noted as the ATDs migrated through the test fixture during the roll event. The undamaged as well as the fractured laminated door glazing was found to retain the ATDs with no ejection through this portal with no additional glazing fracture or minimal propagation of glazing cracks.

Rollover, Laminated Glazing, Containment

C34 Increased Risk of Submarining and Lower Extremity Injuries Associated With Obesity in Frontal Impacts

Christopher J. Furbish, BSc, Biodynamics Engineering, Inc., 3720 East La Salle Street, Phoenix, AZ 85040; Parris Ward, JD, Biodynamics Engineering, Inc., 17383 West Sunset Boulevard, Suite A300, Pacific Palisades, CA 90272; and Hrire Der Avanessian, PhD, Biodynamics Engineering, Inc., 2831 Montrose Avenue #5, La Crescenta, CA 91214*

After attending this presentation, attendees will be familiar with various risk factors associated with restraint effectiveness relative to body mass index (BMI), primarily for lower extremity injuries in frontal impacts.

This presentation will impact the forensic science community by aiding in better understanding occupant kinematics and restraint effectiveness during frontal impacts.

Between 1960 and 2004, the CDC reports that the obesity rate in the United States more than doubled from 13.3 to 32.1 percent for adults aged 20 to 74. Should the current trend continue to the year 2015, some models predict that the obesity rate will reach 41 percent, with as many as 75 percent of U.S. adults being overweight. After attending this presentation, attendees will be familiar with various risk factors associated with restraint effectiveness relative to body mass index (BMI). Multiple volunteers of various body sizes were placed in the driver's seat of a 2003 SUV and measurements of the seat belt and body-to-vehicle interior distances were recorded. These measurements revealed trends indicating an increased risk for submarining and lower extremity injuries for occupants with higher BMI ratings involved in a frontal impact.

Previous studies addressing obesity and injury severity for various body regions and crash conditions have revealed some contradicting conclusions. For example, a 2003 study found that the overweight occupant has a decreased risk of abdominal injury compared to both lean and obese occupants. However, a 2008 study concluded that overweight occupants (but not obese occupants) are at risk of suffering more severe injuries than an occupant with a normal BMI. The majority of these studies were based on statistical epidemiological analyses of data reported in various databases, such as CIREN, NASS-CDS, etc. This study addresses the expected kinematics of occupants with various BMI ratings based on the seat and restraint geometries, while keeping the vehicle and assumed impact configuration constant. Based on these expected kinematic differences, the potential injury patterns and risks were determined.

The male and female adult volunteers used in this study were of various ages with BMI's ranging from 20 to 45. A BMI greater than or equal to 30 is generally considered to be obese. Each volunteer was placed in the driver's seat of the SUV and asked to adjust the seat fore/aft position and seat back recline angle into the most comfortable driving position. Multiple measurements of the lap belt were taken relative to the left and right anterior superior iliac spine (ASIS) locations of the pelvis. Knee-to-dash, abdomen-to-steering wheel, and sternum-to-steering wheel distances were recorded. Additionally, the positioning of the seat bottom, seat back, and lap belt relative to the occupant compartment were documented.

Based on the recorded data, various trends were found as a function of BMI. As BMI increased, the average seat back angle relative to horizontal decreased. In other words, the higher the BMI the more likely the occupant would ride in a more reclined position. The distances in the longitudinal (x-axis) and vertical (z-axis) directions between the ASIS and the most forward portion of the lap belt both increased as BMI increased. Additionally, the length of the lap belt from the floor anchor to the latch plate increased with an increase in BMI. The data presented demonstrates how these trends predispose an occupant with a higher BMI to greater risk of lower extremity injuries and/or submarining injuries. For occupants of higher BMI, the longer lap belt length and its increased distance from the bony pelvis due to additional soft tissue would allow for a greater amount of lower extremity forward excursion during a frontal impact. The more reclined seat back position, as well as the increased height of the forward-most portion of the lap belt, would place a high-BMI occupant at greater risk of submarining as the direction of force from the lap belt shifts up toward the abdominal structures with a higher probability of overriding the pelvis. Additionally, vehicles equipped with load-limiting energy activating webbing loops in the lap belt further increase the likelihood of submarining and resultant lower extremity injury.

Mathematical dynamic models (MADYMO) simulations were conducted to demonstrate some of the expected differences between the occupant kinematics for occupants in the normal, overweight, and obese BMI ranges. Additionally, a real world case study with an occupant sustaining both lower extremity and submarining injuries was analyzed to demonstrate the potential outcome of these risk factors.

Body Mass Index (BMI), Restraint Effectiveness, MADYMO

C35 Assessment of Extended Range Electronic Projectile Impact Injury Potential Using Cadaveric Testing

Scott R. Lucas, PhD, Exponent, 3401 Market Street, Philadelphia, PA 19064*

After attending this presentation, attendees will be familiar with a recent human cadaveric test series that was executed to assess the impact injury potential of the newly designed XREP (eXtended Range Electronic Projectile).

This presentation will impact the forensic science community by providing an assessment of human impact injury potential from a shotgun round with an electronic charge. The results from this study are useful in assessing the effects of the XREP impact velocity on human tissue and in identifying superficial wounds as a result of XREP deployment.

The XREP was designed as a wireless electronic neuromuscular incapacitation (NMI) electronic control device (ECD) self contained within the XREP projectile. Utilizing NMI, it is intended to neutralize a threat up to 100 feet away as it is deployed from a 12-gauge shotgun. It is not intended to produce significant impact injuries such as significant blunt trauma or for the cartridge to penetrate the skin. As with any kinetic energy munition, design variables such as mass, velocity, and impact cross-sectional area must be considered to reasonably minimize potential penetrating or blunt impact injuries. During the design process, extensive experimentation is necessary to minimize unintended injuries. This paper presents the results from a recent evaluation of blunt trauma and penetration potential of the XREP design via a series of human torso cadaveric tests.

Two male cadaver torsos were obtained. The torsos were frozen postmortem, were not chemically preserved, and were completely thawed prior to usage. The stature and mass of the two cadavers were 68 inches and 165 pounds and 72 inches and 165 pounds. A nitrogen powered air cannon was used to fire the XREP rounds throughout the study. This air cannon consisted of a pressure regulator and gas reservoir arranged to propel the experimental device through either a smooth-bore or rifled-bore shotgun barrel. A range of cannon firing pressures and corresponding pre-impact velocities were utilized. These values were designed to replicate velocities that would be obtained by firing the XREP with a conventional shotgun. A total of 43 shots impacted the torsos, including 12 shots on the posterior aspect of Torso 1, 14 shots on the anterior aspect of Torso 1, and 17 shots on the anterior aspect of Torso 2. Impact areas included the ribs and abdomen. Two tests were fired at a range of 15 feet and all of the other tests were fired at 1.5 feet. Pre and post-test photographs were taken and high-speed video was recorded at locations orthogonal to and oblique to the impact location. Pre and post-test magnetic resonance imaging (MRI) and computerized tomography (CT) images were obtained. Post-test internal examinations were performed by dissection.

The measured and calculated XREP pre-impact velocities from the test series ranged from 230 to 315 feet-per-second (fps). The majority of the shots fired were at a cannon pressure of 300 pounds-per-square inch (psi) and resulted in pre-impact velocities averaging 251 ± 6 fps (ranging from 244 to 257 fps) for the rifled barrel and 265 ± 11 fps (ranging from 234 to 280 fps) for the smooth barrel. In 42 of the 43 shots fired, the XREP impacted the torso and its nose section did not penetrate the skin, resulting in superficial wounds only. Internal examination of these 42 shots revealed that the XREP barbed electrode tips penetrated through the skin layer and into the superficial fat. At most, the XREP electrodes

penetrated through the skin and fat and punctured superficial muscle tissue as there was no evidence of penetration through the peritoneum on the deep surface of the muscle layer. On the remaining shot it was observed that the nose section of the XREP separated prematurely in flight which then exposed the smaller diameter chassis to impact with the torso. That shot in particular was fired at the closest range at the highest cannon pressure, and was directed to a relatively fatty portion of the abdomen lateral to the umbilicus. It penetrated the abdominal wall and lodged inside the torso. Separation of the nose section had been previously noted to occur in air cannon firings but not in shotgun firings. In the study, no rib fractures or other bony fractures were observed with any of the shots. When the XREP remained intact to point of contact, there was no evidence of blunt impact trauma or electrode penetration through the abdominal, thoracic or the retroperitoneal wall based upon external observation, imaging, and internal examination.

Blunt Impact, Kinetic Energy Munitions, Human Injury

C36 The Effect of Restraint Use on Skull Vault Fractures in Rollover Crashes

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After attending this presentation, attendees will understand the relationship between roof crush, restraint use, and risk of skull vault fracture in rollover crashes.

This presentation will impact the forensic science community by discussing the belief that this analysis is the first population-based study to evaluate a specific injury type (skull vault fracture) and associate it with a specific injury mechanism (contact with a crushed roof) in rollover crashes. These research findings lead to a rejection of the crash test dummy-based "diving" theory as the primary cause of head injury in rollover collisions with roof crush.

Introduction: Skull vault fractures (SVF) are a serious complication of rollover crashes and there is a question as to whether they result from roof crush or "diving" kinematics of the occupant toward the roof. Based on the effect of three point restraints in limiting occupant movement in rollovers we hypothesized that progressively greater crush would result in a relatively greater increase in the rate of skull vault fractures in unbelted occupants if diving was the mechanism, and a greater increase in belted occupants if roof crush was the injury mechanism.

Methods: A search was conducted of the National Automotive Sampling System-Crashworthiness Data System (NASS-CDS) of the United States National Highway Traffic Safety Administration (NHTSA) for the years 1997 through 2005, inclusive (9 years total) for rollover crashes with at least two one quarter turns and in which an occupant sustained a head or neck injury of some degree as a result of roof, windshield headliner, or side rail contact (as opposed to ejection). A case was only included for analysis if the degree of roof, windshield headliner, or side rail intrusion at the position of the occupant was recorded and correlated to the head injury, as well as the restraint use status of the occupant. Both raw and weighted counts of injuries as well as occupants were recorded by NASS injury code, and also the number of occupants with head and neck injuries by injury severity rank was recorded. The ratio of skull vault fractures versus other injuries by roof crush severity was calculated for restrained and unrestrained occupants and tabulated.

Results: A total of 2,120 injuries were recorded in the NASS given the above parameters for 558 restrained occupants (330,056 weighted), and 1,261 injuries were recorded for 288 unrestrained occupants (143,389 weighted).

Although belt use decreased the rate of serious head injury among restrained occupants relative to unbelted occupants in all crashes except those with >61 cm of roof crush, the efficacy of seatbelts was inversely related to the degree of intrusion (see Figure 1). At 3-8 cm of roof crush belted occupants sustained a reduction of serious or greater head injuries of 45%, at 8-15 cm serious injury was reduced 40%, at 15-30 cm serious injury was only reduced 23%, and at 30-46 cm and 46-61 cm serious injury was reduced 15% in each category in belted vs. unbelted occupants.

A risk ratio assessment of the effect of belt use vs. roof crush was performed. Among restrained occupants SVF comprised 11.9% of serious and greater (AIS≥3) head/neck injuries (6.4% of all head/neck injuries), and thus only 0.8% of all injuries at the lowest level of roof crush (3-8 cm). At 8-15 cm of crush the risk was 1.9 times the lowest level, at 15-30 cm it was 2.5 times greater, at 30-46 cm of crush the risk it was 3.5 times greater, at 46-61 cm of crush it was 8.4 times greater, and at more than 61 cm the risk was 6.6 times greater. Among unrestrained occupants at the lowest level of roof crush SVF accounted for 20.6% of all AIS≥3 injuries (10.9% of all injuries in this category were serious), and thus 2.2% of all injuries. Risk ratios, relative to the lowest level, were as follows: 8-15 cm, 0.7; 15-30 cm, 0.9; 30-46 cm, 1; 46-61 cm, 1.8; and at >61 cm, 1.6.

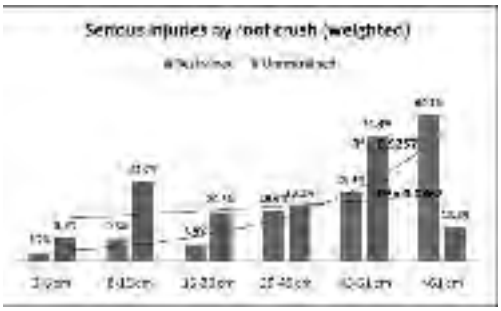

Figure 1

Discussion: At the lowest levels of roof crush SVF occurred 175% more often in unrestrained occupants. In contrast, SVF occurred 22%, 68%, and 47% more often among restrained occupants in rollover crashes with 30-46, 46-61, and more than 61 cm of crush, respectively. The explanation for this finding is that SVF results from sudden forceful loading associated with the higher head accelerations resulting from increased roof crush, and a relatively less mobile restrained occupant is more likely sustain a head impact from a collapsing roof, relative to an unrestrained occupant. Additionally, higher speed rollovers are theoretically more likely to result more violent occupant kinematics, leading to a higher probability of displacement of unbelted occupants in rollovers away from a crushing roof, and thus the observed relatively lower frequency of SVF. This finding is the opposite of what would be expected if the injury mechanism was diving.

Conclusions: As a general rule the use of passive restraints reduces injury frequency, although are specific exceptions to this rule. We have identified one of these exceptions; skull vault fracture risk in rollover crashes with 30 cm or more of roof crush. Increased roof strength would likely reduce the frequency of these injuries.

Skull, Vault, Fracture

C37 Using CT Scans to Identify the Mechanism for Left-Sided Skull Fracture From a Right-Sided Broadside Collision

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The goal of this presentation is to introduce the three-dimensional and scaled information contained within CT scans, and demonstrate how this information can be used to identify the mechanism of injury.

This presentation will impact the forensic science community by showing how the three-dimensional and scaled information contained within CT scans, can be used to identify an injury mechanism.

CT scans provide three-dimensional information of injury patterns skeletal system, which can be used to narrow down or even define the injury mechanism. The use of CT scan images to determine the mechanism of a left sided-skull fracture in a right-sided broad-side collision is presented.

Figure 1, Rear Wheel Area Damage After Partial Repairs

The sedan pictured above sustained a right-sided broadside collision centered about the right rear wheel. Using the vehicle damage and post-impact vehicle motion, the lateral Delta V was estimated to be within the approximate 10 to 12 mph range.

The collision pushed the vehicle side-ways and rotated it clock-wise, as viewed from above. The driver initially continued at the pre-impact speed and direction, as per Newton's laws. As such, relative to the vehicle interior, the driver moved rightward until striking structures to their right and/or until sufficient force supplied by their restraints to limit this relative motion.

With right-sided occupant strikes, the mechanism for injuries from right-sided blunt trauma is clear. However, as shown in figure 2, the driver sustained a left-sided skull fracture. The narrow punch-out type appearance of the fracture confirms that it was caused by forceful contact with a narrow object that was partially penetrated the skull.

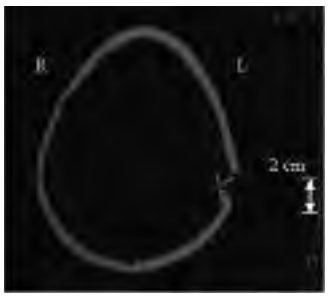

Figure 2, CT Image Showing Left Skull Fracture

Vehicle inspection revealed a lap and shoulder belt with a webbing sensitive emergency locking retractor, pass through latch plate, seat mounted buckles, and an adjustable D-ring. Scratching on the latch plate consistent with habitual seat belt use was found. Seat belt abrasions on the outboard side of the seat back hinge cover and loading marks on the latch plate confirmed seat belt use during the collision.

Placing the driver in the vehicle, it was noted that due to height, weight and seat position, the shoulder belt was not in contact with the left shoulder. This would contribute to the shoulder belt slipping off the driver's shoulder during the rightward body motions within the vehicle interior. Indeed, the driver described a memory of being face-to-face with the radio during the collision.

Figure 3, Driver Seated in Vehicle

Rebound from the seat belts as well as slowing from the vehicle's lateral motion and rotation evidently combined to produce sufficient leftward body motion within the vehicle immediately following the collision to produce left-sided occupant trauma. As shown in figure 3, this leftward body motion makes a left head to B-pillar strike possible.

Using the scale shown in figure 2, the object that caused the skull fracture was about ¾ inches or 2 cm wide. As shown in figures 3 and 4, the knob for the adjustable D-ring was not only aligned with the fracture site, but it was also about ¾ inches wide.

Figure 4, Width of D-Ring Adjustment Knob

With this evidence it can only be concluded that the driver sustained a left-sided skull fracture from strking the D-ring adjustment knob during leftward rebound-type motions immediately following the right-sided broadside collision.

The three-dimensional scaled information contained in the CT scan images made this type of lock-and-key identification of the injury mechanism possible.

CT Scan, Skull Fracture, Injury Mechanism

C38 Head Injuries in Lower Speed Collinear Collisions: An Analysis of the National Automotive Sampling System Database

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After attending this presentation, attendees can expect to learn about the types and severity of head injuries that may occur in low speed

front and rear impact collisions. This information will be beneficial in assessing claims of injury or head impact in such collision.

This presentation will impact the forensic science community by describing how delta V corresponds with head injury in lower speed collisions, and demonstrates a lack of a lower threshold for injuries such as concussions and other closed head injuries.

Introduction: Occupants with head injuries following lower speed frontal or rear collisions will occasionally claim to have struck their head on a steering wheel or even windshield despite the use of a restraint. The claims defy common clinical and biomechanical experience and are thus sometimes doubted. The goal was to evaluate the potential validity of such claims by searching the NASS for cases of head injury associated with lower speed collinear collisions.

Methods: Individual counts and weighted data were obtained from the NASS-CDS for the years 1997-2007 for all collinear crashes in which there was a single front, single rear, or rear and then front impact collision with a delta V of 20 mph or less and in which a head injury was coded. A collinear impact was considered to be one with a principle direction of force making an angle of 15 degrees or less with the long axis of the vehicle. Rollovers and ejections were excluded from the analysis. Parameters evaluated were injury type and severity, delta V, restraint use, airbag deployment, and injury contact source.

The National Automotive Sampling System-Crashworthiness Data System database for the years 1997-2007 inclusive was queried per the parameters described above. The Crashworthiness Data System (CDS) collects detailed information on an annual sample of approximately 5,000 Police Accident Reports involving at least one towed vehicle, and includes cars, vans, or trucks with less than 10,000 pounds GVWR. The NASS reports both raw data counts and weighted counts, with the latter intended to indicate the likely number of real world cases represented by each NASS case.

Results: The query yielded 947 injuries among 711 occupants, and a weighted value of 365,732 crashes. There were 787 frontal crashes ranging from 5-20 mph in delta V, 166 rear impact collisions ranging from 7-20 mph delta V, and 75 rear-front impact collisions at 7-20 mph delta V. There were three injury groups; superficial (scalp) injuries (488), brain concussion (348 injuries), and AIS≥3 injuries (127). Seatbelt presence played the largest role in AIS≥3 frontal collisions (24.4% of injuries in belted occupants versus 47.9% and 45.3% of concussion and scalp injuries, respectively). In contrast, most injuries seen in the rear impact collisions occurred in belted occupants (75.8, 80.8, and 100% of scalp, concussion, and AIS≥3 injuries, respectively). Airbag deployment was indirectly related to injury severity in frontal collisions; 41.6% of scalp injuries involved an airbag deployment, whereas 36.6% of concussions and 31.2% of AIS ≥3 injuries occurred in crashes with an airbag deployment (See Table 1).

Among the frontal crash concussion cases with three point seatbelt use 15 of the injuries occurred without head contact, 21 resulted from a strike against the steering wheel rim, six involved a head strike to the windshield, and two struck the roof and A-pillar each. Average speed change was the same among belted and unbelted occupants; 14 mph. A concussion occurred in one restrained occupant at 5 mph.

In the rear impact concussion cases there were an equal number of head restraint/seat contact and no head contact injuries. Five of the concussions resulted from rebound movement and contact with the steering wheel or mirror despite the use of a three point seat belt.

In the frontal crash AIS≥3 cases there were 28 skull fractures, 11 in belted occupants. The injuries resulted from contact with a variety of frontal structures. A skull fracture occurred at 7 mph in an unrestrained occupant. There were 4 AIS≥3 injuries resulting from a rear impact collision, all in restrained occupants.

Discussion: It is apparent that head injuries such as concussion, intracranial bleeding, and even skull fracture can and do occur in restrained occupants in lower speed rear and frontal collisions, including those with speed changes below 10 mph. Because of the bias of the NASS-CDS toward more severe collisions it is difficult to estimate a lower threshold for any of these injuries, even skull fractures. The fact that a fracture was observed at 7 mph in the NASS's higher crash severity-biased sample suggests that in the general population of real-world crashes such injuries may occur at even lower speeds. It is concluded from this, inter alia, that there is a small but real possibility that a restrained occupant can strike the windshield in a <10 mph delta V frontal collision, or that a rear impact collision of can cause a belted occupant to rebound and to strike the steering wheel and sustain a concussion.

It is likely that the lack of non-tow away crashes in the NASS had the effect of greatly understating the number of concussion associated with rear impact collisions. Since more than half of the concussions were attributed to either no head contact or contact with a head restraint and occurred at speed changes as low as 7 mph it is reasonable to infer similar injury mechanisms at lower speed changes.

Conclusions: These results may be some of the first to indicate significant head injuries can and do occur in lower speed frontal and rear impact collisions, with and without head contact, regardless of restraint use.

1. All but 2 of the scalp injuries were AIS 1 severity, which consisted of contusions, abrasions, and lacerations.
2. Concussion was accompanied by loss of consciousness in 84.8% of frontal impacts, 7.7% of rear impacts, and 52.6% of rear-front collisions.
3. Delta V for the rear-front collisions is the total for both rear and frontal impact.

Lower Speed, Collinear, Collisions

C39 Solar Heat Buildup in a Parked Automobile

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After attending this presentation, attendees will understand how temperature rises inside an automobile parked in the sun.

This presentation will impact the forensic science community by providing data on temperature inside a parked vehicle. This information is related to hyperthermia and material properties.

The temperature inside a parked vehicle can rise dramatically, when parked in the direct sun. This can play a role on both the comfort and safety of occupants. Children, elderly, those taking certain medications and pets are particularly vulnerable to heat related sickness or even death. Hyperthermia or increased core body temperature leads to heat stroke. In humans, it is life-threatening when the core body temperature rises above 40°C (104°F) and brain death begins above 41°C (106°F).

The elevated temperature can also affect the material properties of components in the vehicle. In particular, the strength properties of plastic materials are temperature dependent. This is true of structures like the plastic layer sandwiched between the glass layers in laminated safety glass. To be valid, demonstrations, including rollover testing to evaluate the performance of laminated safety glass must take this temperature into account.

A vehicle was tested in Arizona, in direct sun, when the ambient temperature was a peak of 93°F. The vehicle was facing northwest on a Portland cement pad. The testing was conducted within five miles of the National Weather Station at Sky Harbor International airport. Hourly official temperatures were compared with measured ambient temperatures.

Measurements were taken for approximately four hours starting at 10:45 a.m. on May 22, 2007. Measurements were taken on the surface of the windows, interior of the vehicle and externally.

The temperature sensors consisted of six National Semiconductor Corporation's LM35 Precision Centigrade Temperature Sensors. A handheld Cen-Tech Non-Contact Thermometer (model 91778) was used to take temperature measurements on the exterior of the windows. The six sensors were located in the following locations:

1. Interior to the vehicle, on the driver's side, 10 inches from the interior roof and centered on the visor;
2. Same as 1 except on the passenger side;
3. Between the glass and gasket on the upper rear corner of the driver's door window;
4. Same as 3 except on the passenger side front door;
5. On a tripod near the vehicle in the direct sun;
6. Attached to the front bumper. Initially in the shade and was moved at 2:00 because it was no longer in shade of vehicle;

The temperature from these sensors was measured continuously in one hour blocks. The surface temperature of the gasket around the driver's door window and passenger's door window was measured every fifteen minutes at the center top, center rear and center bottom with the hand held sensor.

The interior air temperature started out 100°F and reached 130°F after the first hour. The temperature continuously climbed till it reached a temperature in the 140 to 145°F range.

The temperature between the glass and gasket for the sunny side reached a maximum of approximately 165°F.

The hand held sensor roughly followed the measurements made by the sensors between the glass and gasket.

The high temperature of 93°F was reported at the airport at 2:00 p.m. The temperature at 1:00 and 3:00 was 88 and 90 deg. F.

In summary, on a day that the ambient temperature is 93°F., the interior air temperature will reach over 140°F, which poses a serious health risk for any occupants and the glass temperature can reach 165°F which can have an adverse affect on the material properties of laminated safety glass.

Car Temperature, Car Heat Soak, Solar Car Heating

C40 Investigation of Illumination State of High-Intensity Discharge Automotive Headlamps

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The goal of this presentation is to establish methodology in determination of illumination state of high-intensity discharge (HID) automotive headlamps.

This presentation will impact the forensic science community by demonstrating the microstructural and chemical condition of lamp fragments after hot and cold fracture.

The forensic examination of tungsten filament headlamps has proven to be very useful for determination of fault and cause of car accidents and has been widely covered in the literature. Automobile manufacturers and customizers have been increasingly moving toward HID headlamps, especially in higher-end automobiles. Analytical techniques such as Scanning Electron Microscopy/Energy Dispersive Spectroscopy (SEM/EDS) and Auger Electron Spectroscopy (AES) have been utilized to determine microstructural condition, elemental composition and degree of oxidation of the tungsten. However, HID lamps have a structure and mixture of compounds completely different from conventional bulbs. While the same analytical techniques can be applied to analysis of the HID lamps, a new interpretation will be necessary due to the potential presence of halide gases and rare earth elements and potential changes in compositional ratios. Forensic analysis of tungsten filament lamps does not apply to analysis of HID lamps due to their vastly different construction and mode of operation. As the popularity of this type of lamp increases, it becomes important to develop suitable methods of forensic evidence collection and analysis. One important issue concerning fracture of HID lamps is the high internal pressure (3 atmospheres in the off [cold] state). In the on state, the temperature of the quartz tube reaches temperatures around 1,000C, raising the internal pressure of the lamp to 30 atmospheres. Clearly, fracture of the lamp in either condition presents evidence collection issues with severe fragmentation of the quartz envelope. Fractured at high temperature, the remnants of the quartz envelope may be anticipated to have differences in structure and residual chemical traces.

A method for controlled fracture and fragment collection was developed. A custom jig was fabricated for safe fracture of the lamps in both off and on state. It was found possible to collect quartz fragments and identify the internal surface of the tube. Analysis of the cold-fractured quartz shards showed the presence of residual halides (bromides and iodides) rare earths (neodymium and dysprosium), as well as cesium and mercury. In the hot fracture condition, the absence of mercury was noted. This may have been anticipated, as this element was the most volatile of those present, and was expected to be the most completely vaporized during operation. Notably the other elements were present as surface deposits on the interior of the quartz, presumably in the form of complex compounds in both the cold and hot condition. The tungsten electrodes that provide the required voltage and current to create and maintain the plasma become red-hot during operation. Despite the temperature at the time of fracture, it was observed that there was very little oxidation of the tungsten, presumably because unlike with a conventional lamp, current is immediately interrupted upon fracture.

The nature and construction of HID lamps presented challenges in distinguishing whether the lamp was on or off at the time of fracture. Although it was possible under controlled circumstances to demonstrate a difference in mercury concentration, experience gained in this study illustrated the difficulties that may be encountered in the field in terms of illumination state and evidence collection.

Automotive, Headlamp, Failure Analysis

C41 Human Injuries Accompanying Collisions With Wood Plank Fences

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After attending this presentation, attendees will understand how automobile or light truck collisions with wood plank fences can result in human injury due to passenger compartment plank penetration. This hazard is largely unappreciated due to its sporadic publication in isolated case reports. The present study shows that such collisions, even those recorded during a limited time and area, are more prevalent than suspected and that the associated human injuries appear "binary" in severity.

This presentation will impact the forensic science community by discussing how the study of vehicle collisions with roadway signs and guard rails have led to new designs and materials that have reduced motorist injuries, but wood plank fences have not been considered. The

present study offers new information regarding the incidence of motor vehicle – wood plank fence collisions as well as the type and severity of human injuries that can occur. The goal of this presentation is to raise awareness of the hazards posed by roadway adjacent wooden plank fences and motivate additional studies that will result in fence redesign, altered placement, or use of new materials to mitigate injury risk to errant motorists.

Wooden plan fences are commonly used to delimit real estate or constrain the movement of large animals. These fences are typically constructed of three or four horizontally placed oak or hickory boards (~2" thick, 4" – 6" wide, 6' – 16' long) nailed to intermittently spaced (6'-16') vertical round wooden posts (~6" diameter, ~8' long, ~4' of which are underground). Isolated sporadic reports exist of injuries to errant motorists who strike these fences at an acute angle, but this hazard is largely unrecognized. Similarly, the frequency and type of injuries suffered by these motorists are also not well known. The purpose of this study was to quantify the frequency and severity of injuries to motorists due to this mechanism that were observed during more than a decade at a single location.

The databases of a major University Level I Trauma Center and the County Coroner were retrospectively analyzed over the period 1995-2007. This study was IRB approved. Hospital charts, operative reports, and charges were abstracted retrospectively to confirm fence contact, injury data, subject demographics, and hospital costs. Motorcycle collisions were excluded. Mean values were compared by using Student's t-test; correlation was analyzed by using regression techniques.

One hundred and twenty eight subjects were involved in 127 acute-angle collisions of automobiles or light trucks with wooden plank fences during this period. Of these 128 subjects, 123 were evaluated at this Trauma Center and of these, 35 (27%) had a documented wood fence plank-patient interaction (PPI). Mean subject age was 32.8 years. Males (30 of the 35) were more frequently (86%) represented and 91% of these 35 subjects were in the driver's seat at the time of injury. Fourteen of the 35 (40%) died from injuries related to PPI. Blunt injury predominated over penetrating injury; only one subject had a mortal penetrating head injury from PPI. Survivors of PPI had a lower (p=0.05) Injury Severity Score (14.5 vs. 27) than nonsurvivors. Restraint data were available for 87 of the 128; 48.5% were restrained. No correlation was detected between restraint status and level of injury or mortality**.**

Two-thirds (64%) of the impacts occurred on the subject's right side. The most common body region of plank contact was the head (13/14, 93%) and as expected, brain injury was the most common cause of death in that group. The upper torso (chest and shoulder) was the next most common region of injury; PPI was associated with significant soft tissue, bone and vascular injuries as well as tissue loss. PPI involving the upper extremity was also associated with neurovascular compromise and these injuries required extensive operative intervention for salvage or repair. Near complete amputation of the involved extremity after plank contact was not uncommon. Neck injuries were uncommon but when present, they were associated with significant vascular and soft tissue injury. A single penetrating abdominal injury (fatal) occurred in this group of 35 subjects.

Total mean hospital incurred costs for 13 of the 35 PPI related injuries were $50,530 for those requiring surgery (n=6) and $34,256 for those not requiring surgery (n=7). The latter value was skewed because 4 of the 7 subjects expired shortly after arrival at the hospital.

This study adds new data underscoring the frequency of this injury mechanism and suggests that injuries to motorists who collide with wooden plank fences at acute angles are binary in severity; either none/minor or major/fatal. This conclusion is based upon a limited time and region sample; the national extent of this problem is unknown due to the lack of standardized databases linking this specific mechanism. Engineering initiatives to mitigate injuries associated with PPI are complicated by the absence of wood plank fence construction standards and the lack of information regarding the mechanism by which wooden planks enter the passenger compartment of roadway errant automobiles and light trucks.

Additional studies are needed to quantify the extent of the problem nationally, understand the mechanism of vehicle penetration by wood planks, increase public awareness of the hazards attending collisions with these fences at acute angles, and develop injury-mitigating fence construction strategies or new frangible material alternatives.

Human Injury, Collision, Wood Fence

C42 Trajectory Analysis Applied to Snowboard Terrain Park Crash Investigation

Seth W. Bayer, BS, Ponderosa Associates, Ltd., 130 Miners Drive, Lafayette, CO 80026*

After attending this presentation, attendees will understand some principles of trajectory path as a function of inrun (take off ramp) angles, out run (landing ramp), and initial speed for a snowboard terrain park jump features.

This presentation will impact the forensic science community by providing a clear analytical model which can be used to calculate the take off speed of a user of a ski jump based on measurements of the snow surface take-off angle, snow surface landing angle, and the distance the user was not in contact with the snow surface.

This presentation will also show how it is possible to calculate the initial speed of a snowboarder based on the takeoff angle, landing angle, and total airborne distance as measured through the distance on the snow surface between the take off point and the appearance of ski tracks on the outrun snow surface where the jumper landed. The length of the gap between take off point and landing point is easily measured along the snow surface. Take off angle and landing ramp angle are easily measured using a digital level. Using the three parameters of take off angle, landing slope angle and the distance the skis are not in contact with the snow it is possible to calculate the path of the trajectory including the maximum height above the snow as well as the vector velocity components at landing and the time period of the jump. Understanding the velocity of the jumper at the landing area is a fundamental aspect of creating good jump design

In regard to the investigation and reconstruction of terrain park accidents it will be shown how the initial speed of the user can be calculated based on the physical parameters of the jump and the distance of the jump.

This presentation will provide a simple analytical tool that could be used by the designers of snowboard terrain parks as an aid in designing jump features so that the in-run speeds and angles are coordinated with the landing ramp so that for expected take-off speed ranges the users of the features will not "overshoot" the landing ramp.

The author will present a case study in which a terrain park feature in-run was modified following reports of users (snowboarders) overshooting the landing, due to excessive speed at take off. Instead of modifying the in-run to control the take off speed of the jumpers, the park designers decided to increase the steepness of the take off ramp. The intent was to increase vertical projection of the jumpers and reduce the horizontal projection down the hill.

The modifications resulted in a greater horizontal projection and "overshooting" of the landing ramp by the users-not what was intended. Also, increasing the steepness of the take off ramp created more counter rotation (as in back flip) to the user. The problem with overshooting the landing area is that the user then lands on a "flatter" part of the ski hill which results in a harder landing. The injured user had used the jump the day before the modifications without incident. The jump take off angle was modified during the evening hours when the terrain park was closed. During first use of the jump the next day the snowboarder rotated

rearward approximately 180 degrees in the air and overshot the landing ramp landed on his head.

The ramifications of the trajectory of the jump modifications will be shown to be contrary to what the jump modification was intended to show.

Trajectory, Snowboard, Jump

C43 Forensic Evidence on Highway Hardware in Accident Reconstruction and Analysis

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After attending this presentation, attendees will understand the design and performance criteria by which highway hardware is designed. A background on Federal Highway Crash Testing will be presented, as well as how to use these tests in accident reconstruction.

This presentation will impact the forensic science community by examining forensic evidence found on highway hardware after motor vehicle impacts. Currently, the performance of highway hardware is often ignored or misinterpreted during an accident reconstruction.

According to the Fatality Analysis Reporting System (FARS), roadway departure crashes account for 53 percent of all fatal crashes in the United States. A roadway departure crash is defined as a non-intersection crash in which a vehicle leaves the traveled roadway. Highway hardware, such as longitudinal barriers, crash cushions, luminaire, and sign supports, are installed along roadways to help mitigate the dangers of these roadway departures.

This presentation examines forensic evidence found on highway hardware after motor vehicle impacts. Currently, the performance of highway hardware is often ignored or misinterpreted during an accident reconstruction. After attending this presentation, attendees will understand the design and performance criteria by which highway hardware is designed. A background on Federal Highway Crash Testing will be presented, as well as how to use these tests in accident reconstruction

The American Association of State Highway Transportation Organization (AASHTO) Manual on Uniform Traffic Control Devices dictates the dimensions and hardware requirements of highway hardware, while the National Co-operative Highway Research Project (NCHRP) 350 dictates the crash test requirements that highway hardware must meet. NCHRP 350 requires testing by different sized vehicles and at various speeds and impact angles. The exit angle of the impacting vehicle must be less than 60 percent of the entrance angle. The hypothetical occupant's impact velocity should be below 12 meters per second and their ride down acceleration must remain under 20 g's.

Many accident reconstructionists rely upon National Highway Traffic Safety Administration (NHTSA) crash tests, but are unaware that the Federal Highway Administration (FHA) requires crash tests of their highway hardware and that the results of these tests are publicly available in a test database, which is a useful resource. This presentation will demonstrate how to apply these crash test results as an accident reconstruction tool. Understanding the damage caused to both the impacting vehicle and the highway hardware itself at varying speeds and impact angles can help the reconstructionist in the analysis of their case accidents.

An examination of several cases studies will be presented. In one case, the investigating officer opined that the vehicle had become airborne as a result of an impact, spun around in the air and came to rest further down the road. Forensic evidence confirmed that the vehicle in fact contacted a bridge rail. In another case, the accident reconstructionist was able to determine the orientation of the vehicle as it passed through a cable barrier based on striations left by the cables as they contacted the vehicle. Another case study revealed that vehicle damage, originally attributed to contact with another vehicle, was actually caused by contact with a guardrail.

Highway Hardware, Contact Evidence, Roadway Departures

D1 The Society of Medicolegal Death Investigators (SOMDI)

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The goal of this presentation is to review the history of the medicolegal death investigator profession, to introduce medicolegal death investigators and forensic scientists to the Society of Medicolegal Death Investigators (SOMDI), and to explain why SOMDI has been formed, its goals and objectives.

This presentation will impact the forensic science community by discussing why/how the Society of Medicolegal Death Investigators was created to provide medicolegal death investigators with a professional membership organization to assist in their training, education and professional development.

Medicolegal death investigators are lay individuals employed by medical examiner, coroner offices, and private organizations to investigate violent, suspicious, and sudden unexpected deaths. There are more than 3,100 counties within the United States; each jurisdiction requiring some type of death investigation system. It is a conservative estimate that there are more than 8,000 people currently serving as death investigators in these medicolegal jurisdictions.

Medical examiner and coroner offices in the United States first began employing lay medicolegal death investigators (MLDI) in the late 1960s. This occurred as medical examiner and coroner offices recognized the need for independent death investigations to be conducted by their staffs. These investigators are responsible for representing the medical examiner or coroner at the death scene. They take charge of the decedent's body and actualize the subject at the scene of death. They develop pertinent scene-related information. They are responsible for ensuring that the subject is conveyed from the scene to the forensic office for examination and that a balanced death investigation is performed with local law enforcement authorities.

Investigators develop the decedent's demographic information and medical/social/occupational/criminal history. They establish the person's identity. They then are responsible for locating and notifying the decedent's next of kin. This need is magnified because few forensic pathologists conduct scene investigations due to time constraints.

After several years of effort by veteran medicolegal death investigators working on a Technical Working Group for Death Investigation; the National Institutes of Justice published the *National Guidelines for Death Investigation* in December 1997. Adopting those guidelines, the American Board of Medicolegal Death Investigators (ABMDI) was created in 1998 and began operation at Saint Louis University School of Medicine in St. Louis, Missouri. In 2005, the ABMDI was accredited by the Forensic Specialties Accreditation Board. Two levels of ABMDI certification now exist – the basic level (Registry) and advanced level (Board). Currently there are more than 1,000 ABMDI Registered and 150 Board certified medicolegal death investigators worldwide.

In February 2009, the National Academy of Sciences released their report, *Strengthening Forensic Science in the United States: A Path Forward*. The report emphasized the future needs for forensic practitioners: mandatory professional certification, development of practice standards and adequate training and continuing education opportunities.

In response to that report, a new professional organization, the Society Of Medicolegal Death Investigators (SOMDI), has been created specifically for the medicolegal death investigator forensic practitioner. SOMDI is expected to begin operations in early 2010. Its purpose is to promote medicolegal death investigators training, education, and encourage to ABMDI certification for its membership. SOMDI is expected to provide medicolegal death investigators with an association dedicated to their specific needs and encourage professional development and networking opportunities. SOMDI is expected to provide the membership a forum for exchange of information, ideas, and experiences. Standards for medicolegal death investigators will be discussed, formulated, and scrutinized for future adoption by the membership. A list serve and website will be developed to support membership-wide communications. In the future, SOMDI will conduct membership meetings in conjunction with other forensic organizations to foster collaborative projects.

This presentation will provide attendees updated information as to SOMDI's goals and objectives, membership criteria, and organizational applications.

Medicolegal Death Investigators, The Society of Medicolegal Death Investigators, SOMDI

D2 Experiment Design for Taphonomic Studies: Improving Research Designs, Data Acquisition, and Collaborative Research

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After attending this presentation, attendees will have learned ways to improve taphonomic experimental designs which will improve the science produced, increase data acquisition, decrease monetary expense, and increase collaboration between scientists practicing forensic anthropology, archaeology, and paleontology.

This presentation will impact the forensic science community by outlining a philosophy of research design that, if followed, will improve the scientific quality of taphonomic studies, and increase collaboration between scientists practicing different historical sciences. The collaborative philosophy combined with improvements to experimental design will yield quantifiable reproducible data making the interpretations derived more defensible and rigorous. In addition, collaborative research designs maximize data acquisition per monetary expense which improves both study resolution (discriminatory power) and efficiency.

Applied forensic sciences are, by their nature, historical sciences; observations are collected in the present and used to reconstruct the past. Analytically the fields of archaeology and paleontology perform an identical task; however, their data sets are collected in different ways. It is not surprising that there is an observational and experimental taphonomic literature in all three fields, which has largely developed independently of each other, though there has been a long and productive exchange between anthropology/archaeology and the forensic sciences.

Given that all three fields are interested in the same processes, albeit at different temporal scales, similar experiments and observational studies have been performed in each field. Forensic experiments typically focus on early stages of decay, while archaeological studies focus on longer durations of exposure into disarticulation.

Paleontological studies are often even longer in duration since the assemblages studied are frequently accumulations formed through thousands to hundreds of thousands of years. Consequently the studies performed by each group focus on different time frames which often only partially overlap. Needless time, resources, and money are spent performing experiments on only portions of the taphonomic history of a set of remains. If members from the three fields collaborated to perform one experiment from inception and experiment design to publication, all three fields would benefit from a coherent longitudinal data set. Rather than performing three experiments, one would suffice, and the results from different phases could be used by each principle investigator as per their research interests.

Although the three disciplines actively study taphonomy, there are only two general study types: observational and experimental. Observational studies provide essential initial data with which hypotheses can be erected. At present there is voluminous literature involving observations and experiments upon which one can erect hypotheses concerning most taphonomic processes. Consequently it is time for taphonomy to adopt hypothesis driven science utilizing the method of multiple working hypotheses. Not only does such a method yield results faster, but it also increases the chance that the results are correct, which is a problem for research designed to identify positive correlations between variables.

Studies should be designed with clearly defined and explicitly stated multiple hypotheses. The data required to falsify these hypotheses should be determined before the experiment is designed to direct data collection. This procedure will prevent the waste of both money and time in performing unsuccessful pilot studies. Each study should include a control and multiple treatment groups with specimens randomized into each group. Large sample sizes should be used, usually defined as greater than ~30, for each treatment since such large samples improve test resolution and power. Studies should be run for long periods, observing decay processes from death to bone weathering and breakdown. In addition replicates of each experiment should be performed to better constrain the variability within and between treatments and trials. Experiment samples should all have the same known history and future studies should utilize the same specimen histories and data collection techniques. This procedure would enable direct comparison between data collected in multiple experiments conducted by different investigators since the same protocols were followed. Analytically statistics should be used to quantify the variability and differences between treatments. Each investigator should learn which statistical tools are appropriate for each data set, and how to correctly apply them.

Lastly, previous research, including the initial "classic" studies, should be repeated and their conclusions tested. A fundamental tenant of science is the replication of research by other groups. Too frequently previous research is accepted uncritically, leading to further studies based on false conclusions since the original research was not subjected to falsification.

If these general guidelines are followed there will be a general increase in taphonomic information gathered for a lower cost and over a shorter time. Collaboration will improve experimental design, data analysis, and applications to the historical problems faced by each investigator. This will result in the field of taphonomy moving forward at a faster rate and improve the scientific quality of the research performed.

Taphonomy, Experiment, Design

D3 The New Adversarial System in Colombia: Difficulties and Challenges

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After attending this presentation, attendees will understand the current situation of the new adversarial system in Colombia and also its social, cultural, forensic, and legal impact during the last five years.

This presentation will impact the forensic science community by showing how the defense lawyer is at an enormous disadvantage in relation with the prosecutor, especially in the quality and facilities for forensic analysis and criminal investigation.

For almost 100 years, the Colombia criminal system was an inquisitive one. For this reason more than 80% of criminal lawyers were trained to undertake cases for the defense using all the legal tools of this system. At the same time, criminal investigators and forensic scientists working for the General Attorney Office have been the only ones able to assist cases in a legal context, getting training and experience. On January 1, 2005, Colombia changed its criminal system implementing an adversarial type system. From this moment the defense lawyers had been in a disadvantage in relation to the prosecution due to several reasons, especially training in the new system, independent forensic support, and limitations in criminal investigation among others. On the other hand, especially due to international support, the General Attorney's Office and its forensic scientists and criminal investigators are getting better facilities and training.

Three cases will show how this situation has caused a troubling social situation in Colombia because most defense lawyers are not giving correct advise to their clients and for that reason, defendants are accepting guilty charges before a trial, even if they are innocent. In this way, defense attorneys avoid the preparation of the case for the trial.

Adversarial System, Criminal Investigation, Defense Investigation

D4 Studying the Effects of Plastic Storage Systems on DNA Degradation of Blood Evidence

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After attending this presentation, attendees will have a greater understanding of the effects of storing blood evidence in plastic containers as opposed to the conventional paper bags.

This presentation will impact the forensic science community by serving as enlightenment to alternative storage methods for blood evidence that is collected from a crime scene. The goal is to avoid evidence contamination by increasing organization abilities and reduce the effects of damp storage conditions or flooding.

This research challenges the conventional wisdom that blood evidence should only be stored in paper bags. By expanding the knowledge of the effects of various storage systems on the rate of DNA degradation from blood evidence collected from a crime scene, it will be possible to create alternative storage opportunities for evidence, especially for archival purposes. This has been of concern because evidence stored in paper bags and cardboard boxes have been susceptible to extreme condition changes such as an evidence storage locker flooding or being stored in a freezer. The same properties that allow for moisture to escape, also allow moisture to enter and contaminate the evidence. However, plastic containers are known for trapping moisture as well as repelling it. By learning more about the degradation of evidence stored in plastic containers, future catastrophes

could be avoided by storing blood evidence in airtight and waterproof plastic containers. The hypothesis being tested is that if blood evidence is allowed to dry before being stored, there will be lower or equal degradation rates observed in samples stored in plastic containers compared to those stored in conventional paper bags. Moreover, if plastic containers can be employed as a storage system, it would provide for better organization and cataloguing of evidence that could minimize the unnecessary handling of evidence and possible contamination.

The hypothesis is tested by establishing various experimental conditions that are prepared in triplicate and vary in the type of container used and the interval of time that the evidence is stored. Samples are prepared from fresh blood used to stain swatches of t-shirt material in order to replicate actual evidence collection conditions. The controls consist of closed and open paper bags, which respectively represent the current method of evidence collection and evidence that is not stored, but isolated. The time variables being employed were 1 day, 1 week, 2 weeks, 1 month, 2 months, and 3 months. Varying types of commercially available plastic bags and containers as well as plastic evidence bags are used for the container variables. The samples are collected and stored for their assigned lengths of time before organic DNA extractions are performed on the samples. In order to measure the results in a quantitative manner, DNA degradation is measured through the allelic dropout rate observed after amplification using Promega's Powerplex® 16, a NIST approved set of human STR primers. Allelic dropout can be related to DNA degradation because as DNA degrades, it will break randomly throughout the strand, occasionally causing breaks in a sequence that is supposed to be amplified. This occurs first in the longer strands and progressively into the smaller strands as the DNA becomes more degraded. Thus, allelic dropout will begin in the longer sequences and can be measured as it becomes more prominent throughout the DNA profile. This allows for the quantification of the number of samples affected and the degree of degradation observed thus the rate of allelic dropout will be used to test the hypothesis to a 95% statistically significant level.

Plastic, Storage, Blood

D5 A Quantifying Study of VOCs Released During Early Decomposition Using SPME and GC/MS and the Relationship to the Interval Since Death

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After attending this presentation, attendees will develop a better understanding of the human decomposition process and the analytical techniques used to analyze the volatile organic compounds emitted. Attendees will also learn that the gases released can provide forensic scientists with information on the interval since death as a alternative to cadaver dogs.

This presentation will impact the forensic science community by providing an insight on the chemical composition of the volatile organic compounds humans release during decomposition. It will also provide clues about the impact that the environment has on the decomposition process and the VOCs released. Furthering this study, will benefit the forensic science community by establishing a new method for detecting and quantifying VOCs which can ultimately assist in victim recovery such as in mass graves and clandestine burial sites.

The basis for human decomposition has been studied and researched thoroughly for a long time. Decomposition refers to the reduction of the body of a formerly living organism into simpler forms of matter. The process of decomposition can be divided into two categories. Phase one is where the production of vapors occur. In the second phase, liquid materials form and the flesh matter begins to decompose. The progression of decomposition in a living organism occurs in four stages: fresh, bloat, decay, and dry. Fresh is the stage of decomposition that occurs in the first few days following death. During this stage of decomposition, the body enters algor mortis, which is where the body cools to a temperature consistent with its surroundings. When the body reaches the final stage of autolysis, an anaerobic (without air) environment is created. When this environment is generated, it allows the normal bacteria to breakdown the remaining carbohydrates, proteins, and lipids in the body. The products of the breakdown then create acids, gases, and other products which then produce volatile organic compounds (VOC). The putrefaction stage is where odor, color change, and bloating of the body occur. The bacteria activity occurring in the cecum, area near the small intestine, causes the lower abdomen to turn green which is a result from the breakdown of the hemoglobin into sulfohemoglobin ultimately causing the green color change. The formation of gases enters the abdomen which forces liquid and feces out of the body. The bacterium formed in this stage enters the venous system therefore causing the blood to hemolyze. Once the putrefaction process concludes, the body enters the black putrefaction stage. During this stage the body cavity ruptures, the abdominal gases escape, and the body darkens from its greenish color. This stage ends when the bones of the corpse become evident, which can take anywhere from 10-20 days after death. The conclusion of this stage is dependent on the temperature and region where the body is located. The Butyric fermentation stage is where mummification of the body starts to take place. During this stage the body starts to dry out and then goes through adipocere formation. The final stage of human decomposition is dry decay. There are a number of factors that affect the rate and manner of decomposition such as temperature, humidity, rainfall, and bug activity.

Human decomposition is a very complex process and has not been well studied at the chemical level. Many studies have been done to measure the accumulation of volatile organic compounds (VOC) that are produced during the early stages of human decomposition. Studying the development of VOCs over a certain period of time using pig (*Porcus*) carcasses as an alternative to human bodies could possibly provide important results about the unknown chemical composition of death. The VOCs will be collected using solid phase microextraction (SPME) fibers. Once the compounds are collected, they will be quantified and identified using gas chromatography/mass spectrometry (GC/MS). The data will be used to determine if there is a correlation between the compounds present and the interval since death. The results will also be studied to determine whether or not the environmental conditions have an impact on the formation and distribution of the VOCs from the body during the decomposition process. Four different scenarios will be established to measure the VOCs released during the early decomposition of a pig. According to current literature publications, the VOCs that release during this process occur most often within 0-3 days after death. The pig carcasses will be monitored at varying time intervals ranging from hours to days. Each scenario will take into account different environmental factors such as humidity, temperature, and rainfall which could possibly affect the decomposition process of the pig and ultimately the release of VOCs.

Human Decomposition, Volatile Organic Compounds, Interval Since Death

D6 The Influence of Experience on Utilized Coefficient of Friction While Walking in High-Heeled Shoes

Mark G. Blanchette, MS, 352 Myrtle Street, #6, Glendale, CA 91203*

After attending this presentation, attendees will have been introduced to the preliminary findings of a research study investigating how an individual's experience wearing high heel shoes influences the utilized coefficient of friction (uCOF) during walking. After attending, attendees will understand the basic theory of why slips occur, how heel height affects uCOF, and whether one's experience wearing high-heeled shoes plays a role in contributing to increased slip risk.

This presentation will impact the forensic science community by sharing the beneficial knowledge obtained from this presentation to forensic scientists/engineers who study the scientific and/or practical aspects of slip and fall events.

Slips occur when the utilized friction (uCOF) of an individual exceeds the available friction provided by the shoe/floor interface.[1] uCOF can be influenced by a number of factors including walking speed, age, the presence of a disability, shoe hardness, and shoe design.[2,3] With respect to shoe design, we recently have reported that the friction demand during walking increases as a function of heel height.[4] More specifically, we reported that the uCOF while wearing high heels (9.5 cm) was significantly higher than when wearing shoes with low (1.3 cm) and medium heel heights (6.4 cm). Although uCOF increases with heel height, it is not known how experience affects uCOF during walking. It is conceivable that women who do not have extensive experience walking in high heels may ambulate in a way that increases uCOF and therefore slip risk. The purpose of this study was to determine whether the level of experience wearing high heeled shoes affects uCOF during walking.

To date, six healthy women have been recruited for this study. Based on a survey describing their experience wearing high heeled shoes, three subjects were classified as "experienced" (experience rating of 8 or higher on a 10 point scale) and three were classified as novice (experience rating of 3 or lower on a 10 point scale). The two groups were similar in terms of age (28.0 ± 4.4 vs. 26.0 ± 5.3 yrs), height (159.3 ± 7.5 vs. 166.0 ± 6.6 cm), and weight (53.7 ± 12.6 vs. 64.4 ± 16.1 kg). Subjects walked at self-selected velocity under 2 different shoe conditions that varied in heel height (low: 1.27 cm and high: 9.53 cm). Each subject was provided with footwear in their respective size. Both shoes had the same manufacturer and were chosen for their similarities in design, construction materials, and quality. Ground reaction forces were recorded using a force platform at 1560 Hz. Utilized friction was calculated as the ratio of resultant shear force to vertical force. For each trial, subjects' peak uCOF was determined during the first 50% of the stance phase.

Subjects in both groups walked at similar velocities for both shoe conditions. For all subjects, utilized friction increased for both groups as heel height increased. However, the change in uCOF across shoe conditions in the novice group (0.23 to 0.35) was more pronounced than the experienced group (0.22 to 0.29). The higher uCOF in the novice group during the high heel trials was the combined result of a 14% decrease in the vertical ground reaction force and a 30% increase in the resultant shear force when compared to the experienced group.

Consistent with the previous study,[4] results indicate the friction demand during walking increases as a function of heel height. When wearing high heels, novice subject demonstrated a 51% increase in uCOF compared to the low heel condition. This was in contrast to the 31% increase in uCOF observed in the experienced group. These results signify the need for individuals to be properly acquainted with high-heeled shoes in order to minimize the risk of slips and falls.

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Slips, High Heels, Utilized Friction

D7 Was It an Accident That He Shot His Wife With a Gun?

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After attending this presentation, attendees will understand the principles of crime scene reconstruction and the use of firearms training and pattern injuries in investigating a death scene.

This presentation will impact the forensic science community by demonstrating the real world implementation of the knowledge gained through hours of lectures and training in crime scene reconstruction and the use of firearms training and pattern injuries in investigating a death scene.

During this presentation, a case study will be presented of an actual investigation that was initially reported as an accidental shooting. Through the evaluations of statements, observation at the death scene, examination of pattern injuries, and radiological testing, the investigation took a sharp turn. This was no longer being investigated as an accidental shooting.

Using trajectory, mathematics, bloodstain pattern analysis, pattern injuries, and gunshot pattern analysis, the crime scene was physically reconstructed. This was all due to refute the statement of the suspect that he tripped, while walking down a dark hallway, causing him to shoot the victim.

The investigation started on January 24, 2001 when the Tippecanoe County Sheriff's Department was advised of a shooting that had occurred in the south/east part of the county. When officers arrived at the scene, they found a 20-year-old female lying on the basement bedroom floor. The female had a gunshot wound to her lower left abdominal area. She was transported to an area hospital and pronounced dead on arrival.

While investigating the shooting scene, the husband of the victim was explaining to the officers what had occurred. He told officers that he had been hunting earlier in the evening and had brought the shotgun into the residence where he and the victim, his girlfriend, lived with his parents. The husband had stated that he and the victim had drunk some beer and had retired to bed. After having intercourse, the male states that he got up to use the bathroom. Upon returning from the bathroom, the male tells deputies that he remembered the shotgun that he had brought into the house and wanted to put it up. He said he retrieved the weapon and was walking through the darkened living area towards the bedroom when he tripped over a small stool. He told the deputies that when he fell to the floor the shotgun struck the floor with the butt of the shotgun and discharged. He then heard his wife moaning and turned on the lights. He found that she had been shot in the stomach by the shotgun.

An examination at the hospital was requested in order to look for any evidence on the body that might help the investigation. The female

victim's body was still in the trauma room. Her injuries were still bandaged and upon removing these to examine the wound, it was noticed that the intestines had eviscerated. An x-ray of the victim was taken and it was found that the pellets from the shotgun had gone down into her pelvic area and not up into her chest. This directionality of the pellets reinforced this shooting did not occur as relayed by the husband.

After an autopsy was performed, it was noted that the gunshot wound was 35½ inches from the bottom of the wife's heel. There was also no stippling pattern which indicated that the shotgun blast was from 3-6 feet away from the victim. The approximate angle of entry of the shot pattern was 27 degrees.

Using this information, a number of forensic disciplines were utilized to come to the conclusion that the husband had intentionally shot his wife. The reconstruction will be discussed and the attendee will be able to observe how this conclusion was attained.

Homicide, Accidental Shooting, Crime Scene

D8 Rodent Gnawing, Wildfire, and Cultural Modification: Using Forensic Techniques to Interpret Historic Artifacts From the Spencer Site

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The goal of this presentation is to provide an example of how modern forensic techniques contribute to the field of historic archeology.

This presentation will impact the forensic science community by highlighting a case where knowledge relevant to both fields assisted with the interpretation of a historic site. The presentation will hopefully encourage communication between forensic experts and archeologists; ideally, this would optimize the insights of professionals in the interpretation of sites and cases through reciprocal knowledge, therefore benefiting all parties.

The Spencer Site is a historic site in the Seeley Lake area of Western Montana that contains a wealth of information within only a few artifacts. The site was revealed to archeologists in the fall of 2007 after a large wildfire swept through the area, which severely burned the vegetation and exposed the ground surface. The Spencer site lies within a travel corridor proximal to the Old Jocko Indian Trail and dates to the late Bison fur trade period, around the late 1870s. Spencer .56-52 cartridges were the dominant artifact at the site, and a cluster of other high value artifacts were found amidst the dispersed cartridges. The cluster of artifacts included a bullet mould, a pair of scissors, a cut nail, components of a possible beaver trap, an axe head, and a Bison hide scraper crafted from an octagonal rifle barrel. The artifacts were analyzed and curated in the Heritage department at the Lolo National Forest Supervisors Office. Each artifact was analyzed individually as well as macroscopically to determine the effects different environmental and cultural processes had on the artifacts over time. Some of the artifacts that were found in the cluster at the base of a stump exhibit unique characteristics that were produced through cultural means, including odd striations on the axe head, strange use patterns on the scissors and bullet mould and hammer marks on the Bison hide scraper. The Spencer cartridges were malformed from a variety of cultural and environmental influences. Rodent gnawing marks of various degrees occur on the bullets; some of the bullets have been extensively gnawed, while others show no gnaw marks. The bullets also show various degrees of melting and oxidation that would have taken place prior to the Jocko Fire of 2007. Several unique metal pieces were analyzed using a SEM with EDX to determine their elemental makeup, and the results provided key insights into the events surrounding the deposition of the site materials. The artifacts and the cultural modifications as well as the environmental processes that affected them have interesting implications to the overall interpretation of the site and how the site fits into the historical context of Montana during this fascinating period of history. These artifacts reinforce the possibility that Native American artifact assemblages during this time period look strikingly similar to Euro-American assemblages due to the extent of assimilation. Though the artifacts at the site provide insight for the events that happened at the site, the evidence was not conclusive enough to determine which cultural group the artifact assemblage should be associated with.

Spencer Cartridges, Rodent Gnawing, Historic Archeology

D9 Field Capability of Dogs Trained to Locate Individual Human Teeth

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After attending this presentation, attendees will have a basic familiarization with the use of human remains detection dogs and will specifically learn what to expect from a team capable of locating teeth in support of forensic investigation. In addition, the attendees will gain an understanding of the relevance of utilizing dogs trained specifically for locating a particular target, such as human teeth, rather than a generalized "search dog."

This presentation will impact the forensic science community by expanding knowledge about the capability of dog teams trained for human remains detection focused on human teeth. A second impact will include demonstrating the educational value for investigators on how to approach requests for this specialized but highly useful resource.

Avulsed teeth can be difficult if not impossible to recover in the outdoor environment, yet are important for victim identification. Dogs have an advantage as a tool to locate teeth in that they rely primarily on olfactory rather than visual cues and their olfactory sense exceeds man-made equipment. However, not all search dogs teams are trained for human remains detection, and within that specialized detection discipline not all teams are prepared for, or necessarily capable of, precision detection in support of forensic evidence collection. Teams that are capable of working this type of assignment can be an efficient and valuable means for locating evidence during an investigation. Furthermore the use of such dog teams may reduce costs, minimize scene disturbance, and/or expedite data collection.

Results are presented from a study which had two objectives, (1) quantify the capability of dog teams at locating individual human teeth in the field setting; and, (2) quantify the role of human remains detection training relative to field performance. The field capability trials were conducted using a double-blind research design. Each of three dog teams searched two separate $(10m)^2$ plots containing ten teeth each. Dog teams worked between 27 and 50 minutes in each plot. Study results demonstrated that dog teams can locate individual human teeth in the field environment, with a recovery capability to 79 percent, but not all teams were equally capable.

Training data were analyzed for the seventy-eight days immediately preceding the trials. Dog team capability in the field trials correlated with capability in training. The best predictor of capability during the trials was the cumulative recovery rate for the team's last training prior to participation in the trials. This is important because "recovery" during training equals the probability of detection (POD), and POD is variable based on numerous factors one of which is the sensitivity, strengths, and limitations of the detection tool. Based on the results from this study, capability in training predicts the POD of a team during an actual deployment, which directly relates to evidence recovery.

Overall, results showed that human remains detection dog teams can be an effective and efficient tool for locating individual human teeth in the field setting. Individual team qualifications are important when selecting teams to search for individual human teeth and training specifically for this task is critical. It is common in human remains detection dog training to expose the dogs to as many different sources as reasonable to help expand their scent picture as to what constitutes human remains. Nevertheless, the challenge of finding such small and limited scent sources as single human teeth should not be underestimated. While this study demonstrated that dogs are capable of finding single human teeth in a field setting, it also showed the variability in capability in dog/handler teams. Much of this could be connected with both the type and amount of training the teams did prior to the field trials. Working blind problems, where both the number and location of sources are unknown to the handler, is an important means to develop the skills of the team to find target sources in a search environment. Finally, a team's recovery rate in training, calculated on success during blind problems, is a good predictor of POD on actual search deployments.

Evidence Collection, Odontology, Forensic Investigation

D10 Problematic and Perspectives of Child Abuse Investigation in Colombia

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After attending this presentation, attendees will become familiar with child abuse legal problems in Colombia and will learn some suggestions for the criminal investigation of these cases.

This presentation will impact the forensic science community by exhibiting the difficult current situation about legal classification of some behaviors related with child abuse in Colombia and the introduction of useful research directives in certain cases of maltreatment.

Child abuse is defined as a series of deliberated actions and/or omissions that are carried out by parents, relatives, caretakers, or other children, that result in physical or emotional damages, or the imminent risk of serious damage or death. Nevertheless, within the Colombian penal code, child abuse phenomenon is not clearly defined. It is determined according to the characteristics of each case as well as the public prosecutor criteria, that a crime can be typified as a personal injury, abortion, kidnapping, torture, human trafficking, sexual assault, sexual abuse, nutritional nonattendance, incest, or domestic violence, among others, being this last one the most frequently used to process the case. An example of this situation is the statistical results released by the National Institute of Legal Medicine and Forensic Sciences, which in 2008 completed 13,523 medical examinations by physical injuries within the domestic violence context, 16,120 sexual examinations, and 882 autopsies in cases of homicide, but this information does not emphasizes the conditions under the facts took place or the specific kind of child abuse.

Although there are some guides and protocols regarding forensic medical examination on physical injuries and sexual violence, both in adults and children, there is not a manual to guide in the criminal investigation of child abuse cases. The investigation is restricted to fulfillment of routine activities which do not provide an integral understanding of the phenomenon and less to undertake the right judicial decision and to achieve an effective children protection.

Doing a review to the current situation of these cases and analyzing child abuse typology, widely described in scientific and forensic literature, certain directives and checklists within the criminal investigation are suggested in order to make emphasis in an interdisciplinary work and approach on the victim (family and social structure, socioeconomic context, medical background, stage of development, scholastic performance, etc.), the aggressor (maltreatment antecedents, drug abuse, labor situation, mental condition, educative level, relationships, criminal antecedent, etc.), the crime scene (characteristic of the place, suitable inspection, compilation of evidences, versions given by the victim and the aggressor correspondence, etc.), and other alternative sources of information (documents, professors, neighbors, relatives, civil servants of social services, medical personnel, etc.), applicable in cases of physical abuse, Münchausen by proxy syndrome, shaken baby syndrome, negligence, psychological maltreatment, institutional abuse, sexual violence and homicide of children.

Child Abuse, Criminal Investigation, Check List

D11 Cognitive Contamination in Medicolegal Death Investigations

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After attending this presentation, attendees will recognize the affects of biases and heuristics in medicolegal death investigations.

This presentation will impact the forensic science community by providing awareness of the internal and external factors that influence medicolegal death investigations and providing techniques to mitigate those destructive influences.

Independence and objectivity are the most important values in medicolegal death investigations. Preliminary information provided by law enforcement officials, witnesses, and family members can affect an investigator's observations. These external sources in conjunction with internal processing of information can mislead or damage an investigation. Internal processing includes "heuristic thinking" which are simple mental shortcuts ("rules of thumb") used to comprehend a large amount of information in an efficient (quick and dirty) manner.

All forensic investigations, especially medicolegal death investigations, are influenced by conformity effects, confirmatory biases, and availability and representative heuristics. In order to maintain independence and objectivity, an investigator must not only have awareness of biases and heuristics, but institute investigative techniques to mitigate these influences. A case example will be used to illustrate how biases and heuristics affect medicolegal death scene investigations.

Medicolegal Death Investigations, Cognitive Contamination, Bias

D12 A Forensic Investigation of an Epidemic of Blindness

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The goal of this presentation is to review the details of the blinding worldwide *Fusarium keratitis* epidemic of 2004-2006 and present laboratory proof that defective plastic bottles and improper temperature control resulted in fungistatic failure of the contact lens solution.

This presentation will impact the forensic science community by discussing why the previous theory to explain the *Fusarium keratitis* epidemic of 2004-2006 was based on a false premise; namely, that the components of the contact lens solution itself interacted in such a way that Fusarium growth was facilitated. If this were correct, then cases of *Fusarium keratitis* should have been traced to all four worldwide factories where the solution had been manufactured. In fact, the cases

could be traced to only one factory, in Greenville, South Carolina. The attendees will learn the details of the epidemic and the laboratory investigation which showed that defective plastic bottles and improper temperature control resulted in fungistatic failure. The attendees should learn not to accept superficial answers to difficult questions. As the Nobel Laureate Albert Szent-Gyorgyi said: "Research is to see what everybody has seen and think what nobody has thought."

Background: In August 2004, Bausch & Lomb (B&L) introduced a new contact lens solution, ReNu with MoistureLoc (ReNuML), containing the antimicrobial agent alexidine; an agent not found in other contact lens solutions. In July 2005, an increased incidence of *Fusarium keratitis* was noted in Hong Kong and in February 2006, the first 35 of 62 cases of ReNu-related *Fusarium keratitis* were reported from the Republic of Singapore. In early March 2006, the first U.S. reports of ReNu-related *Fusarium keratitis* were reported to both the Food and Drug Administration (FDA) and the Centers for Disease Control and Prevention (CDC) from Newark, New Jersey and (by JDB) Dayton, Ohio. A total of 154 confirmed cases were ultimately identified in the U.S. outbreak and the use of ReNuML was significantly associated with having *Fusarium keratitis* (adjusted odds ratio, 22.3). In mid-May 2006, the product was finally withdrawn from the world market. At the termination of the epidemic, hundreds of cases of *Fusarium keratitis* had occurred worldwide with many resulting in permanent blindness. Numerous researchers have since attempted to explain the etiology of this epidemic. B&L investigators acknowledged that all of the cases were related to the ReNuML solution produced only in their Greenville, South Carolina plant (as opposed to the other manufacturing sites in Italy, China, and India). The CDC found no fungal contamination of unopened bottles produced by that plant (including bottles with the same lot numbers as those that were used by affected patients) and noted multilocus genotyping of clinical isolates from affected patients, essentially excluding the possibility of a single-point source contamination of the solution itself. They concluded that this epidemic was due to a failure of ReNuML to disinfect adequately after point-of-use contamination rather than from intrinsic contamination with *Fusarium*. Factors hypothesized to have contributed to this epidemic include direct uptake of alexidine by contact lenses, reduced antimicrobial activity of evaporated ReNuML, enhanced growth of *Fusarium* on ReNuML biofilms on contact lens cases, direct penetration of *Fusarium* into soft contact lenses, and patient noncompliance. However, none of these factors, either alone or in combination, would explain why only the ReNuML produced in South Carolina had been implicated. A recently published study (Bullock et al, *Arch Ophthalmol* 2008;126[11]:1493-1498) reported that a May 2006 FDA inspection of B&L's Greenville, South Carolina manufacturing site affirmed that B&L had failed to regulate storage and transport temperatures of their products, even though the label on the bottle clearly stated: "Store at room temperature." Historic climatological and other data revealed that the solution, when stored and transported without temperature controls, could have been exposed to temperatures as high as 75^{o}C (167^{o}F). Six different contact lens solutions were then studied for temperature stability. Two bottles of each solution were separately stored at room temperature and 60°C (140^{o}F) for 4 weeks, serially diluted, and then tested for their ability to inhibit growth in two different fungal media of 11 *Fusarium* isolates (7 of which were associated with the *Fusarium keratitis* epidemic). ReNuML demonstrated the greatest decline in efficacy after 60°C storage. Regarding the *Fusarium keratitis* epidemic isolates only, the ReNu with MoistureLoc bottle stored at room temperature allowed growth in 27 of 84 combinations vs. 67 of 84 combinations with the 60°C-stored bottle (P<0.0001). Thus, when exposed to prolonged temperature elevation, ReNuML lost its *in vitro* fungistatic activity to a much greater extent than other commercial products. That study concluded that improper temperature control of ReNuML may have contributed to the *Fusarium keratitis* epidemic of 2004-2006. Bullock et al also demonstrated that boiling (~100^{o}C/212^{o}F) the solution for ten minutes in a glass tube did not degrade its fungistatic capability, suggesting that the plastic container, in combination with prolonged heat exposure, could have been the cause of the observed fungistatic failure.

Purpose: To demonstrate the effects of container properties and storage temperatures on the ability of the ReNuML contact lens solution, previously implicated in the *Fusarium keratitis* epidemic of 2004-2006, to inhibit growth of *Fusarium* species.

Methods: The solution was divided into six aliquots and stored separately for four weeks at room temperature (RT), 42^{o}C (108^{o}F), and 60^{o}C, in both their original plastic bottles and similarly-sized glass containers, then tested in triplicate for their ability to inhibit the growth of seven *Fusarium* isolates previously associated with the *Fusarium keratitis* epidemic of 2004-2006.

Results: When stored in glass containers, the solution demonstrated no fungistatic deterioration at all three temperature levels. However, when the solution was stored in its original plastic container at 60^{o}C, a highly statistically significant fungistatic deterioration of the solution was noted compared to those stored in plastic at either RT ($P = 4.0x10^{-7}$), 42^{o}C ($P = 2.10x10^{-6}$), or in a glass container at 60^{o}C ($P = 1.29x10^{-6}$).

Conclusions: When stored in its original plastic (as opposed to a glass) container and exposed to prolonged temperature elevation (60^{o}C for four weeks), the contact lens solution implicated in the *Fusarium keratitis* epidemic of 2004-2006 loses its *in vitro* fungistatic capability. The temperature required for fungistatic failure is >42^{o}C and ≤60^{o}C. Thus, a lengthy and highly detailed forensic investigation revealed that this epidemic was associated with a combination of defective plastic bottles and improper storage temperatures. In the interest of preventing future epidemics, since the exact type of plastic containers used at each of the various manufacturing sites is presently undivulged, this information should be revealed.

Blindness, Epidemic, Fusarium

D13 Ancient DNA Analysis of Dried Coral Samples: An Accurate DNA-Based Identification of Threatened Species for Support of Wildlife Trade Law Enforcement

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The goal of this presentation is to introduce attendees to a new ancient DNA-based approach to extract DNA from dried and/or processed coral samples. Attendees will also gain an understanding of how this technique will benefit wildlife trade law enforcement, through the accurate identification of threatened and endangered coral species.

This presentation will impact the forensic science community by providing a reliable, sensitive, DNA-based protocol for the rapid identification of protected coral species, and provide law enforcement with an effective method of detecting illegally traded specimens of protected coral species. This technique will contribute to the long-term protection of coral reefs, which has wide implications for marine ecosystems, environmental conservation, and sustainable trade.

Despite being listed as protected taxa under CITES**,** every year over one million corals are illegally harvested and shipped worldwide for the use in jewelery, art, and for the purpose of collection. For example, red coral (*Corallium rubrum*)-or precious coral- has been highly valuable as a gemstone for millennia. Illegal coral harvesting (in addition to the effects of global warming) has significant harmful impact on the marine ecosystem. Stony coral colonies are an essential part of highly diverse marine reefs, providing the basis for food and shelter of other marine wildlife. Research has shown that the slow growth rate of some species leads to colonies with ages of up to thousand years old.

To ensure the survival of these coral species and subsequently of the fragile marine ecosystem, law enforcement personnel must be able to discriminate between material manufactured from protected species, those made from unregulated species, and imitations made from legal materials to uphold international agreements such as CITES and national laws for wildlife conservation. However, these efforts are handicapped by the lack of reliable and accurate methods for species identification. The currently common visual identification of protected coral species is hampered by corals' diverse morphology, the modification of the coral into beads and other jewelery, and the excellent quality of some imitation material.

Although DNA-based species identifications have been applied to fresh coral specimens, the feasibility of extracting DNA from museum specimens or modified specimens found in jewelery and arts has not been tested. The goals of this pilot study were to test the feasibility of extracting DNA from modified or dried red coral samples and to obtain an accurate DNA-based species identification. Ancient DNA extraction protocols and strategies used here are highly sensitive techniques originally designed to maximize the amount of DNA recovered from severely degraded materials. The coral samples used in this study were obtained from the TRAFFIC repository in Vancouver, Canada. Coral samples were prepared and extracted using a modified ancient DNA extraction protocol (Yang et al. 1998). To ensure a reliable DNA-based species identification, the study targeted short, conserved regions (including COI and 16S gene fragments) of the coral mitochondrial genome. In this study, red coral DNA was successfully extracted and amplified from less than 0.5g of coral specimen, and the obtained sequences matched available red coral (*Corallium rubrum*) reference sequences. This result demonstrates the feasibility of recovering DNA from dry coral samples and the high sensitivity of this method for species identification with minimal destruction of the source material.

Once optimized, this technique will prove to be a fast, reliable and sensible DNA-based method for wildlife law enforcement agencies to identify endangered and protected coral species during investigations of illegal trade of protected coral species.

Ancient DNA, Forensic Wildlife, CITES

D14 Location of Graves Through Soil Spectroscopy: Differentiating the Reflectance of Grave Soils From Common Fertilization Treatments

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After attending this presentation, attendees will have learned that common fertilization practices of soils minimally affect the spectral signatures of soils and that the spectral signatures of grave soils differ from non-grave soils and fertilized soils. This differentiation in the spectral signature of grave soils, soils treated with manure, bone meal, or compost indicate that it is possible to use the spectroscopy of soils to identify locations of clandestine graves through aerial or satellite imagery with minimal confusion from common soil treatments.

This presentation will impact the forensic science community by increasing knowledge on how common fertilization practices affect the spectral signature of soil. A better knowledge about this matter indicates that it is possible with high confidence to determine the location of graves using hyperspectral data from aerial or potentially satellite imagery. Confusion between spectral signatures of treated soil (non grave soils mixed with manure, bone meal, or compost) and graves is minimal.

This research is part of ongoing multidisciplinary studies at the burial site of an African animal zoo (Parc Safari), near Montreal, Quebec, Canada. This site is an ideal ground to conduct research on the effects of cadaver decomposition on the soil properties. The site contains several graves with multiple animals that had been buried 6 to 50 years ago. For this particular aspect of the research a total of three different burial sites were examined: an African elephant buried six years ago, a comingled mass grave of unknown age containing the remains of several animals such as a zebra and a ram, and an unexcavated grave containing a large ungulate (similar to a buffalo) and potentially other remains and a reference area (non-grave site). Furthermore, treatments that are often found in association with fields (compost, manure, bone meal, blood meal) that may have effects on the reflectance properties of the soil similar to cadaveric decomposition were examined.

The objective was to determine if the reflectance of grave soils can be differentiated from soils that have been fertilized with manure, compost, bone meal, or blood meal. The manure used for this experiment was collected from the McGill University Farm and came from cattle that had been fed a mixed diet similar to what free range cattle would have. The organic bone meal and blood meal were purchased at a local gardening center and the two-year-old compost had been produced from grass cuttings. While spectroscopy of soils and soil properties is a well developed and studied field in the physical sciences, few studies have examined the effect of adding products such as manure or compost on soil reflectance. Virtually no studies have yet compared the reflectance of such treated soils to grave soils from the same site. It is important to be able to differentiate between the spectral signature of cadaveric decomposition in the soil and soil that has been fertilized or treated with additives such as compost and others in order to reduce the potential false positives when searching for clandestine graves from aerial or satellite imagery.

Soil samples were taken from the three aforementioned graves in addition to reference soil collected from an area of the cemetery containing no bodies. The reference soil was mixed in equal parts with each of the additives (manure, compost, bone meal, blood meal) and the reflectance from 400-1,000nm of each grave, pure treatment (e.g. pure bone meal), treatment mixed with reference soil and pure reference soil was measured with an Analytical Spectral Devices Handheld Spectrometer in a dark room under a high intensity halogen light source for illumination. Lighting and viewing geometries were kept constant for each measurement. The reflectance data was subsequently classified to allow for a quantitative assessment of spectral differences and also converted to spectral fingerprints to allow for a visual comparison.

The results indicate that not only does each of the treatments have very different spectral signatures from the reference soil, but when mixed with reference soil, the spectra are still from that of that of the reference soil. Furthermore, the spectral signatures of the treatments and the treated reference soil also differ markedly from the spectra of the three graves indicating that the likelihood for confusion between the spectra of graves and soils treated with common forms of fertilizations is minimal from hyperspectral data.

Spectroscopy, Clandestine Graves, Fertilization

D15 Tangled Corpses: Interpreting a Complex Mass Grave at the Parc Safari Cemetery

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After attending this presentation, attendees will better understand the complexities of mass grave excavation, especially the necessary archaeological methodology for collecting, analyzing and interpreting disarticulated skeletal and non-skeletal remains, where no oral narrative of that burial event exists.

This presentation will impact the forensic science community by augmenting with traditional grave recovery tools, an interdisciplinary methodology, to assist mass grave investigation. That, in turn gives the community at large, an approach that can be applied in parts of the world where sensitive social relations exist as a result of human rights abuses.

Very often, investigations of human rights abuses have focused on the identification of individual and mass graves. Reconstruction of the burial event has taken a secondary position in those scenarios. Yet, using an interdisciplinary methodology, the scope of investigation can be widened by collecting important contextual information during grave identification and excavation.

A more thorough recovery and analysis of the collected contextual information offers scholars and human rights investigators greater understanding of the depositional context, and the stratigraphy related to the burial event. That information is augmented with an analysis of the recovered skeletal and non-skeletal remains.

On-going studies of a mass grave at a zoological park in Quebec, Canada will be presented as an example of that interdisciplinary methodology. The fall 2008 excavation recovered from the mass grave the disarticulated remains of up to four mammalian individuals, including a zebra, bighorn sheep, antelope, and water buffalo and a black garbage bag with the semi-decomposed remains of a flamingo. Found in close proximity to the mammalian remains, were garbage bags with semi-decomposed intestinal remains.

The spatial entanglement of the skeletal and non-skeletal remains suggested that the individuals were buried in a single burial event. The bodies were piled on top of each other, rather than arranged side-by-side in the grave. The disarticulated state of their remains led excavators to speculate that the animals were partially dismembered before burial. Laboratory examination and analysis of the skeletal remains confirmed the hypothesis when, cut marks were identified at two points: below the head, and on the lower thoracic vertebrae. No cutting implement was recovered in the excavation. Investigations to identify the implement that was used for dismemberment are continuing.

Close examination of the soil stratigraphy in the excavation unit indicated the northern edge of the grave cut. The remains were situated in the southwest of the grave. There are strong indications that more individuals will be recovered from that part of the grave. The material evidence of the buriers suggests that the dismembered bodies were likely transported in garbage bags to the burial site. Excavators recovered thick nylon ropes from the grave. The rope is seen in prevalence on the surface, and just below ground cover throughout the cemetery. That in turn has raised questions about how it was used by the buriers.

There exist no institutional records at Parc Safari for this mass grave, or for the cemetery grounds where excavations are taking place. This cemetery ground is no longer used by Parc Safari, and represents up to forty years of animal burials. Because there is limited or no memory about the mass grave of interest, or about burial practices in the past, excavators are relying on high-resolution collection and analysis for their reconstruction of the burial event.

Mass Graves, Excavation Methodology, Human Rights

D16 Insect Succession Model for Southeast Texas in Early Spring

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After attending this presentation, attendees will be briefed on the first controlled human decomposition study for the Piney Woods biogeoclimatic zone which incorporated Houston, TX.

This presentation will impact the forensic science community by creating the first insect succession model on humans in this area and provide a baseline for future studies.

A human corpse was allowed to decompose above ground at the Southeastern Texas Applied Forensic Science (STAFS) Center at the Center for Biological Field Studies (CBSF) at Sam Houston State University in early spring. Other studies on carrion and survey studies using liver and heart had been previously conducted in the area. This study; however, represents the first controlled observation of human decomposition for the Piney Woods biogeoclimatic zone, an expansive area of sub-tropical Texas that includes the metropolis of Houston. Insect succession was recorded three times daily for approximately three weeks to document thoroughly the insect activity. During decomposition, night time temperature lows frequently dropped below 10 °C while day time temperature highs were frequently above 18.3°C. Several brief but drenching rain showers occurred. Of particular interest is the rapid mummification of the remains and the suite of insects specific to this process. Data from this research will be presented.

Forensic Entomology, Corpse, Early Spring

D17 Seeing Is BeLeeding

Matthew Doyle, BSN, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will understand some investigative principles that are required when investigating deaths due to exsanguination from an AV fistula used for hemodialysis. The attendees will also gain awareness of the physiology underlying the disease processes of chronic renal failure, diabetes mellitus, hypertension, and coronary artery disease and will be able to apply this knowledge to their death investigations. Some of the treatments for these diseases will be discussed as they are contributing factors for exsanguination. The types of hemodialysis access sites will also be reviewed in relation to manner of death.

This presentation will impact the forensic science community by serving as an educational tool for death investigators and augmenting investigative practices currently in place in each attendee's locale. Better investigations being performed allows for more accurate statistics to be kept, possibly preventing some of these deaths in the future.

This project was designed to assist death investigators ascertain all the necessary information on deaths due to exsanguination from hemodialysis sites. This presentation will be useful as an introduction into these disease processes, highlighting the symptoms and contributing factors that can lead to exsanguination. The reasons behind the need for investigating psychiatric history will also be explored. Many times, it is assumed that exsanguination from the AV fistula is a known

complication of hemodialysis and the manner of death is either natural or accidental. No questions are asked about suicidal ideations. The initial investigation and interviews of family members in deaths caused by exsanguination from the AV fistulas in decedents with chronic renal failure may be the most important aspects of the case. The cause and mechanism of death are rarely questionable mainly due to the quantity and pattern of arterial blood spatter present. The investigator can rule out blunt or sharp force injuries as he/she performs his/her physical assessment of the decedent during the scene examination. The manner of death requires further scene investigation as well as communication with the family and friends.

Although most of these deaths can be ruled as natural deaths after a quality investigation is performed, some of the deaths may be ruled as accidents or suicides, depending on the circumstances. It is the job of the investigator to gather the pertinent information during the investigation. Therefore, the investigator is the key to classifying these deaths properly. Since 2003, Harris County Medical Examiner's Office (HCMEO) has investigated 29 cases of exsanguination from hemodialysis sites. One incident occurred at the decedent's dialysis facility while the remainder of the incidents occurred at the decedent's residence. Of these 29 cases, 21 were ruled as natural deaths, 4 were rules as accidental deaths, 2 were ruled as suicides, and 2 were undetermined. Of the 29 cases, 18 were scenes while the remaining 11 were hospital deaths.

With an adequate investigation, jurisdiction of some of these cases can be released with only the questionable cases requiring the medical examiner/coroner to perform an autopsy. Of the 29 cases, jurisdiction was released by HCMEO in one of the cases for the primary care physician to sign the death certificate and that took place in January 2009. Autopsies were performed in 20 of the cases. With improved investigations, HCMEO has been able to perform more external examinations on these cases. So far, six of the eight total external examinations since 2003 have been performed in 2008 and 2009 (through June) with eight autopsies from 2008 to present (June).

Exsanguination, Hemodialysis, Death Investigation

D18 Current Status of the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN)

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After attending this presentation, attendees will have an understanding of the current objectives and purposes of the Scientific Working Group on Bloodstain Pattern Analysis (SWGSTAIN) as well as the potential impact the guidance documents produced by this working group will have on the discipline of bloodstain pattern analysis.

This presentation will impact the forensic science community by updating them on the work currently being completed by SWGSTAIN.

In 2002, the FBI Laboratory coordinated a meeting to explore the idea of a scientific working group related to bloodstain pattern analysis. A core group of sixteen recognized bloodstain pattern analysis experts affirmed the need for a scientific working group on bloodstain pattern analysis, SWGSTAIN. Currently, the membership of SWGSTAIN includes 29 recognized bloodstain pattern analysis experts who represent law enforcement agencies, laboratories, and private practitioners, in North America, Europe, New Zealand, and Australia. In 2009, the Midwest Forensics Resource Center, assumed the leadership role of SWGSTAIN from the FBI Laboratory.

The mission of SWGSTAIN is to promote and enhance the development of quality bloodstain pattern analysis practices through the collaborative efforts of governmental forensic laboratories, law enforcement, private industry, and academia. Currently, the SWGSTAIN membership is split into five (5) standing committees: (1) Taxonomy and Terminology; (2) Training and Education; (3) Quality Assurance; (4) Legal; and 5) Research. Each of these sub-committees has been assigned and is working on specific tasks that are deemed necessary by the entire working group. During our bi-annual meetings each sub-committee presents status updates to the entire working group. Once a committee is nearing the completion of a guidance document, the document is then distributed amongst the entire group for comment. This often occurs multiple times prior to the documents being published for public comment. Documents are not released for public comment until the document is passed through the membership and then through the SWGSTAIN Executive Board.

Within this presentation, the role of each sub-committee will be discussed along with their respective published guidance documents. In this presentation specific attention will be given towards addressing the projects currently being undertaken by the SWGSTAIN Research sub-committee. SWGSTAIN recognizes the need for further research in bloodstain pattern analysis and is working towards addressing what areas in the discipline are in need of research. In addressing the areas in need of further research, the Research sub-committee with the assistance of the entire SWGSTAIN membership, has compiled an extensive bloodstain pattern analysis bibliography that is available on www.swgstain.org.

In addition, SWGSTAIN is working to be proactive towards current issues impacting the discipline. A public position statement regarding the National Academy of Sciences Report on Forensic Science was recently published. The work of SWGSTAIN is on-going and relies upon the input of bloodstain pattern analysis practitioners. The current documents that are available for public comment as well as the completed guidance documents can all be found on www.swgstain.org.

Bloodstain Pattern Analysis, SWGSTAIN, Bloodstain Research

D19 A Short Stab in the Back at Long Distance

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After attending this presentation, attendees will learn of the potential of computed tomography (CT) for not only the evaluation of the manner and extent of intentional sharp trauma in the living, but also influencing the deliberations of the judges of fact.

This presentation will impact the forensic science community by increasing the appreciation of the usefulness of sectional imaging in evaluating trauma in the living.

A young woman, 28-years-old, was injured in her home by her 29-year-old ex-boyfriend during a social visit including consensual sex. The mood of the moment was destroyed when the young woman, hereinafter called the "victim" received a telephone call from another man. This enraged her visitor, hereinafter called the "defendant" who began to punch and kick her. The battering moved to the kitchen where the defendant knocked the victim to the floor, stepped on her face, and stabbed her in the back with a steak knife from the kitchen counter. He then screamed that he could not believe that he had stabbed her, but hit her in the head twice more. The defendant's emotions swung from remorse that he'd stabbed her to rage over the phone call but within minutes the victim persuaded her attacker to drive her to a nearby urgent care facility. Upon arrival, she fled inside while the defendant fled in the victim's automobile.

The victim was seen to have a stab wound in the back and immediately was transferred to a hospital. In the emergency department she was found to have bruises and tenderness around the eyes, nose and mouth, stable vital signs, and a 1 cm transverse stab wound in the back just to the right of the midline.

The American College of Radiology Appropriateness Criteria, and most surgical literature, recommend CT examination for stab wounds in the back to determine the necessity for surgical exploration. This was done and showed retroperitoneal air bubbles in the paraspinous soft tissues and around the kidney and renal pedicle. Subsequently the wound was packed with ¼ inch gauze, she was observed for about 36 hours, and discharged home.

Approximately 24 hours after the stabbing, the defendant was arrested in an adjacent state while driving the victim's automobile. He was charged with: (1) attempted 1st degree homicide while armed as a repeater; (2) felony aggravated assault while armed as a repeater; and (3) felony bail-jumping as a habitual criminal. Sequential terms of imprisonment for these charges would amount to 107 years.

A court-appointed defense attorney asked for an evaluation of the knife wound and its significance as depicted on the CT. He had received differing reports from the local physicians, neither of which was wanted to give an "expert" opinion. The CT findings were reminiscent of an obsolete method for visualization of the kidney and/or adrenal gland before the advent of CT. The anatomy of the renal fossa is pertinent to that old method and to this contemporary care, and will be illustrated.

The victim's CT show a cutaneus defect at the site of the stab wound. As the CT slices progress cephalic, small air bubbles indicate the angulation of the blade, reaching the area of the kidney and its pedicle. There is no evidence of extravasation of blood or urine on this or for a delayed re-study. The renal vessels are intact. The tip of the knife (with a 4 inch blade) only penetrates 2.5-3 inches — a half-hearted stabbing in an area where the compressibility of soft tissue allows a blade to penetrate substantially deeper than its length.

Direct questioning and cross-examination at a juried trial brought out the opinion that the wound was relatively shallow compared to the weapon, and no vital organ or vessel was damaged. The tip of the knife blade obviously just nicked the renal facia sufficiently to admit some air without damaging a capsular artery or the kidney *per se*. (Comments will describe the unusual, if not unique, problem of testimony and display of courtroom exhibits over a "crow-fly" distance of approximately 860 miles because the State Public Defender Office refused travel money.)

The jury, apparently influenced by the lack of significant harm done and by the defendant taking her to medical care immediately after the stabbing, decided that it was not the defendant's intent to kill her. They brought in a reduced verdict of first degree reckless endangerment and bail jumping which carries a 25 year maximum sentence with a maximum of 15 years in prison up front with 5 years supervision, and 5 years concurrent time for bail-jumping.

Forensic Science, Forensic Radiology, Intentional Stabbing

D20 The Bullet That Killed Confederate GeneralBen McCulloch? Firearm Identification and Analysis of a Civil War .58-Caliber Bullet

Douglas D. Scott, PhD, Nebraska Wesleyan University, 11101 South 98th Street, Lincoln, NE 68526*

After attending this presentation, attendees will understand employing modern firearm identification procedures and theory to historic situations providing an alternative validation process to the field of firearm and tool mark examination.

The presentation will impact the forensic science community by demonstrating the capability and validity of firearm and tool mark examination to very old cold case evidence, in this case an 1862 battle-related death.

A large impact-deformed lead bullet that is purportedly the bullet that killed Confederate General Benjamin McCulloch during the Civil War battle of Pea Ridge, Arkansas on March 7, 1862 was examined using modern firearm identification procedures to ascertain if the bullet type and condition are consistent with the family story of this being the fatal projectile. McCulloch was a prominent Texan who had been appointed a Confederate general officer to command Texas and Arkansas troops in 1861. He had been a Texas Ranger and was a veteran of the Mexican-American War of 1846-1848. McColluch's daring came to an abrupt and fatal end in Oberson's field on August 7, 1862 at the Battle of Pea Ridge, Arkansas. The bullet purported to have been recovered from McCulloch's body is a .58-caliber hollow base Minié ball or bullet with three rings or canelures around the lower skirt. The purported McCulloch bullet is impressed with three broad shallow land and groove marks. The land and groove marks are consistent with the bullet having been fired from a Model 1855 or Model 1861 rifled musket or other firearms rifled according to U.S. Government specifications such as the altered M1841 "Mississippi" rifle. The hollow base exhibits a rough surface or stippling effect that is consistent with the bullet being fired from a blackpowder weapon. The bullet essentially mushroomed on impact, although the mushroom effect is asymmetrical. The impact deformation on the bullet head is consistent with it having struck and penetrated an object with no intervening hard elements. The deformation is consistent with a bullet that was spin stabilized, and at the time it struck the object was still traveling in trajectory at a velocity well above its terminal limits. The deformation is consistent with having penetrated tissue, but not striking any bony features. On one side of the bullet's impact deformed area a tool mark is evident. The area is slightly flattened and impressed with very fine crisscross striations. These crisscross tool marks are consistent in type with the gripping or inside surface of the jaws of a medical forceps tip of the type in common use in the mid-nineteenth century. The impact deformed bullet was fired in a rifled musket of .58-caliber that is consistent with the type of weapon known to have been issued to the men of Company B, 36th Illinois Infantry Regiment who are credited with killing General McCulloch on March 7, 1862. The impact deformations evident on the bullet are consistent with it having struck McCulloch in the breast, but passing between the ribs, encountering only soft tissue in its path. The tool marks present on one side of the bullet are consistent with the gripping surface of medical forceps of the type known to be part of Civil War era surgical kits. None of the observations are inconsistent with the oral history ascribed to the bullet's origin or that it was removed from General McCulloch's body.

Firearm, Bullet, Historic

D21 The Rosario Shooting Incident: A Complex Analysis and Reconstruction

Alexander Jason, BA, ANITE Group, PO Box 375, Pinole, CA 94564*

After attending this presentation, attendees will become familiar with techniques for performing shooting reconstruction and analysis.

This presentation will impact the forensic science community by teaching novel and advanced techniques and technology for shooting reconstruction and analysis.

An officer involved shooting occurred in which two NYPD police officers fatally shot two suspects. Firing three handguns, a total of 28 rounds were fired by the officers striking the two decedents 8 and 14 times, respectively. The shooting scene included many bullet defects in the floor beneath where the decedents were laying.

The primary issue: Were the two decedents shot while on the floor or while they were active. Secondary issues included the location of the two shooters; the movements of the decedents; and time involved in firing the 28 shots. The physical evidence included the location of entry and exit defects on the bodies, wound paths, shored entrance and exit wounds, the bullet defects on the clothing, and the presence or absence of gunshot residue and bullet residue on floor and clothing and the significance of this evidence.

This paper demonstrates the methodology involved in a multidisciplinary approach to the reconstruction and analysis of a shooting incident in which bullet impact damage, cartridge case locations, victim wound path evidence from the autopsy, experimental, and photographic analysis and other elements are all integrated into an overall analysis which can be used to make significant determinations. These facts can then be utilized to determine what could and could not have occurred and specifically, if the description of the two police officers is or is not consistent with the physical evidence. Although a shooting incident reconstruction always includes the forensic crime laboratory analysis of the physical evidence, an effective reconstruction requires an understanding of the capabilities and dynamic characteristics of firearms, projectiles, ejected cartridge cases, gunshot residue, and the dynamics associated with bullet penetration into and out of clothing. This case is an effective example of how all these items can be integrated into an analysis and reconstruction of a shooting incident.

Additional important components in the overall reconstruction include the analysis of layers of clothing, the alignment of bullet defects in the clothing; advanced photographic analysis to attempt to correlate the floor defects with the gunshot wounds on the bodies and to create overlays of clothing layers for analytical purposes and to be used as exhibits; experimental ballistic testing; chemical tests used to distinguish entry from exit; the use of 3D computer animation modeling for both analytical purposes and to be used as demonstrative exhibits. High speed video imaging of relevant ballistic phenomena and fabric dynamics were also utilized for analytical and demonstrative purposes. This paper will discuss the incident, the evidence, and specifically how the analysis and reconstruction was performed.

Shooting Reconstruction, Gunshot Analysis, 3D Modeling

D22 Shooting Dynamics: Elements of Time and Movement in Shooting Incidents

Alexander Jason, BA, ANITE Group, PO Box 375, Pinole, CA 94564*

After attending this presentation, attendees will have an understanding of the times involved in shooting a handgun and become familiar with some of the significant human performance factors associated with shooting.

This presentation will impact the forensic science community by providing baseline data on shooting performance and related dynamics.

In the analysis and reconstruction of shooting incidents, a key element is often the timing involved in shooting, reacting, and moving. These data can be significant because they may be helpful in defining significant elements. These elements can include: how much movement or distance a person could have achieved before or during the shot sequence. Other determinations can relate to perception, reaction, and response before and during the shooting.

Specific data on the ranges of typical, average, or expected rate of firing do not exist in the literature. Although there is much available data on the mechanical firing rates of automatic weapons, there is very little data on basic questions as "How fast could someone have shot," "How fast could the officer draw and fire?" "How could the person have been shot in the back?" or certainly, "Why were so many shots fired?" This paper addresses these and other questions.

Primary Issues Examined:

1. Shooting performance baselines.
2. Time to draw a pistol from a holster and fire the first shot.
3. Time intervals between shots.
4. Time required to stop shooting.
5. Time required to move from standing erect to a prone/supine position

This paper discusses the human performance dynamics involved in shooting and it presents an analysis and of several experiments:

Time Required to Stop Shooting: Most people have experienced instances in which they decided to inhibit or stop an action but were unable to do so. Clicking a computer mouse just after you noted that the dialog window closed or tossing an object (like a pen or candy bar) at someone just after you noted that their head turned away and would not see it coming. You know you shouldn't do it, but you can't stop your action.

There are psycho-physiological mechanisms which limit the time in which a human action (motor program), once begun, can be stopped. This experiment was designed to test the perception and the stop reaction time of a group of police officers.

Shots Fired at a Falling Person: The falling movement – whether a rapid collapse or a crumple resulting from incapacitating wounds – cannot be distinguished from a deliberate tactical maneuver of someone who has decided to go to ground to avoid being shot or to assume a less exposed position while returning gunfire. Falling to the ground itself cannot be a reliable indicator that a threat is no longer active. Even a mortally wounded person can fall to the ground and fire one or more shots before becoming incapacitated and/or unconscious.

The goal of this experiment was to measure the amount of time required for a person to fall to the ground from a standing position and to determine the number of shots that could have reasonably been fired during that period.

Time to Draw & Fire, Shooting Speed: The goal of this experiment was to determine the minimum, maximum, and average time required for a group of police officers to draw their handgun from a holster and fire one shot.

Experienced & In-Experienced Shooters: The shooting speeds of experienced and in-experienced shooters were measured. The purpose being to establish performance rates which can be used as reference baselines.

Rates of Fire (Shooting Intervals): Historical and empirical data was used to establish the fastest shooting rates measured during highly skilled professional shooting events and by experienced shooters.

Shooting Reconstruction, Human Factors, Reaction Time

D23 An Interdisciplinary and Community Approach to the Identification of Clandestine Mass Graves: The McGill University - Parc Safari Project

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After attending this presentation, attendees will better understand how to structure a large mass grave identification project that is interdisciplinary and features a community participation component and collaborations with private enterprise.

This presentation will impact the forensic science community by making three main contributions with the help of scholars of a number of disciplines, of private enterprise partners, and of local community members, the project will develop, refine, and test methods for the location of mass graves. It increases knowledge of how mass graves modify a pre-existing built landscape, and it helps identify ways in which local traditions reflect the presence of graves. A non-negligible benefit of the project is that it shows how academics, private enterprise, and local community members can cooperate to each reach their own objectives and at the same time produce knowledge critical to addressing a serious human rights-related issue.

For the past year, archaeologists, remote sensors, geologists, wetland scientists, legal scholars, representatives from private enterprise and local community members have been collaborating to develop innovative ways of locating clandestine mass graves and identifying and solving the main challenges involved. In September 2007, the zoological director of an African animal park located near Montreal, Canada, contacted the Anthropology Department at McGill University to explore the possibility of recovering animal skeletons from the park's cemetery to create educational exhibits. The Parc has been in operation for nearly 40 years, but due to a recent change in ownership and administration, the cemetery is almost entirely undocumented. Even its spatial extent is currently uncertain. The land on which the cemetery stands no longer belongs to the park, but is owned by a local farming family.

The McGill Anthropology Department began using the cemetery as the location of its archaeological field methods course. Members of the Geography Department working on the question of clandestine mass graves in genocide and war crimes contexts soon added themselves to the team and started using the cemetery to test new methods for locating graves using a mix of remote and onsite sensing. Scholars from the McGill Faculty of Law are now participating in the project.

The cemetery is currently a mix of graves in various stages of archaeological documentation, some of them being merely identified through test-pitting or surface visible remains, others being partially or fully excavated, others still being excavated and their remains studied and processed in the laboratory, and reassembled as exhibits. The remote and onsite sensing researchers on the team have a ready made experimental situation in which to develop and test methods for the identification of graves of various types, from individual to mass graves. They have known graves on which to develop and refine methods, and a large area (< 1 acre) of possible or suspected graves on which to test those methods. Over time, the archaeologists are using excavation to test the predictions of the remote and onsite sensing researchers as to the location and nature of graves, and the extent of the cemetery.

Because the park has been a major feature of the local community, and a major employer for over a generation, there is considerable local oral tradition about the park and its cemetery. There is also limited institutional memory at the park itself about what is in the cemetery and where. These local stories are being recorded and compared with the results of excavation and sensing in order to determine in what ways they relate to the actual material record. There has been considerable community interest in the project. The archaeological survey of the suspected extent of the cemetery and surrounding areas has also turned up significant historical remains dating from the 18th century onwards, some of which are co-mingled with documented animal graves. The project is therefore producing a record of how later events modify and mix with earlier remains and how they are perceived locally and integrated into local traditions.

Mass Graves, Interdisciplinary, Community Based Approaches

D24 Remote Detection of Clandestine Graves: A Comparison Across Ecosystems

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After attending this presentations, attendees will gain an understanding of the use of remote sensing for detecting clandestine graves across a range of ecosystems. The fundamental concepts of remote sensing utilizing the reflectance of solar radiation are presented as applied to forensic investigations of clandestine graves.

This presentation will impact the forensic science community by demonstrating how imaging spectroscopy can be used to detect the spectral signature of subsurface cadaveric decomposition in a range of ecosystems. This technology goes beyond the simple detection of "disturbed soil" and illustrates how cadaveric decomposition affects the reflectance of soils in a similar way in varying ecosystems from tropical to temperate.

Remote sensing in the earth and planetary sciences is a well developed field with several proven applications in geology, forestry, ecology, marine sciences, defense and security, biogeochemistry, and agriculture and soil sciences among many others. The transfer of this technology to forensic investigations has been relatively recent. This form of remote sensing utilizes solar radiation to infer characteristics about the Earth's surface. The solar radiation reflected from the surface to field-portable, airborne and satellite sensors is recorded across of range of hundreds of narrow, discrete wavelengths of light. Specific patterns in this reflected radiation (i.e., spectral signatures) can be used to determine the nature of the material or objects on the Earth's surface or in more precise studies to identify individual targets such as vegetation types, vegetation health, mineralogical compositions, and water content of soils, among many other others.

For several years, a critique of this technology had been that "generic" disturbances in the soil would lead to several false positives in the detection of clandestine graves, which, from a solely contextual perspective, such as the interpretation of aerial photos resemble other forms of disturbance. In these critiques; however, the spectral information from the hyperspectral domain was often neglected.

The potential of differentiating the reflectance of subsurface cadaveric decomposition from generic soil disturbance in a seasonal tropical environment has been recently shown in the literature from field spectroscopic and airborne imaging spectroscopy.

This research is part of an ongoing interdisciplinary research program investigating the detection of clandestine burials across ecosystems. A comparison in the similarities of the spectral signatures from field and airborne imagery across contrasting ecosystems: tropical seasonal (distinct dry season with no rain), tropical rain forest (limited dry season and overall precipitation in excess of 4m), and temperate (distinct summer and winter with freeze-thaw cycles). In each ecosystem the graves examined are animal proxy graves, encompassing a wide range of species from cattle in the tropical systems to elephant, zebra, buffalo, and several unknowns in the temperate environment. Additionally, a broad temporal range in the ages of the graves from one week to over six years at the time of data collection.

Each of the graves consisted of one to several bodies interred in soil. The spectral signatures of the graves differed from reference non-grave soils and "disturbed" soil in each environment. Furthermore, similarities in the spectra of the grave soils were observed across environments indicating that subsurface cadaveric decomposition alters the soil reflectance in similar ways in different ecosystems with different soil types, climates, and ages of the burials, and species compositions. Physical soil chemical composition and temperature, vegetation reflectance and vegetation pigment concentration data corroborate the findings from the soil spectral data. The similarities in the spectra of the graves from the various ecosystems can be used to further develop detection methodologies that can be applied to airborne or satellite imagery.

Remote Sensing, Clandestine Graves, Detection

D25 A Comparison of Conventional or Plain Radiography Versus Computerized Radiography (CR) in Forensic Imaging

Gerald J. Conlogue, MHS, c/o Diagnostic Imaging Program, Quinnipiac University, 275 Mount Carmel Avenue, Hamden, CT 06518; Tania Blyth, MHS, 169 Watch Hill Road, Branford, CT 06405; and Jiazi Li, BS, Bioanthropology Research Institute, Quinnipiac University, 275 Mount Carmel Avenue, Hamden, CT 06518*

After attending this presentation, attendees will have a better understanding of the two types of digital imaging systems that are being integrated into medical imaging, the advantages and disadvantages of each, and a comparison between one of the systems, Computed Radiography, CR, and conventional x-ray film. In addition, attendees will learn the benefits of an industrial CR in cases of suspected child abuse.

This presentation will impact the forensic science community by explaining why digital radiography should be integrated into forensic setting as it has been into the medical setting. Although the initial cost of the switch is considerable, the savings over time would be significant. In addition, the ability to adjust the appearance of the imaging following processing would eliminate the need for repeat exposures. However, dedicated medical CR systems may not provide optimal images in all situations. On the other hand, industrial CR would provide more imaging flexibility and the higher image resolution necessary in cases of suspected child abuse.

In medical imaging, film, the principle recording medium since 1895, is rapidly being replaced by one of two digital imaging systems: computed radiography (CR) and direct digital radiography (DR). Both systems have numerous financial advantages over film, but there may be disadvantages for forensic applications. This presentation will compare the image quality of one of the digital systems, CR, with conventional film in a forensic setting. In addition, a comparison will be made between medical and industrial CR image receptors, demonstrating the benefits of the latter.

Eliminating film as the recording medium in forensic imaging has a number of advantages, but care must be taken to avoid the limitations of digital imaging systems that have been designed for medical applications. Algorithms for medical applications are designed for hydrated living tissues and based on lower radiation doses. In order to achieve the low dose, pre-set algorithms sacrifice image detail. Because of this, medical applications are less than satisfactory for demonstrating forensically relevant defects such as a non-displaced rib fractures in deceased children. Also, because these systems were developed for hydrated tissue, images of skeletal material are less than optimal. An industrial CR system, in contrast, is based on five to ten times the radiation dose of a medical system. It produces an image with high image resolution and employs various algorithms developed for materials ranging from plastics and rubber to metals such as steel and aluminum.

All radiographs were taken at the Office of the Chief Medical Examiner for the State of Connecticut in Farmington, Connecticut. Anterior-posterior, AP, and lateral projections of the skull and chest were taken on a cadaver with three systems: conventional film in a cassette, Konica medical CR, and Fuji ST-VI CR plates. The conventional films were processed through a Kodak automatic processing unit, the Konica plate with a Konica CR reader with medical algorithms. The Fuji plates were placed into a Fuji high resolution (HR) CR reader capable of 50-micron resolution. A sudden infant death case was examined using the same three systems. Selected areas from each set of images were compared to determine the best resolution.

Digital radiography should be integrated into forensic setting as it has been into the medical setting. Although the initial cost of the switch is considerable, the savings over time would be significant. In addition, the ability to adjust the appearance of the imaging following processing would eliminate the need for repeat exposures. However, dedicated medical CR systems may not provide optimal images in all situations. On the other hand, industrial CR would provide more imaging flexibility and the higher image resolution necessary in cases of suspected child abuse.

Forensic Radiography, Forensic Imaging, Computed Radiography

D26 The Shroud of Turin as an Object of Forensic Science Investigation

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The goal of this presentation is to present an overview of the scientific data that exists with respect to the Shroud of Turin and its image in order to encourage new collaborative studies that involve the methods and techniques of applicable forensic sciences.

This presentation will impact the forensic science community by helping attendees who wish to contribute their particular expertise to the understanding of the Shroud as a legitimate forensic object, and could increase the knowledge of the Shroud from a forensic perspective.

The Shroud of Turin is a long rectangular cloth that exists in the Italian city of Turin. This cloth appears to bear full-size frontal and dorsal images and apparent bloodstains of a human male. It is seriously thought to be by many to be the burial cloth of the historic Jesus. This paper is presented at this time to coincide with a public showing in Turin of this cloth.

The Shroud of Turin was allowed to be examined for five days (around the clock) during October 8-13 in 1978. This examination was conducted to extract, in a non-destructive manner, scientific data for

later hypothesis testing pertaining to image formation and authenticity (with respect to the hypothesis that the Shroud is the historic burial shroud of Jesus). The data collections included sticky tape sample removal, Spectral reflectance and UV fluorescence photography, close-up photography, spectral reflectance spectroscopy, x-ray radiographic imagery, and x-ray fluorescence. The results of these data collections and their subsequent analyses were published in the peer-reviewed scientific literature which are available for reference and study. The two major conclusions from the scientific team, working collaboratively, were: (1) that the image on the Shroud, which contains no evident extraneous substances that can be associated with the image color, is chemically a degradation of the cellulose; and, (2) that the blood-like stains on the Shroud are indeed blood.

Ten years later, in 1988, the Shroud was subjected to radiocarbon analysis, which yielded a radiocarbon date of mid-Fourteenth century. Certain challenges to this result are currently under investigation based on possible contamination from air-borne carbon-containing molecules.

From the available scientific data that is presently available for the Shroud, collaboration is encouraged and even solicited from the forensic community to formulate and test hypotheses via the Scientific Method in order to advance proper understanding of the Shroud and its image. The presentation will discuss several example topics where forensic input might be useful from scientific, cultural, and historical perspectives. Finally, collaborative ideas may be suggested from the forensic community regarding how modern techniques might acquire useful data from the Shroud of Turin in a non-destructive manner for further hypothesis testing.

Shroud of Turin, UV Fluorescence, Forensic

D27 Optimizing Radiographic Image Quality in the Postmortem Investigation of Child Abuse

Tania Blyth, MHS, 169 Watch Hill Road, Branford, CT 06405; and Gerald J. Conlogue, MHS, c/o Diagnostic Imaging Program, Quinnipiac University, 275 Mount Carmel Avenue, Hamden, CT 06518*

After attending this presentation, attendees will gain a further appreciation of the importance of skeletal imaging in the investigation of sudden, unexplained deaths in infants and children. The attendees will acquire an understanding of the imaging techniques necessary to optimize image quality, and therefore, to best demonstrate subtle fractures.

This presentation will impact the forensic science community by providing an understanding of the imaging techniques recommended in order to enhance radiographic image quality and discussing the techniques which should be avoided during postmortem pediatric skeletal imaging.

This research includes 29 deceased infants and children aged several days to five years that underwent autopsy and radiographic examination at the Office of the Chief Medical Examiner in Farmington, Connecticut between the period of December, 2005 and December, 2007. "Babygrams" and skeletal survey examinations were performed. In addition, various combinations of image receptor speeds (400, 100, and 50 relative speed index (RSI)) were used in order to observe the differences in recorded detail for each image receptor speed. To establish optimal exposure factors for various sized infants and children, the length, weight, kVp, mAs, RSI, source-to-image distance (SID), and the presence or absence of a grid were recorded. Bilateral oblique views of the thorax were included in the protocol to determine if those projections enhanced the ability to detect rib fractures in these cases. Two of the cases demonstrated rib fractures and the affected ribs were extracted and specimen radiographs were performed.

The results of this study confirmed the superiority of the skeletal survey images over the "babygram" images as anticipated. In addition, 50 RSI image receptors offered superb recorded detail compared to the 100 and 400 RSI counterparts. Rib fractures demonstrating abundant callus formation were present in two of the 29 cases (case # 1 and case #29). Both infants suffered from multiple bilateral fractures of the posteriolateral ribs. AP thorax radiographs in case #1 demonstrated evidence of healing fractures of the left 3^{rd}-6^{th} and right 2^{nd}-7^{th} posteriolateral ribs with abundant callus formation bilaterally. Addition of AP oblique views of the thorax provided improved fracture visualization and demonstrated abundant callus formation and possible new fractures through the bony callus. Specimen radiographs provided improved visualization of the fracture sites and confirmed the new fractures through the bony callus; however, no additional fractures were identified in case #1 through this method since the bony callus allowed for easy fracture visualization.

The initial AP radiograph of the thorax in case #29 failed to demonstrate evidence of bony thoracic trauma. The addition of AP oblique views of the thorax resulted in visualization of multiple rib fractures with callus formation of the left 4^{th}-6^{th} posteriolateral ribs. The entire thoracic cage was removed at autopsy and specimen radiography was performed using 50 RSI image receptors. The specimen images resulted in improved visualization of the left posteriolateral rib fractures which were also easily visualized upon gross inspection. However, specimen radiographs revealed multiple fractures of the right 4^{th}-6^{th} posteriolateral ribs which were not easily visualized on the previous radiographs or upon gross inspection. Additionally, a 3° cephalic angle was utilized in order to demonstrate the fractures from another perspective and further enhanced the visibility of the fracture of the 5^{th} rib.

Many child abuse fractures are subtle and can easily be overlooked, therefore optimal images are critical. In order to produce images with the best diagnostic quality, specific protocols and image receptors must be used, and "babygrams" should never replace skeletal survey examinations. Proper positioning of the anatomy is imperative, otherwise fractures can be missed. The addition of oblique views of the thorax increased the fracture yield in case #29 and proved to be beneficial since rib fractures have a high specificity for abuse and oblique views can increase the visibility of such fractures. In this study, the addition of a 3° cephalic angle during specimen imaging better demonstrated the fracture line of the right 5^{th} rib in case #29. This finding reinforced the fact that the relationship between the x-ray tube, anatomy, and image receptor plays a significant role in fracture visualization, particularly with rib fractures.

Radiography, Child Abuse, Rib Fractures

D28 Inadequate Investigation Impedes Determination of the Manner of Death

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After attending this presentation, attendees will have learned the importance of on-scene investigation in the determination of the manner of death.

This presentation will impact the forensic science community by demonstrating the consequences of an inadequate on-scene investigation and collection of evidence.

The importance of a thorough and meticulous on-scene death investigation cannot be over-emphasized. The failure of law enforcement to adequately recognize, document, and collect evidence at the scene may impede the medical examiner's ability to determine the cause and manner of death.

The body of a 25-year-old, Caucasian male (D.S.) was found at the edge of the woods on his "best friends" property. D.S. was found to be on his knees with his upper body and head flopped forward with his face on the ground and mud in his mouth. The family of the decedent, reported that he had recently been arrested for public intoxication and placed on a "suicide watch" while incarcerated. The family also reported that D.S. had one prior suicide attempt and is known to have "no friends and hangs around drug dealers." After being released from jail two weeks prior to the death, he had been residing with his "best friend" who reportedly argued with D.S, on the morning of the incident secondary to "drinking his beer" and had told him he needed to move out to "watch dirty movies." No suicide note was located.

The "best friend" found the decedent's body approximately 90-yards from the house. Two revolvers were found at the scene along with two spent shell casings in one of the handguns. One weapon was found in the pocket of D.S. and the other was found lying on the ground next to his left foot and a large pile of cerebral tissue. Both firearms were noted to be .357 magnums. At the insistence of the law enforcement officer a gunshot residue test was not performed at the scene. D.S. is reported to be right handed.

At autopsy, the body was found to have an explosive type stellate, hard contact gunshot wound to the right forehead, a graze wound of indeterminate range over the right eyebrow with associated tattooing, and a perforating contact gunshot wound with near amputation of the right index finger with a large amount of soot present. No exit wound located. Toxicology was positive for alcohol and cannabinoids. The brain was within the body bag in a separate biohazard bag. No projectiles were found on physical or radiographic examination of the skull or bagged cerebral tissue.

The trajectory of the right forehead wound is noted to be from front to back, right to left, and downward. The path of the projectile of the right forehead graze is noted to be from front to back with minimal rightward and up deviation.

Review of the coroner and law enforcement investigative reports failed to reveal that a gunshot residue test was performed. In addition, the reports did not indicate that the ground surrounding the victim was examined for additional footprints.

Most forensic disciplines assume that a decedent who has been shot more than once is a victim of homicide, and usually they are correct. However, forensic literature has multiple cases of multi-shot suicides. When presented with a victim with multiple gunshot wounds the investigating agency must use extreme caution in assuming the manner of death to be either homicide or suicide. Special attention must be paid to recognize, preserve, and collect on-scene evidence if the forensic pathologist is to be able to determine the manner of death. The loss of the trigger finger on the right hand of a right-handed individual is of concern if the individual was to have fired both rounds with his dominant hand.

The possible failure to collect all of the biologic material surrounding the head wound at the scene may have resulted in the inability to locate the offending projectile. In addition, the on-scene law enforcement agency advised the coroner that an autopsy was not necessary for this "obvious suicide." The manner of death in this case remains undetermined secondary to inadequate on-scene collection of evidence.

Suicide vs. Homicide, On-Scene Investigation, Evidence Collection

D29 Interactions Between the German Cockroach (*Blatella germanica*) and Pooled Bloodstain Patterns

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After attending this presentation, attendees will have a better understanding of bloodstain pattern analysis and interactions between cockroaches and bloodstains.

This presentation will impact the forensic science community by increasing knowledge of insect stains, specifically those made by the German cockroach (*Blatella germanica*), and bloodstain patterns at crime scenes; this will result in a more accurate bloodstain pattern analysis.

Bloodstain pattern analysis can assist in reconstructing a sequence of violent events at crime scenes. Yet, bloodstain pattern analysis can be confounded by the behavior of insects that use blood as a food source. For example, cockroaches have been reported anecdotally to change the shape of bloodstain patterns and form additional patterns (insect stains) through feeding. At present these changes are poorly understood. To improve understanding of these processes, a laboratory experiment was conducted to observe the interactions between German cockroaches (*Blatella germanica*) and pooled bloodstains. The null hypothesis was tested that German cockroaches will not alter the morphology and presumptive chemistry of pooled bloodstain patters over a period of 48 hours.

This experiment was conducted in a microscene. A microscene is a 47.5 cm^3 wooden box with two glass walls, two wooden walls and a Plexiglas ceiling. The two wooden walls were covered with wallpaper and the floor was covered with linoleum. Six milliliters of freshly drawn human blood was pooled on the linoleum. Five cockroaches were then added to the microscene. Cockroaches were kept in the microscene for 48 hours. After this time three presumptive blood tests were used (phenolphthalein, leucocrystal violet, Hemastix®) to determine if cockroach stains tested positive for blood. This experiment was replicated four times and controls (blood without cockroaches) were used.

During the initial 30 hours the cockroaches did not alter or feed on the bloodstains. Cockroaches walked around pooled bloodstains when moving throughout the microscene. In the final 18 hours, however, cockroaches fed on bloodstains and formed insect stains via defecation and tracking (transferring blood from feet or abdomen to surface). Insect stains were present on the linoleum floor only and could be confused with impact bloodstain patterns. No significant differences existed when testing insect stains and blood with Hemastix® and phenolphthalein. However, insect stains did not react with leucocrystal violet.

Insect Stains, Bloodstain Pattern Analysis, Insect Artifacts

D30 Weapon Width Determination Using Cast-Off Blood Spatter

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The goal of this presentation is to show attendees that cast-off blood spatter can be useful in the determination of weapon width using both the phenomenon of side-by-side blood drops within cast-off spatter trails and the proportionality of width between the spatter trails and respective weapons of use.

This presentation will impact the forensic science community by demonstrating the phenomenon of weapon determination using cast-off blood spatter and its application in the investigation and discovery of the weapon in question in forensic casework, including analysis at the crime scene.

Bloodstain pattern analysis can be a very useful aid in the investigation and reconstruction of a crime. Created when blood comes in contact with a surface following a bloodshed event, key pieces of information may be obtained including the object in question and the minimum number of blows. Different bloodshed events produce varying bloodstain patterns. Impact spatter, and more particularly cast-off blood spatter, is created when blood is flung or projected from an object in motion, following adherence of a sufficient volume of blood to the object. When swung, blood will be propelled off the end. This action is the result of the angular momentum overcoming the surface tension of the blood. The result of such action is distinct linear patterns, or trails, of bloodstain. SWGSTAIN defines a cast-off pattern as a bloodstain pattern resulting from blood drops released from an object due to its motion.

Crime scene casework has seen the potential of side-by-side drops, an uninvestigated cast-off blood spatter stain phenomenon. The objective of this research is to investigate the phenomenon of observed side-by-side cast-off blood spatter stains to determine the relative size of the swinging object. As different objects have more surface area and create different linear patterns, the volume of blood present on the object and the width of the object are important in the determination of the object of interest based on the examination of the resultant cast-off pattern. By varying weapon characteristics, experimentation will be conducted to confirm this principle. Observations of spatter trail widths will also be performed for comparison to the weapon of creation's widths.

In this study, twenty-five objects of varying sizes, construction, and dimensions commonly used as weapons were used to generate cast-off blood spatter for analysis. These objects included tools/building materials (pry bar, an adjustable wrench, two different sizes of hammers, a wooden stake, a metal ruler, painters' pole, brick and two different sizes (length and diameter) of PVC piping), metal blades (switchblade, butter knife, axe, and machete), and sport equipment/miscellaneous items (plastic bat, golf club, hair brush, spatula, hardcover book, remote control, plastic sword, wine bottle and ice scraper). Each weapon was moved in a manner analogous to a bloodshed event producing cast-off spatter. Observations were made regarding the width of the spatter trails and the presence of any side-by-side drops.

Twenty-two of the weapons produced the desired side-by-side drops, with the other three illustrating alternate results. Both the axe and switchblade resulted in vertical drop pairings, corresponding to the height, rather than the width of the weapon blade. The butter knife was the only weapon to result in no visible pairings. Following repeated experimentation, the results were found to be reproducible. Proportional spatter trail widths were also observed for all weapons used. Overall, the results of the experimentation were able to demonstrate the correlation between weapon widths and spatter trail width. The appearance of side-by-side stains was also observed, supporting the aim of this project.

Cast-Off Spatter, Weapon Width, Side-by-Side Blood Drops

D31 Stressors, Needs, and Management of Death Notification for the Working Professional

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The goal of this presentation is to inform attendees of the need for formal death notification training, primarily from the perspective of stress management and awareness for the notifier.

This presentation will impact the forensic science community by making professionals aware of the effect that death notifications have on the notifier and the suggested solutions for this traumatic task.

The emotionally difficult task of informing a survivor that their loved one has died is an assignment that is necessary, yet traumatic, for everyone involved. While this understudied area is reviewed largely from the perspective of how to assist the loved one's next-of-kin, studies have not fully addressed how the notification affects the individual delivering the bad news. Forensic professionals, including death investigators, crime scene personnel, and even laboratory analysts, may face this situation in their professional roles.

What must be considered is that any forensic professional who is exposed to a case involving death is potentially exposed to the trauma of death notification. Whether they make the notification personally, or are present at a scene where a notification occurs, forensic professionals need to be prepared to deal with survivors of the deceased. While some professionals may take the attitude that notification is just part of the job and that they don't need any assistance, studies in this presentation show effective notification delivery skills and stress management tools for notifiers to follow.

The leader in death notification study and training is the group Mothers against Drunk Driving (MADD). The research, protocol and training that MADD performs have opened a door toward conducting effective death notifications as well as strategies to reduce stress and trauma for the notifier. In this presentation MADD's suggestions and protocol are combined with research results of Lord, Stewart, and Mercer whose extensive survey of 245 professionals provides information relative to notifier stressors including causes of death, survivor reactions, and methods used to cope with the difficulties associated with notifications.

The Lord, Stewart, and Mercer study also showed that 70% of participants had performed at least one death notification; however, nearly 40% of these participants had never received formal training in death notification. The call for training in delivering effective notifications as well as the need for professionals to implement stress management tools is a need that should be continually addressed. Ultimately, the goal is the well-being of the survivors and the ability for forensic professionals to continue in their respective professions with good mental health and effective work relationships.

Death Notification, Stress Management, Communication

D32 Remote Hyperspectral Imaging of Human Remains

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After attending this presentation, attendees will have a better understanding of the role that remote hyperspectral imaging could play in the search for human remains.

This presentation will impact the forensic science community by providing a possible method for detecting human remains via remote sensing using hyperspectral imaging cameras that are sensitive in the shortwave region of the electromagnetic spectrum.

Human skin has been shown to possess characteristic reflectivity in the infrared region of the electromagnetic spectrum. Previous research using a hand-held short-wave infrared (SWIR) spectrometer has revealed that there are key wavelengths that can be used to distinguish skin and bone from foliage and other environmental objects. As a result, the current research study was designed to investigate the ability of an airborne SWIR hyperspectral system to detect human remains.

To determine the viability of differentiating spectral signatures of human skin from background variables, data were collected from decomposing remains at the Anthropological Research Facility at the University of Tennessee at Knoxville using portable SWIR spectrometers. Libraries of these data were developed, along with data on live human skin, and common environmental factors such as vegetation, roofing, asphalt, and other debris. Following development of the spectral libraries, principle component analysis was performed to create data models, which were subsequently tested using a soft independent modeling of class analogy (SIMCA) classification. The SIMCA results revealed that the PCA models were able to distinguish between the spectral signatures of human skin versus environmental variables. In addition, SIMCA results were used to demonstrate that live human skin and skin from human remains are spectrally similar.

Once it was determined that the categories of interest for this project were each spectrally unique in the SWIR region of the electromagnetic spectrum, the concept was applied to hyperspectral imaging (HSI). HSI allows for the collection of spatial and spectral data simultaneously, creating a "data cube" which can be used to chemically classify objects in an image. The spectral profile collected for each pixel contains reflectance data characteristic of the material or combination of materials present in that location in the image. By processing the hyperspectral images using commercial image analysis software, spectra in the image can be matched to reference spectra, allowing for the detection and visualization of specific substances or objects.

Tests using an airborne hyperspectral system (400-2350nm) have been completed. A small human remains sample was placed on the ground along with live skin subjects, various test materials, and debris. Hyperspectral images were obtained at altitudes ranging from 200-1500 ft from a helicopter hovering over the target area. Using reference spectra, each image was calibrated and atmospherically corrected. The Spectral Angle Mapper (SAM) classification method was used to match spectral library data from skin to spectra from the airborne images. The reference spectra were successfully matched to spectra within the images, and the corresponding pixels were then classified and illuminated accordingly. These results suggest that airborne hyperspectral imaging can be used to remotely detect human remains.

Remote Sensing, Hyperspectral Imaging, Human Remains

D33 Suicide Notes: What Are the Victims Trying to Tell Us?

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After attending this presentation, attendees will gain knowledge in the motivation of suicide victims. Suicide notes offer the only insight into the mind of the victim. These suicide notes, recovered from actual cases, have been analyzed for theme, content, and demographic information.

This presentation will impact the forensic science community by serving as a key aspect into the behavior and thoughts of those committing suicide. It will provide further incite to criminal investigators and medical examiners to aid in the determination of manner of death.

Each day in the United States, between eighty and ninety individuals commit suicide. Suicide is the eleventh leading cause of death in the United States. For young men between 15 and 24, it is the third leading cause after accidents and homicide. The suicide victim leaves uncounted "victims" that are friends and family who struggle to determine why this happened. Medical professionals have looked to chemical imbalances and brain defects to explain suicide. Criminal investigators and medical examiners labor with lengthy investigations and testing to determine the mindset of the suicide victim so they can conduct an adequate investigation and correct classification for manner of death. The U.S. Military is having an unprecedented number of suicides with the rate rising each of the last four years. This had lead to the U.S. Army developing new programs and studies to help prevent suicides.

A number of studies and theories on suicide indicate that the suicide victim has feelings of hopelessness. They feel that they are a burden on others and society. When they are caught in a personal crisis, their reaction is to end their lives. In the vast majority of cases, the motivation is for suicide will never be known, only about 30-35% of suicide victims leave a note showing their intention.

Suicide notes from actual cases were collected for this research. They were analyzed using a qualitative research method known as "Grounded Theory." This method, developed by Anselm Straus and Juliet Corbin, has been used in sociological research to get to the meanings and themes of dialogues and discourses of individuals. The suicide notes themselves offer the thoughts of the victim at or near the time of death. It is their dying declaration.

This presentation will provide the results of that research. It will provide insight into their behavior and motivation for suicide. Common themes will be revealed of suicide victims and provide investigators information that can be used in determining manner of death.

Suicide, Notes, Criminal Investigation

D34 A Case Study of a Suicide in the Mountains of Cyprus - Focusing on Postmortem Changes

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After attending this presentation, attendees will be familiar with the difficulties of working a death scene in the extreme conditions of the

Cypriot Mountains and the unique postmortem changes that occur in the harsh environment

This presentation will impact the forensic science community by exposing attendees to postmortem changes and activities, including putrefaction, mummification, adipocere, antemortem, and postmortem injuries, as well as insect activity, and animal activity.

In July 2007, a decorated U.S. Army Colonel, serving as the Defense Attaché at the United States Embassy in Cyprus was reported missing. It was believed by the Associated Press and the U.S. Ambassador that the Colonel may have been abducted by one of a several organizations hostile to the U.S. Mission in the Middle East. An extensive search by the Cypriot police and the Cypriot Military was initiated. The U.S. Ambassador requested assistance from the U.S. military. A joint Department of Defense team of Special Agents was formed through the U.S. Army European Command, consisting of Special Agents from the U.S. Army Criminal Investigative Command, the U.S. Air Force Office of Special Investigations, and the U.S. Naval Criminal Investigative Service. This team gathered in Nicosia, Cyprus and assisted the Cypriot Police and the Foreign Service Office Investigator of the U.S. Embassy during their investigation. The formal investigation showed the Colonel was not abducted, but had taken his own life in the austere conditions of the Cypriot Mountain Range.

The Colonel committed suicide by slicing his neck with a sharp paint scraper extending from just below the left ear to about midline of the neck. The carotid artery was nicked as a result of the slice, as well as damage to the jugular vein, and the Colonel slowly bled to death. Evidence from the scene and the autopsy confirmed that the cause of death was exanguation as a result of the damaged artery and vein. Suicide as the manner of death was confirmed through normal investigative measures such as interviews, scene analysis of multiple scenes, and computer forensics.

In the time after death, the severe conditions of the mountain range caused several postmortem changes that are rarely seen together. The putrefaction caused severe blotching of the skin. This led several newspapers to report the Colonel was severely beaten and that the cause of death was a murder. These reports were incorrect and were due to leaks of pictures and information from within the police force. The extreme heat and dry air caused mummification to occur on the Colonel's hands. Additionally, sweat from his bout of shock became trapped when the Colonel liad down in the shade and created a small area of adipocere on the Colonel's back. The injury to the Colonel's neck provided an area of antemortem injury. However, animals and insects were drawn to the area of injury after death and caused several postmortem injuries. There were also several areas of animal activity on the Colonels right leg. Taken together, the areas of postmortem activity and changes provides as excellent opportunity to refresh one's knowledge in these areas.

Suicide, Cyprus, Postmortem

D35 Front Line Forensics: Expeditionary Forensic Facilities in Iraq and Afghanistan

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After attending this presentation, attendees will gain knowledge about the use of forensics and biometrics to identify, arrest, and bring to justice terrorists in Iraq and Afghanistan.

This presentation will impact the forensic science community by providing information and knowledge on the impact of forensics in the global war on terrorism. Forensics is used on a daily basis to identify terrorists, develop methods to protect individuals, and deter terrorists.

The concept of battlefield forensics is not new to the Global War on Terror or the military actions in Iraq and Afghanistan. This concept dates back to WWII when a mobile lab was used throughout North Africa, Italy and France to investigate fraud, homicides, and war crimes. Since World War II, the U.S. Army developed several "stationary" criminal laboratories in Japan, Germany, and the United States. These stationary labs were consolidated into one crime laboratory for all military services at USACIL, Forest Park, GA in 1996.

The U.S. Marines recognized the value of forensics in identifying snipers and bomb makers during the insurgent phase of the War in Iraq. This led to the development by the U.S. Army and Navy of the Joint Expeditionary Forensic Facilities (JEFF) with the mission to use ballistics, latent print, and DNA analysis to identify sniper and IED threats.

The JEFF labs returned to the World War II concept of mobility. To remain effective, the labs had to be near the conflict and move as the insurgency moved to other areas of the country. The labs also serve to assist Iraq into returning to a "Rule of Law."

There are presently six JEFF labs operating or under construction in Iraq and Afghanistan. They provide a scientific and methodical approach for evidence exploitation while providing general support to theater by providing customers with specific forensic applications or full spectrum forensics analysis.

This presentation will provide the audience an overview of battlefield forensics and how forensics has become an integral part of the military mission. The labs have provided a comprehensive program for oversight of forensics collection, handling, analysis, intelligence reporting, case development, storing, and disposition. They also provide standards for supporting Iraqi and Coalition Forces for intelligence, investigative, and judicial processes. The presentation will also provide information on situations that are unique to the battlefield forensic lab.

A case study of the use of forensics in a battlefield environment will also be presented.

Battlefield Forensics, Terrorism, Criminal Investigation

D36 Interdisciplinary Forensic and Investigative Efforts Paramount for Resolving Violent Crime

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After attending this presentation, attendees will understand the importance of methodical crime scene processing, the necessity of employing a multi-disciplinary scientific approach when conducting violent crime investigation, the tenacity required in violent crimes investigation once the "shock" of the initial report has subsided, and the enduring and critical role of "old-fashioned" detective work when investigating violent crime, particularly serial crime.

This presentation will impact the forensic community by demonstrating that significant advances in technology still rest upon time-honored crime scene processing and investigative techniques. New technology, bolstered by the effective use of the wide spectrum of scientific disciplines within the forensic community, and coupled with major case management, are all critical components to effectively resolve violent crime, particularly serial crime.

With the advent of DNA and other technologies, the days of being unable to link crimes committed in varied jurisdictions to a "travelling" serial criminal are quickly coming to an end. Despite the developments in technology, which allow near real-time access to the report, and investigation, of crimes literally around the world, the efficacy of all efforts is still directly tied to the initial police response, the initial crime scene processing, and the effective cooperation of investigating agencies

across jurisdictions. Research of and incorporation of the psychological or crime scene assessment of violent crimes rests upon those similarities noted at varied crime scenes. Recognizing and documenting relevant facts remains largely dependent upon the experience of the responding investigative personnel, the tenacity of the investigator assigned to pursue the information, and the willingness of law enforcement to share information, pool resources, and cooperate to resolve serial crimes.

A case study will be presented which illustrates how the initial methodical approach to processing a crime scene, leveraging of the multi-disciplinary approach in the subsequent advanced and continued processing of the crime scene, the management of a task force, and the incorporation the forensic pathology and laboratory findings, combined with the efforts of traditional stalwart investigative methods, resulted in identification of a violent serial offender

Crime Scene, Serial Crimes, Investigation

D37 Battlefield Forensics: The Application of Traditional Criminalistics/Forensics on the Battlefield to Support Combat Operations

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After attending this presentation, attendees will have a better understanding about how military personnel are trained to collect forensic material on the battlefield. Attendees will also understand how military personnel are trained to prioritize evidence on an objective, how to protect, document, preserve, collect and transport forensic material, but also how to process items expeditiously at the scene in order to develop and collect latent evidence, such as fingerprints, DNA, shoe impressions, etc.

This presentation will impact the forensic science community by discussing the application of traditional forensic/criminalistics techniques on the battlefield for intelligence and operational purposes. Combat actions in Iraq and Afghanistan have identified a need across the Department of Defense to increase the ability to collect and exploit forensic materials for targeting and/or prosecution. The Army must substantially increase the training and ability of soldiers to identify, collect, preserve, and process forensic material with potential evidentiary value. This skill, normally performed by military investigators during garrison law enforcement operations and by specialized crime scene teams in civilian law enforcement, must be done by deployed soldiers in both Iraq and Afghanistan, regardless of Military Occupational Specialty (MOS).

Forensic Material Collection and Exploitation Course will train the collection, processing, and preservation of forensic material on an objective or site. Students will be taught not only the basics, such as how to prioritize evidence on an objective, how to protect, document, preserve, collect and transport forensic material, but also how to process items expeditiously at the scene in order to develop and collect latent evidence, such as fingerprints, DNA, shoe impressions, etc. The course will consist of both classroom training and hands-on practical exercises. This training will be geared towards selected soldiers preparing for deployment who will serve as part of a unit's forensic material collection team. Each team member will be cross-trained in every area, to include photography, sketching, note-taking, latent print processing, and trace evidence collection.

Battlefield, Forensics, Criminalistics

D38 Evidence From Forensic Botany in Establishing Time of Death in Incarcerated Persons

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After attending this presentation, attendees will be able to understand how prison and hospital records can be used to help in determining the time frame for deaths of inmates and patients as well as elimination of some possible suspects.

This presentation will impact the forensic science community by providing a little used and inexpensive method for narrowing the possible time of death and suspect in a suspicious death when the victim is a confined person.

Two cases where prisoners were murdered were investigated. In one case, the prisoner was in a state prison. In the other, the person was confined in a prison for the criminally insane. Fellow inmates were suspected in both crimes.

In both cases stomach content samples were provided as well as autopsy reports. In both individuals, the digestive tracts appeared to be normal. Menus for the full days meals on the deaths of the prisoners were also provided.

The objective of this evaluation was to determine the last meal that was consumed by the prisoners in order to eliminate some suspects and to evaluate testimony given by fellow inmates about their whereabouts and their observations of the victims' movements around the time of their deaths.

In both cases it was determined the contents of the last meals could be defined. In one case, due to the condition of the stomach contents, it was determined that the prisoner was likely to have died shortly after meal consumption. In the second case, the nature of the last meal could be stated in comparison with the details of the prison menu; but there was a complicating factor. This prisoner was a hoarder. He had sequestered a great deal of food in his cell. However, the nature of the last known meal was still clearly indicated by the stomach contents.

Forensic Botany, Time of Death, Incarcerated Persons

D39 A Crime Scene That Included Six Vehicles, Fifty-Eight Cartridge Casings, and Over Twenty Homes: Using a Different Method of Sketching to Document Large Scenes

Claire E. Shepard, MS, Griffin Technical College, 501 Varsity Road, Griffin, GA 30223*

After attending this presentation, attendees will have learned an alternative method for sketching large or non-traditional crime scenes.

This presentation will impact the forensic science community by providing alternative documentation methods that can be used at crime scenes where traditional textbook methods are not feasible or effective.

In March 2001, police were called to a shooting in a suburban Atlanta neighborhood. Almost immediately the 911 system was flooded with calls from the same general area, regarding more shots fired, vehicles leaving the scene driving at high rates of speed, and a deceased victim dumped in a neighborhood park. Victims suffering from gunshot wounds showed up at local hospitals, and crime scenes with vehicles related to the case were located. Not long after the initial call it was determined the initial shooting occurred at the home of the prime suspect in the recent assassination of the incumbent Sheriff and a former police officer.

Due to the nature of the case, all hands were on deck. The primary scene included fifty-eight cartridge casings, four vehicles, and over twenty homes. Questions began to arise as to the documentation of the scene in a timely manner. Since the shooting encompassed an entire subdivision, there was concern with keeping families out of their homes for an extended period of time. Also, deciding where to begin documentation of the scene was a difficult task when in addition to a primary scene there was a separate death scene, a bullet-ridden vehicle from the scene found on the interstate, and another vehicle presumably used to transport the deceased victim to the park, abandoned in a wooded area. When there are four scenes related to a homicide and two crime scene investigators on duty, where and how should the documentation begin? Not only must these scenes be worked in a timely manner, but no stone can be left unturned. Additionally while this murder investigation was beginning, it was also tied to the active murder investigation of the incumbent sheriff, a law enforcement officer.

In this case, it was determined that the traditional method of using triangulation or rectangular coordinates would be too time consuming and cumbersome for a scene of its size. Therefore the scene was divided into twenty foot sections and sketched using paint, photography, and a spreadsheet. This method provided adequate documentation of the scene and was presented in court.

Therefore, proper documentation procedures can be employed even if the standard procedures are deemed to be an inefficient method due to the circumstances of a large scene or multiple scenes that must be worked consecutively. Finally teamwork between all investigators and members of the forensic science community is essential in non-traditional scenes to get the job done legally, correctly, and efficiently.

Crime Scene Investigation, Sketching, Documentation

D40 The Obsession With Online Role-Playing Games and Child Neglect Deaths

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After attending this presentation, attendees will understand how a caregiver's obsessive on-line gaming activities can contribute to child neglect deaths.

This presentation will impact the forensic science community by bringing to light the negative impact of obsessive on-line gaming on parents' ability to properly care for their children. Supervisory neglect can often be difficult to ascertain particularly in the absence of other witnesses. This presentation supplies an additional line of questioning to the investigator which may shed some light on the predisposing or direct causes of effect in child neglect deaths.

Research on obsessive internet use and electronic gaming has provided insight into a host of potential problems not only for the individual(s) but also for those around them. Those often most at risk are children neglected due to this obsessive behavior, particularly those who lack the ability to engage in the most basic of self-care. Of the various types of child abuse, neglect is the most prevalent form. In 2007, an estimated 1,760 children died due to abuse or neglect, with 34.1% of all fatalities attributed to neglect. Physical and supervisory neglect become significant concerns when the caregiver(s) are obsessively preoccupied with the above-mentioned media. Neglect issues become even more concerning when caregivers engage in "Massively Multiplayer Online Role-Playing Games" (MMORPGs) as unlike many other types of media, there is no ability to immediately "pause" the game and MMORPGs have no termination point, leading to marathon gaming session in which all other concerns are ignored including the well being of their infants and children.

In this paper, four case studies will be presented that constitute both physical and supervisory neglect that resulted in death. In each case study, parental obsession with on-line gaming and its role in each child's death will be discussed. In the cases presented, all children were under the age of four, with three under the age of one year. In three cases, the parents admitted to leaving their children unsupervised on average up to 14.5 hours while they either played on-line games or slept after extensive gaming sessions.

The published literature has identified several factors as "indictors" of the potential to abuse or neglect children. The indicators of abuse include depression, psychological inadequacy and poor problem solving skills amongst several others. The purpose of this paper is to propose obsessive preoccupation with MMORPGs or online role-playing as another indicator of potential child neglect. Although the obsessive behavior may be a symptom of some of the indicators noted above, it is important to explore this avenue of investigation when processing a child death scene.

Child Neglect, Online Role-Playing Addiction, Child Death

D41 "If I Had a Hammer, I'd ...": Rare Case of a Hammer Initiated Self-Inflicted Bullet Wound

William S. Smock, MD, University of Louisville Hospital, Department of Emergency Medicine, 530 South Jackson Street, Louisville, KY 40202; and Mariah E. Smock, Centre College, Danville, KY 40422*

After attending this presentation, attendees will be introduced to the unique use of a tool as an improvised firearm.

This presentation will impact the forensic science community by expanding the knowledge of forensic investigators involved in the investigation of improvised firearms.

A 33-year-old Caucasian male presented to an urban Trauma Center with a complaint of pain from a reported self-inflicted gunshot wound to the left lower quadrant. There was no active bleeding and the patient only complained of slight pain. The patient admitted that this was a suicide attempt but denied having a history of depression. However, upon further questioning, he admitted to a prior attempted suicide four months earlier by overdosing on acetaminophen. At that time his family had removed his .22 caliber pistol, but not the ammunition, from the home.

Examination of the abdominal wall revealed a small, round and abraded tissue defect without evidence of soot or tattooing. Plain radiographs and a contrasted CT scan of his abdomen and pelvis revealed a round nose bullet in the subcutaneous tissue of the left anterior abdominal wall. There was no evidence of intra-abdominal injury or fascia penetration from the bullet. When questioned about the weapon, the patient explained that he had put the head of a hammer on his abdomen, then wedged a cartridge in the claw of the hammer and used a second hammer to strike its base. When the cartridge discharged, the bullet traveled into the subcutaneous tissue and stopped. When viewed on CT scan, the projectile appeared to have traveled at a 45-degree downward angle from left to right. The patient reported the cartridge was a .22 caliber long rifle.

The use of improvised firearms to inflict injury upon oneself or others is unusual. One of the reasons that handmade firearms are rare is because they usually do not provide the projectile enough velocity to travel very far and are generally ineffective. As this case indicates, the projectile had only enough energy to penetrate the skin and not enough to enter the abdominal cavity.

When fired from a gun, a .22 rimfire bullet reaches the "optimum velocity" in a 14 to 16-inch barrel. Depending upon the weight of the bullet the maximum velocity of a handgun bullet is about 1350 ft/s, but without the barrel, the bullet does not have the energy behind it

necessary to reach that velocity. The minimum velocity reported for a .22 caliber bullet with a weight 16.5 grams to penetrate the skin is 245 ft/sec. Obviously the bullet must have lost its velocity very quickly because it only succeeded in penetrating the skin and caused no intra-abdominal injuries. This failed suicide attempt presumably left no lasting traumatic injuries. The patient was admitted to the surgical service for observation with an inpatient psychiatric evaluation.

In this case, the bullet wound was a contact wound. However, the bullet and *not the barrel of the gun,* was in contact with the skin when the projectile was discharged. Because of this, the wound does not present with the usual characteristics of a contact gunshot wound. This bullet wound of contact is unique, as it has none of characteristics typical of contact gunshot wounds.

The use of a claw hammer as a platform to discharge a round is intended to inform forensic investigators of an unusual type of improvised firearm.

Improvised Firearm, Hammer, Gunshot Wound

D42 Exsanguinated Blood Volume Estimation Using Fractal Analysis of Digital Images

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The goals of this presentation are to introduce attendees to chaos theory and fractal geometry and to demonstrate how fractal analysis may be applied to the characterization of non-linear, morphometrically complex, bloodstain patterns, and ultimately lead to a scientifically reproducible means of estimating exsanguinated blood volume.

This presentation will impact the forensic science community by providing a novel approach to estimating single-event exsanguinated blood volume from blood spatter evidence at crime scenes. This method results in the deconstruction of bloodstain patterns into mathematical parameters thereby removing the subjective element inherent in previous studies. This analytical approach represents a shift from a formerly subjective field towards a more objective analytical technique that can withstand scientific and legal scrutiny.

Although the field of bloodstain pattern analysis has evolved to combine a unique set of well-defined and established scientific principles, drawing on many disciplines to characterize and interpret stain patterns, there is currently no scientifically accepted, or court qualified method of quantifying original bloodstain volume. This information may be vital in cases where a large volume of blood must be correlated to determining post injury survival time, the location of severe or lethal injuries, and the probability of death when no body is found.

The present study combines a quantitative analytical approach with an area previously dominated by subjective qualitative observations and allows the modeling of natural systems such as blood spatter. This research has lead to the development of a novel fractal approach to the estimation of bloodstain volume, which deviates from the classical direct volumetric methods previously proposed by Lee (1986). Variability of the appearance of different bloodstains can be simplified and quantified into a single numerical value that defines its shape complexity, namely its fractal dimension, and are ideally suited for computer analysis, hence, removing inherent observer bias.

The central hypothesis of this analytical technique is that digital images of bloodstain patterns are quantifiable using fractal geometry, hence, each volume may be characterized by a unique Hausdorff fractal dimension. This allows the analyst to provide an estimated volume with a statistically valid methodology in order to conform to *Daubert* Standards.

Binary photographs of passive bloodstains of known volume were subjected to computer analysis using FracLac V2.0 for ImageJ. Through application of the box-counting method, the Hausdorff fractal dimension of each replicate volume was extracted from a scaling plot of these data. Generated fractals were utilized to create scatter plots yielding logarithmic regression predictive equations for blood. Fractal curves, of known and accepted Hausdroff dimension were used to calibrate the system. The validity of the proposed methodology was assessed during a blind trial evaluation.

The results of this study indicate that chaos theory and fractal geometry may be applied in a systematic method to assist in quantitative analysis and modeling of passive bloodstains by a unique geometric Hausdorff fractal dimension through application of the box-count method. A power law relationship is observed when the box size is plotted against the number of grid boxes that contain pixels in a box-counting scan. A scaling plot was subsequently generated by performing a logarithmic manipulation of these data and the fractal dimension was extracted from the slope of the linear portion of this plot. This procedure was repeated for each replicated volume.

Passive blood stain patterns are characterized by a fractal dimension duality due to the underlying mechanisms that influence the resulting primary and secondary spatter, that in combination form the overall pattern. This study used a single line of best fit for the extraction of the fractal dimension from the generated scaling plot.

The regression yielded a logarithmic function that was predicted from the power law. The fractal dimension approached 2, asymptotically. Mathematical theory suggests that as the fractal dimension of a 2-dimensional natural object increases, it will do so as a limit, approaching, but never reaching, 2.0. At this point the pattern is no longer considered fractal and becomes Euclidean.

This study provides the basis for the estimation of blood volume from the fractal analysis of digital images; forging the way for more detailed investigations, while highlighting areas that demonstrate the potential for future research.

Bloodstain Pattern Analysis, Fractal Analysis, Volume Estimation

D43 The Steven Tauzer Murder Case

Gregory E. Laskowski, MPA, Kern County District Attorney's Office, Forensic Science Division, 1300 18th Street, 4th Floor, Bakersfield, CA 93301*

After attending this presentation, attendees will have an understanding of the pitfalls involved when a high ranking member of law enforcement agency is murdered by fellow member of that agency and the ramifications of conflict of interest charges brought against the crime scene investigation team and the laboratory analysts involved in the case.

This presentation will impact the forensic science community by creating awareness on the complexity of murder cases that involve high ranking public officials and the ramifications of investigations by forensic laboratories situated in rural communities.

Assistant District Attorney Steven Tauzer was found murdered in the garage of his residence in September of 2002. Chris Hillis, a former lieutenant of the Kern County District Attorney's Office Bureau of Investigation was soon developed as a suspect. DNA located on key evidence was crucial in developing Hillis as a suspect. Although the case was investigated by the Kern County Sheriff's Department, the crime scene was investigated by members of the Kern County District Attorney's Office Regional crime lab (KCDA). Initial evidence processing was also conducted by personnel from the KCDA Regional Crime Laboratory (KCDA RCL). Because of the onus of 'conflict of interest', the processing of evidence was halted by KCDARCL personnel, and the evidence was then packaged and shipped to the California State Department of Justice Bureau of Forensic Sciences Laboratory. As a result of the Cal DOJ Laboratories Analysis of the

DNA evidence Chris Hillis was arrested and charged with the murder of Steven Tauzer.

This presentation will focus on the evidence collected at the scene, its processing, and the resulting interactions of the presenter with the district attorney, sheriff's homicide investigators, California Department of Justice personnel. The personal conflicts faced by the presenter having to investigate a high profile murder case of his boss and a colleague, who were both more than just acquaintances will be discussed.

Conflict of Interest, DNA, High Profile Murder Case

D44 Women as Killers: Are We Missing Something?

Dayle L. Hinman, BS, Farrell & Associates, Incorporated, 3830 South Highway A-1-A, Suite 4, #200, Melbourne Beach, FL 32951; and Rod Englert, BS*, Englert Forensic Consultants, PO Box 605, West Linn, OR 97068*

After attending this presentation, attendees will have a better understanding of homicides perpetrated by women.

This presentation will impact the forensic science community by promoting a greater understanding of the efficacy of collaborative working relationships between the professional disciplines involved in criminal investigations.

The public's perception about crime and criminals is often shaped by the vast coverage of this subject on television programs, movies, novels and many other media outlets. The writers and producers may be guided more by ratings than by facts. Homicide investigators are frequently portrayed as individuals with special, often psychic abilities. In reality, we draw upon our own experience, specialized training in forensic and behavioral science and empirically developed information about the characteristics of known offenders.

Professionals who participate in the investigation of violent crime should understand and appreciate the potential evidentiary value of what can be discovered on, in, around and near a victim's body at the crime scene. A thorough crime scene analysis can provide clues to the interaction between the victim and the offender along with the specific chain of events that led to the victim's demise. An experienced crime scene investigator can interpret the physical evidence, often through an analysis of bloodshed at the scene, to propose and test theories of how a crime unfolded, to a reasonable conclusion. The crime scene yields clues not only about the victim and the crime but also about the offender. Media portrayal of offender and associated stereotypical behavior may prejudice investigative analysis. Some may assume that "men murder with guns and knives, while women defend themselves with pots and pans." Public accounts seem, more often than not, to attribute female murderers to more familial settings rather than homicide associated with the male offender. Have some cases remained unsolved because investigators disproportionately focused on men to the exclusion of all available possibilities?

Using specific case examples, the speakers will demonstrate how the investigative focus changed and these complicated cases were resolved. Participants will gain a greater understanding and better appreciate the efficacy of collaborative working relationships between the professional disciplines involved in criminal investigation.

Female Offenders, Crime Scene Reconstruction, Rush to Judgment

D45 Elder Sexual Abuse: What is New in 2010?

Diana K. Faugno, MSN, 1351 Heritage Court, Escondido, CA 92027; Patricia M. Speck, DNSc*, 1740 Overton Park Avenue, Memphis, TN 38112; and Patricia A. Crane, PhD*, University of Texas Medical Branch Galveston, School of Nursing, 301 University Boulevard, Galveston, TX 77555-1029*

After attending this presentation, attendees will be able to list obstacles for elderly women in reporting sexual assault, will be able to identify clinical findings or behaviors that may indicate sexual abuse when there is no disclosure, will be able to describe potential challenges in performing a forensic exam on elderly patients, and will be able to discuss current evidence-based literature and injury patterns that are unique to this group.

This presentation will impact the forensic science community by understanding that elder physical abuse, neglect, and exploitation, including reports of sexual assault and abuse, have risen rapidly over the last decade.

The graying of America population is expected to grow from 4 million in 2000 to 19 million in 2050, mainly due to medical advancements. The true extent of this problem is difficult to determine. Post-menopausal women represent 2.2-6.9 percent of women reporting sexual assault. Reluctance to report sexual abuse, relative isolation of elderly victims, and lack of public and professional awareness undoubtedly contributes to the increasing number of undetected cases of sexual assault in this population. This age group is uniquely physically different when compared to young women and health care providers are not generally familiar with the clinical manifestations of sexual trauma in elderly. There are four things to screen for:

- Being sensitive to observable signs and symptoms associated with sexual assault
- Capacity to consent to sexual activity
- Using appropriate interviewing techniques and questions
- Using more formal assessment tools when needed—Teitlman and Copolillo 2002

This presentation will also include the epidemiology of elder abuse and data from several cities across the U.S. has been analyzed that will be presented as well. Elder women are vulnerable because they are likely to live alone, lack physical size and strength, and are less capable of fleeing or resisting attack as well as lacking in guardianship. Elder women also have an increased chance of sustaining serious injury, increased vaginal or anal tearing and bruising that may never fully heal, brittle pelvis or hip bones can be broken by friction or weight, increased risk of infections and STDs. Evaluation and treatment of sexually abused or assaulted elderly women will be discussed using case vignettes (including history and injury associated with each elderly woman's case) that will assist the medical provider in the application of evidence to nursing practice. Because sexual violence takes away a victim's sense of control, returning and offering control empowers victims. It is important to ask the patient if they want to talk where they would prefer you to sit, how they would like to be addressed (first name or Ms., Mrs., Mr., etc.), and whether they would like someone else present. The healthcare provider must also be aware of cultural/religious differences that will impact the patient. There are also prosecutions and investigative challenges that will need to be addressed: Overcoming the attitude: who in the world would want to have sex with an old person?; preserving testimony – death, illness, sexual assault by family member vs. stranger, getting beyond the generational view points; and, the recanting patient. There are key points to examine:

- Elder abuse is very **underreported**
- Injury is higher due to age and medical conditions that are frequent in the elder population
- Consider what support your courtroom and system has for these elders who cannot sit on the hard benches, etc.

- Special needs if this patient
- Talk slowly … and have lots of Patience….Patience…..Patience

Elder, Sexual Assault, Older Person

D46 Intimate Partner Violence — What Causes Victims to Finally Leave: A Case Study

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After attending this presentation, attendees will have learned how to: identify the phases in this case study from the initiation of a violent relationship to the final decision to leave; describe the steps taken to move from victim to survivor; and, analyze how health care professionals can help victims of intimate partner violence.

This presentation will impact the forensic science community by raising awareness of global communities and healthcare professionals in identifying IPV and responding to the needs of victims of IPV. It is the intent of this case study to identify one survivor's story, by investigating what factors brought an end to her abusive relationship, how she executed this task, what and who were of help to her in making this process successful. This survivor's experiences can convey to the worldwide forensic community, ways to be more pro-active in understanding and assisting individuals living in abusive relationships, recapture their lives, and have productive and meaningful futures.

Intimate partner violence (IPV) is intertwined in the lives of untold numbers of men, women, and children around the world. This human abuse dates back as far as the Roman times, when women were considered property of their husbands. In many ways, this viewpoint continues to hold true for many families today. Between one and two million women are victims of IPV yearly. This occurs at the hands of spouses, boyfriends, ex-spouses, and ex-boyfriends. There are numerous assessment tools available to identify victims and potential victims of IPV. Education in this area is insufficient for health care professionals, which makes it difficult to make the transition from assessment to intervention. Healthy People 2010 has identified violence in relationships as having escalated to a world wide pandemic. Millions of dollars are spent annually on studying the short and long term effects of violent relationships and there are thousands of missed work days lost every year. In order to identify and intervene, regular and consistent risk assessments need to be performed. There needs to be more education for medical and nursing professionals so they are better equipped to identify risk factors and red flags in patients and provide help and resources for victims of violent relationships. Many victims feel there are not adequate resources available in their communities or enough professionals who are willing to get involved. Information is abundant about risk factors, types of abuse, why victims continue to remain in these relationships, and who the abusers often are. However, there is very little literature that identifies what decisive factor occurs in the lives of victims that gives them the courage and strength to sever their ties with their abuser and become survivors.

The purpose of this study is to explore all facets of a single violent relationship and identify the causative elements that evolve which finally bolster the victim's need to leave. This qualitative case study of one will describe one participant's encounter with a violent relationship, identify themes and phases of a violent intimate partner relationship, describe what facilitated leaving, analyze how severing ties from the abuser was accomplished, and discuss how the survivor recaptured her life.

Research questions asked in this case study are: how are women drawn into relationships that are abusive; what impact do violent relationships have on victims emotionally, physically, and socially; how and when do victims realize when enough is enough; and how do they go about severing ties from their abuser? Lastly, realizing this case study of one may have limitations because this is one person's encounter with interpersonal violence and it may not be applicable to all violent relationships, cultures, or age groups.

The intent of this case study of one is to document in rich text, the passage of one victim, who unsuspectingly journeys into the dark world of intimate partner violence. She will identify her reason for severing ties with her abuser, and will reflect on her journey through several phases in her life, to emerge on the other side, into hope, healing, and recapturing her life.

Case Study, Intimate Partner Violence, Severing Relationship Ties

D47 Development of a Forensic Nurse Examiner Training Program at a University Trauma Center

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After attending this presentation, attendees will understand the importance of training forensic nurse examiners at a university trauma center.

This presentation will impact the forensic science community by demonstrating the benefits to patients, law enforcement agencies, and the criminal justice system through the use of forensic nurse examiners in a university trauma center.

The goal of this presentation is to provide an overview of the development of a Forensic Nurse Examiner Training Program at a university trauma center to illustrate the unique contributions of the Forensic Nurse Examiner.

The Forensic Nurse Examiner Training Program is a component of the Clinical Forensic Medicine Program within the Department of Emergency Medicine at the University of Louisville Hospital. The program is comprised of registered nurses who have a broad range of experience and who also specialize in the care of sexual assault victims. With the 2005 requirement of JACHO, the hospital recognized the need for a team of trained healthcare professionals to address the forensic needs of crime victims that present to the trauma center. The program has expanded the knowledge and training of sexual assault nurse examiners by providing the forensic education necessary to attain the position of certified forensic nurse examiner. The program is funded under a contract with the Louisville Metro Police Department.

The programs goals are to provide victims of violent crimes with the highest level of medical and forensic care. The forensic nurse examiners advocate for victims of physical and sexual assault; recognize, document and preserve evidence on victims of assault or other violent crime; provide a specialized trained team of forensic practitioners to address the needs of injured victims of crime; provide clinical forensic training for hospital nurses and physicians; and offer an in-patient clinical forensic medicine consultation service.

The educational program addresses a wide variety of forensic topics including: forensic photography, documentation and interpretation of wounds, adult/adolescent sexual assault, suspect examinations, domestic violence, elder abuse and neglect, felonious assault and blunt force trauma, gunshot wounds, stabbings/sharp force injuries, motor vehicle trauma – driver vs. passenger, airbag induced injuries and hit and run pedestrian incidents, in-custody suicide attempts, police internal affair complaints and excited delirium.

Examinations are currently performed at the request of local, state, and federal law enforcement.

An example of a recent clinical forensic medicine consultation performed by a forensic nurse examiner will be presented.

Case #1: In July of 2009, two brothers were engaged in an argument, which escalated into the brothers drawing knives on each other. As a result, one of the brothers presented to the emergency department with a stab wound to the chest requiring a pericardial window. This brother stated he was an innocent victim did not admit to having possession of a knife during the altercation. The other brother, being less injured, was questioned, detained and arrested by the investigating domestic violence detective. The detained brother was adamant he was acting is self defense as the other brother came at him with two knives.

The forensic nurse examiner was called to document, evaluate, and interpret the injuries and wounds of both brothers. Examination of the chest wound revealed a vertically oriented single edged stab wound. The injuries to the brother who was detained at the police department revealed multiple superficial incised wounds that supported his statement that the other brother was in possession of a knife.

After the forensic nurse examiner carefully examined both brothers. The forensic nurse, after an examination of the wounds and the clothing, determined that the injuries sustained by the brother who was in custody were consistent with his statements and not consistent with the statements of the brother who said he was an innocent victim.

Based upon the interpretation of the wounds by the forensic nurse examiner, the detective released and dismissed charges against the brother in custody and filed lesser assault charges against the hospitalized brother.

The forensic nurse examiner is an asset to the community and law enforcement. With an accurate forensic analysis by a trained forensic nurse examiner, justice was served. All trauma centers should consider the establishment of a forensic nurse examiner program as a service to victims of violent crime.

Nurse Examiner, Forensic, Training Program

D48 Sexual Child Abuse and Forensic Nursing

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The goals of this presentation are to provide an overview of the development of forensic nursing in Southern Italy and to illustrate the unique contribution of professional nurses in a child abuse center.

This presentation will impact the forensic science community by demonstrating how nurses are utilized within the GIADA project of Pediatric Hospital "Giovanni XXIII" of Bari (Southern Italy).

GIADA Project is a new program implemented in the pediatric hospital. It was established in 2000 by the department of Psychology to address domestic violence and the abuse of women and children. GIADA is a multidisciplinary team effort and in addition to clinical forensic nursing services, includes expertise by psychologists, pediatricians, gynecologists, medical-legal physicians, radiologists, biologists, dentists, and social work services.

Three scenarios will be presented to highlight the contributions of the clinical forensic nurse (CFN) and how this important specialty compliments other disciplines in these forensic cases.

Case # 1 – 12-year-old female: A 12-year-old female was brought to the hospital by a CFN from the foster home where she had been living. The girl reported that her "foster grandfather" had been sexually molesting her and that she was experiencing continual pain in her vagina and anal areas.

Case # 2 – 7-year-old female: A 7-year-old girl was brought into the hospital by her mother after she noticed a rash on her genital area as well as a yellow secretion from the vagina. The parents were divorced and the girl had weekly visits with her father. Her mother suspected that her ex-husband was sexually abusing his daughter.

Case # 3 – 4-year-old female: A 4-year-old female was brought to the hospital by her mother with bleeding in her vagina. Her underwear was stained with blood and was experiencing severe pain in her pelvic region. Her mother reported that she had fallen out of a closet and she injured herself on the corner of the bed. It was immediately clear to the CFN that the patient history did not match the injury and further investigation was necessary.

Conclusion: The clinical forensic nurse continues to be a valuable member of the forensic team often in the position to identify victims of crime immediately. The CFN is essential in starting the chain of events necessary to manage medical evidence, obtain legal documentation and make referrals to the appropriate services.

Clinical Forensic Nursing, Child Abuse, Sexual Abuse

D49 Capacity Building Towards Public Health and Prevention Among Forensic Practitioners

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After attending this presentation, attendees will have an overview of the injury and violence prevention resources.

The presentation will impact the forensic science community by increasing their potential for public health program development and practice related to injury and violence prevention.

Public health practice can benefit from increased participation of medical examiners and other forensic disciplines as they are inherently involved in cases of injury and violence. Preliminary review suggests that medical examiner/coroner offices have limited in-house prevention programs and direct public health service because they may not have the skill set demanded of a prevention practitioner. If so, what can an individual forensic practitioner and other interested medical and public health personnel address capacity building in injury prevention? The goal of this paper is to provide the reader with an overview of the injury and violence prevention resources to increase public health program development and practice.

Forensic practitioners' knowledge of injury process and fatal injury risk factors put them in good stead to be a critical public health partner. With skill-building and better understanding of the opportunities and the resources in injury prevention, they can be valuable in the planning, implementation, and evaluation of preventive programs in the future. With existing resources, they can already promote better mental health for survivors and assist referral or intervention in vulnerable populations or individuals identified from their casework. Since the most crucial data set, fatality data, is essentially death investigation/medical examiner-derived, forensic practitioners should also support and advocate for stronger forensic and public health systems worldwide.

Numerous documents for individual skills and knowledge acquisition as well as system-wide capacity building are provided online and for free. Compendium of best practices, evidence-based recommendations of groups and public health ministries, coalitions up to the international level and United States fatality databases are highly accessible. Long-distance mentoring (MENTOR-VIP) and injury curricula (TEACH-VIP) through the World Health Organization can supplement knowledge as do subscription to free injury newsletters or relevant article listings (i.e., Safetylit). Memberships in coalitions of injury prevention professionals (STIPDA) or within a specialty (i.e., American Academy of Pediatrics, American Public Health

Association–Injury Control and Emergency Health Services) and participation in mailing lists from relevant agencies are additional ways to link with those in injury prevention.

Any additional stakeholders among the medical and public health disciplines are valuable to add to the cause against injury and violence. Knowledge of the ecological model and rigorous evaluation practices allow establishment of risk factors and effective interventions, the cheapest and most significant being primary prevention at a very young age. By being aware of appropriate and evidence-proven interventions, primary (stopping the violence before it takes place), secondary (minimizing harm), and tertiary (rehabilitation of offender and victim) prevention can be achieved.

Greater support, funding and professionalism are encouraged in all the forensic and public health disciplines towards injury prevention work. Awareness of public health through training and continuing education can nurture multi-sectoral thinking in medical examiner/coroner offices and encourage them and their peers in criminal justice among others towards less punitive and more preventative approaches. In death investigation where the standards are variable from either being a coroner or a medical examiner system, conversion to a medical examiner set-up and/or provision of support in either office to conduct research, develop alliances and initiate programs are helpful to increase public health interest.

Capacity Building, Prevention, Public Health

D50 She Loved Him to Death: A Domestic Violence Homicide Case Study

Carrie Costello, BA, Purdue University/Tippecanoe County Coroner's Office, 2408 Temple Court, West, West Lafayette, IN 47906*

After attending this presentation, attendees will have an understanding of the cycle of domestic violence and how this can be applied to male victims of domestic violence. Although studies indicate that 85% – 95% of domestic violence victims are female, this case study will show there are similarities in cases when the male is the victim of the domestic violence. In addition, this case will demonstrate how difficult it is for the victim to end the relationship and escape the domestic violence even when utilizing multiple resources.

This presentation will impact the forensic science community by not only examining the crimes scenes themselves, it will also relay the killers behavior before, during, and after the murder as it relates to power and control a batterer has over a victim of domestic violence. This presentation will also impact the forensic community by examining this statistically unusual domestic violence homicide case where the male is the victim his wife is the perpetrator. In addition, discussing the multiple crime scenes and the processing of these scenes, how multiple law enforcement agencies worked together, and the cyber crime forensic experts all supported the prosecution of this offender. Finally, examining the importance of how domestic violence has no boundaries or does it target a specific gender, social economic class, race, or ethnic background.

The primary goal of this presentation is to present a domestic violence case study of a Purdue University married student who was killed by his wife. His body was then dismembered and found in a trunk of a vehicle. The multiple crime scenes, weapons used, and the autopsy findings will be described and illustrated. In addition, the cycle of domestic violence, myths surrounding victims and batterers, and how the police, courts, and Purdue University addressed the domestic violence between the student and his wife that preceded his murder.

In this particular domestic violence case study, the wife's physical abuse of the husband came to the attention of the Purdue University Police Department when she physically assaulted her husband causing him minor injuries. She was arrested; however, there were no formal charges filed by the prosecutor's office. The reason given for the "No File" was the determination of mutual combativeness and how the husband/victim refused to cooperate with the prosecution process.

A few months later, the Purdue University Police responded to the apartment again. Upon their arrival they found that while having sexual intercourse the wife had stabbed the husband in the chest with a knife. She then stabbed herself in the chest and cut her wrist prior to the arrival of the police. The husband and wife were taken to the hospital, for medical treatment, where they recovered. The medical personnel informed the police that the husband's pericardium sack had been nicked by the tip of the knife. The wife was arrested a second time for domestic violence battery related crimes and formal charges of attempted murder were later filed against her.

Although the husband told his wife, on numerous occasions he wanted a divorce, he bonded her out of jail. Within a few months, the wife would violate the protective order. The protective order was adjusted so they could attend marriage counseling together. A short time after the adjustment was made, the husband was reported missing by co-workers.

During this investigation, it was learned that the husband had moved out of his campus apartment and was living with his wife in her apartment in Lafayette, Indiana. There was blood found in that apartment and it was learned that the wife had purchased a gun online and shot her husband in the head. She then dismembered his body, placed it in the trunk of her vehicle and went across the state line. She then boarded an airplane, leaving his body in the truck of the vehicle which was parked in a parking garage and left the country. Once she reached China, she was stopped due to not having proper documentation to enter the country. She had stolen her husband's passport and pretended to be him in an attempt to flee prosecution. She was later prosecuted in China and is currently on death row.

Domestic Violence, Dismemberment, Homicide

D51 Picking on the Elderly: An Unfair Fight — Elder Abuse and Neglect Through the Death Investigator's Eyes

Lauralee A. Veitch, ADN, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will be able to identify the risk factors and trends in elder mistreatment; understand the importance of prevention programs; identify possible abuse or neglect related deaths; and, develop methods for prevention. Suggestions for educational resources will be provided to assist in public awareness and prevention.

This presentation will impact the forensic science community by exploring the aging population and the mistreatment elders can succumb to. Emphasis will be placed on identification and prevention methods. Though many elder deaths may be considered "natural" due to their age, the individual and their surroundings must be examined wholly to rule out mistreatment. This includes their current living situation, caregivers, and the individual's own physical and mental abilities. Older individuals usually have fewer support systems, ranging from financial, emotional and physical support, and the impact of abuse and neglect is, subsequently, magnified. This lecture will include several case studies that will highlight common risk factors and key points to consider when investigating elder deaths. Collaboration with outside agencies is an integral part of an abuse and neglect investigation and suggestions into cooperative efforts will be provided. Elder Fatality Review Teams are a collaborative, multi-agency effort to reduce elder abuse or neglect deaths, increase awareness and decrease the incidence of elder abuse, neglect and

exploitation. Information regarding initiating an Elder Fatality Review Team will also be explored.

As the aging population grows, so does the amount of Abuse and Neglect mortality rates. By the year 2030, it is estimated that elders over age 65 will grow to 71.5 million or 20% of the U.S. population. This presentation explores the aging population and the mistreatment they can succumb to. Emphasis will be placed on identification and prevention methods. This lecture will include several case studies that will highlight common risk factors and key points to consider when investigating elder deaths. Collaboration with outside agencies is an integral part of an abuse and neglect investigation and suggestions into cooperative efforts will be provided.

This presentation is recommended for medical personnel, law enforcement, death investigators and individuals working with or caring for the elderly.

Investigation, Elder, Abuse

D52 Use of Dolls in Reenactments in Sudden Unexplained Infant Death Investigations (SUIDI)

Terri O'Shea, MSFS, Harris County Medical Examiner's Office, 7010 Little Redwood Drive, Pasadena, TX 77505*

After attending this presentation, attendees will understand the importance of, and correct use, of dolls in scene reenactments of sudden unexplained infant deaths, the appropriate approach to use with families, the correct dolls to use in various scenarios, the benefits and drawbacks to the different types of dolls, and the photographic documentation needed for the reenactment.

This presentation will impact the forensic science community by creating a better understanding of the scene through doll reenactment and photography, thus providing the forensic pathologist the ability to make more concise evaluations resulting in more accurate determinations of the cause and manner of death.

The ultimate goal is the realization of the benefit in the appropriate use of dolls in reenactments in SUIDI to caregivers, investigators, and to the forensic pathologists.

Following the premises set forth in this presentation will have global implications within the forensic community as well as with those whose lives are touched through doll reenactment within the community. Not only will the investigator gather better information and insight specific to the investigation, but, through proper reenactment techniques, proper use of the correct doll for the scenario, proper photographic documentation, empathy, and compassion, the potential for psychological trauma can be reduced among those involved in reenactment during the investigation of SUIDS. Following these premises, both caregivers and investigators will be more understanding and at ease during the reenactment portion of the investigation. These important factors allow for better documentation of the infant's original placed position as well as the found position, giving the forensic pathologist a more concise understanding of the infant's position in relation to the surrounding physical environment.

The term "Sudden Unexpected Infant Death" is self explanatory in that it describes any infant death that is sudden and unexpected. In the past, most of these deaths were classified under the umbrella of "Sudden Infant Death Syndrome" (SIDS) as the cause of death. Thus, there was often no explanation given for the death. Through investigation techniques including the photographing of doll reenactment, fewer deaths are being classified as an unexplained death syndrome, and more are being determined to be due to suffocation, positional asphyxia or the result of over-lay through co-sleeping.

In 1996, The Center for Disease Control and Prevention (CDC), established guidelines for infant death investigations. They include reenactment of the death scene with the person who found the deceased with photos to assess the sleep environment. These national guidelines should, thus, be incorporated nationally into all sudden and unexpected infant death investigations.

The Harris County Child Fatality Review Board has tracked the mortality rates of infants, documenting a decrease in deaths classified as SIDS from 0.9 per 1000 live births in 1995 to 0.25 per 1000 live births in 2005. The Harris County Medical Examiner's Office (HCMEO) documented a sharp decline in 2000 from 0.6 per 1,000 live births at the beginning of that year to 0.2 per 1000 live births by the beginning of the following year. This significant drop directly correlates to the initiation of the use of dolls in scene investigation reenactments by the investigators from that office. In 2005, HCMEO classified 0.54 SUIDs per 1000 live births as undetermined, 0.1 as asphyxia (over-lay and positional) and 0.27 as actual SIDS. Since that time, the rates of SIDS deaths have continued to decline and the rates of asphyxia from suffocation, positional asphyxia, and co-sleeping over-lays have increased. This is due in large part to a better understanding of the scene through photographic documentation of doll reenactments.

Understanding the best tools and approaches for following these guidelines will allow the investigator to most accurately depict the scene, thus allowing visualization and understanding of the scene for the pathologist. This in turn, yields a more accurate certification of cause and manner of death of the infant. There has been a reluctance to initiate doll reenactments by some forensic death investigators due to the fear of psychological trauma for the caregivers and parents. These fears can be allayed through compassion and the imparting of the information to these people about the importance of the reenactment to the final outcome of the case, as determined by the forensic pathologist.

Reenactment, Dolls, Photography

D53 Forensic Linguistics: An Overview With Emphasis on Questioned Authorship

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The goal of this presentation is to introduce the discipline of forensic linguistics (FL), to present a brief overview of present progress in the field, and to focus in some detail on the practice of one important sub-area of FL - authorship identification.

This presentation will impact the forensic science community by informing attendees of the nature of linguistic analysis and the ways in which it is being applied to forensic questions. It will provide a brief history of FL, specific sub areas of the discipline, including important publications and resources, and the example of linguistic analysis as applied to questioned authorship.

Forensic linguistics is the scientific study of language as applied to forensic ends. With the exception of forensic phonetics, forensic linguistics is a relatively new application of general linguistics and therefore a growing area of modern applied linguistics. While the subareas of FL and their classification are evolving as the field grows, they generally follow given taxonomies for the study of the structure and function of language. Recent research and practice in FL include various forensic analyses of language: *Spoken Language* – auditory and acoustic voice identification, dialect identification, and oral inter-language interpretation; *Written Language* – stylistics and authorship identification, written inter-language translation, legal discourse, product labeling and advertisement, trade marks, legal language, and plagiarism; *Spoken or Written Language* – semantics, pragmatics, discourse analysis, defamation, and jury instructions; and, *Transcribed Language* – transcripts of recorded language, of recorded testimony, perjury, and language of various courtroom participants (e.g., vulnerable witnesses, cross examiners, etc.).

Authorship identification is an important part of FL and is based on the theory and practice of forensic stylistics as a technique that utilizes the linguistic analysis of writing style for the purpose of authorship identification. Such analysis is known as linguistic stylistics, briefly summarized as follows: *Language* is the internal system human speakers and writers develop and use to communicate. A *dialect* is a variety of language that appears when a particular group of speakers develops consistent patterns ("class characteristics") of language use. An *idiolect* is a variety of language developed by the individual speaker as a uniquely patterned aggregate of linguistic characteristics ('individual characteristics') observed in his or her language use. *Linguistics* studies the nature and development of this internal system of language and examines the ways groups and individuals use language in all its communicative contexts. The study of *linguistic variation* identifies linguistic and non-linguistic forces that lead to linguistic diversity among speakers and writers. *Style* is seen as that part of human behavior that reflects individual variation in activities that are otherwise invariant. While style in spoken language is linguistic variation that is directly related to the social context of conversation, style in written language reflects both the writer's conscious response to the requirements of genre and context as well as the result of his or her unconscious and habituated choices of the grammatical elements acquired through the long term, experiential process of writing. *Written style* is in part, then, the sum of the recurrent choices the writer makes in the writing process. Finally, *stylistics* is a broad approach to the study of style in language, and *linguistic stylistics* is the scientific interpretation of style-variables as observed, described and analyzed in the language of groups and individuals.

It is important to distinguish between linguistic stylistics and document examination. The focus of forensic stylistics is on the consistent, variable, idiosyncratic use of language as such. The focus of forensic document examination is on handwriting, typewriting, computer-generated documents, paper, ink, etc. While there is some overlap between these two fields of inquiry (e.g., typing habits that reflect underlying language patterns), their practitioners find little practical difficulty keeping the two fields separate.

Forensic Linguistics, Stylistics, Questioned Authorship

D54 Lesional Aspects of Cranio Encephalic Injury Caused by an Ax: Two Cases

Jocelyn Pollard, MD, Gilles Tournel, PhD, Sebastien Budes, MD, Cedric Houssaye, MD, Anne Becart-Robert, Valéry Hedouin, PhD, and Didier Gosset, PhD, Institut de Medecine Legale, Faculte de Medecine, Lille, 59045, FRANCE*

After attending this presentation, attendees will have learned about cranio encephalic injuries as a result of ax wounds are not commonly reported in forensic literature.

This presentation will impact the forensic science community by describing the forensic investigations, autopsy, toxicological, and histopathological findings in case presentations. Additionally, forensic investigations, examination of the forensic pathologist, and the neurosurgical intervention are discussed, as well as the value of imaging for the justice in such situations will be presented.

Introduction: Cranio encephalic injuries as a result of ax wounds are not commonly reported in forensic literature. Just like machetes and swords, they are suitable for causing not only soft tissue wounds, but also deep slashes in the underlying bone. On the basis of two cases from Lille, in the northern France, fatal and survived injuries caused by ax are discussed.

Materials and methods: The forensic investigations of the crime scene and woman's autopsy findings are reported. Another living woman with important cranial lesions caused by an ax was examined by a forensic pathologist. The cranial lesions are described with important iconography.

Results: Case 1: A 50-year-old woman suffered two strokes from an ax in her home by her neighbor suffering from schizophrenia. The examination revealed a left fronto-parietal fracture and a right temporal wound with achieving the temporal scale and loss of bone substance. It also revealed a right superior frontal contusion, sub arachnoid hemorrhage, sub-dural hematoma, and an extra-dural hematoma of the vertex. Case 2: A 73-year-old woman was hospitalized four months in the aftermath of a stroke. She was back in her home for four days with a left hemiplegia. She was discovered in a wheelchair, dead with a skull fracture. An ax was found on the ground. Body's examination found numerous lesions on the scalp and right hand with suggestive defense lesions. At the autopsy, a cranial trauma and multiple areas of attrition was identified. The police investigation revealed that the fatal blow had been delivered by her husband, who had then committed suicide.

Discussion: Although an ax is potentially dangerous and widespread in the population, there is no legislation concerning. In forensic literature, the common sites of wounds were the head and the neck. Defense injuries are often associated. Homicide represents one of the leading causes of death, and the head is the target in the majority of cases. Most of the victims were predominantly male, contrary to this case report. The majority of the victims died instantly or within 24 hours. Blunt force is commonly used when the head is the target. Defense wounds, when present, are indicative of the homicidal nature of the attack. And multiple strokes present over the body indicate perpetrator's determination to end the life of the victim. Finally, the value of imaging for the justice in such situations is discussed.

Ax, Cranio Encephalic Injury, Hemorrhage

D55 Radiological, Forensic, and Anthropological Studies of a Concrete Block Containing Bones: Report of One Case

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The goal of this presentation is to illustrate the potentialities of multislice computed tomography (MSCT) in forensic anthropology.

This presentation will impact the forensic science community by providing an example of forensic anthropological application of the MSCT. Multi-slice computed tomography (MSCT) is uncommonly used in forensic anthropology. This presentation will present a case of MSCT examination of a block of concrete containing bones. This exploration was performed with an anthropological aim in order to analyze the nature and the type of the bones.

Introduction: During demolition work of houses in France, workers found bone fragments at the surface of a concrete block. Local judiciary authorities asked the block to be analyzed. The forensic pathologist was asked many classical forensic and anthropological questions by the police: how many bones or bones' fragments were present within the block? Were the bones humans or animals?; If human, was it possible to determine the racial phenotype, the sex, the age, and the

stature of the deceased?; and, How old were the bones? In order to answer to these questions, a multi disciplinary study of the concrete block and of the bones' fragments was performed with radiological, forensic, and anthropology studies.

Material and methods: *Imaging study* — The CT examinations were performed at the Department of Radiology, Hospital of Toulouse, France. The block of concrete approximately 42 * 37 * 17 cm in size was fully scanned with a multisection CT scanner using the following parameters: 120 kV, 200 mAs, 0.75 mm section thickness, and 0.5 mm increments. The images were reconstructed according to both soft-tissue and bone algorithms. The reconstructed spiral CT scans were transferred to a workstation for post processing. Maximum Intensity Projections (MIP) and Volume Rendering Technique (VRT) three-dimensional (3D) reconstructions were obtained. Based on axial CT scans, two-dimensional (2D) coronal and sagittal multiplanar reformatted images (MPR) were performed. The images and 2D and 3D reconstructions were studied by a radiologist also medico-legal anthropologist, prior to the removal of the bones from the concrete block.

Virtual Anthropological Study: To determine if bones were human or animal, medullar index was calculated. The medullary index is defined by the ratio: minimal diameter of the medullar shaft/diameter of the diaphysis at the same level. The major drawback of this technique is the necessity to have relatively well preserved long bone. For humans and anthropoid monkeys the medullar cavity is narrow compared to the transverse diameter of the bone. For human adult, medullary index is on average equal to 0.45; for human foetus, varying from 0.15 to 0.48; for human child, from 0.37 to 0.50. For current domestic animals the index is greater than 0.50: on average 0.55 for pigs, 0.66 for dogs, and 0.75 for chickens. To determine the type of bones, racial phenotype, and sexing the deceased, textbooks of anatomy and anthropology were used. To determine the age of the decedent, measures of lengths of long bones were performed, using classical abacuses and textbooks.

Dry Bones' Anthropological Study: This study was possible after the removal of the bones from the concrete block. The bones were carefully extracted from the block of concrete, guided by the indication of the MSCT using basic hammers and gravers. After complete extraction, the bones were partially restored and analyzed. To determine if bones were human or animal, classical macroscopical criteria used in archeology and anthropology was used. To determine the postmortem interval of these bones, a transversal cut of a well preserved long bone was made and macroscopical analysis of the external and internal walls of the shaft was performed. Furthermore, an ultraviolet-induced fluorescence analysis was performed.

Results: *Anthropological Studies* — In summary, internal and surface bones were identified:

- A mix of human and animal's skeletal remains,
- Identified human bones were:
  - Two sided femur,
  - One left tibia,
  - One left humerus,
  - One left peri acetabular region.

Bones were badly preserved and dramatically damaged with absence of epiphyses or cartilages at their proximal or distal extremities.

Human skeletal remains were consistent with a child, from 8 to 13-years-old, with a minimal stature of 128 cm. Sex and racial phenotype determination were not possible.

The bones were interred in concrete after soft tissues disappeared and no anatomical connexion between different bones was visible. The concrete surrounded the bones, with no free space, in favor of a secondary closed space configuration. Some extremities of the bones had brown trace evocating oil. This evocated a secondary burial: secondary removal of the bones from the first (primary) burial after the complete putrefactive process and entire skeletisation.

The bones dating were evaluated at almost 100 years old by ultraviolet fluorescence.

The main hypothesis for the presence of human skeletal remains within the concrete was the secondary removal of bones discovered in a primary burial (soil), but not reported, by a previous owner of the house in which bones were found. This phenomenon is quite often encountered in practice.

Discussion: Forensic cases which involved paving materials, required special equipment and technical considerations. Exhumation of a concealed body is always a complex process best handled by a team of experienced death investigators. Use of heavy construction equipment for exhumation, including the pitfall of creating artifactual injury of the body, has been previously described. When the body is encased in paving materials, heavy equipment is necessary for handling the mass and resistance of the material. The effects of body disposal may include preservation of the body and its identifying marks, preservation of trace evidence and toxicology specimens, and the creation of a negative cast of the body. In several cases the cement provided a mold of evidentiary value that could be used to identify the decedent by fingerprints or other means. On the other hand, removing the body from the concrete may cause artifact. The hydration of cement is exothermic. As concrete cures, it may reach temperatures up to 79° for the first few days, resulting accelerated decomposition. After curing is finished the concrete may insulate the body from heat and air. In addition, damp cement is highly alkaline. Thus encasement in concrete may slow decomposition in some circumstances. Decedents encased in cement or mortar may be discovered by chance, following the confession of the perpetrator, through an anonymous tip, or during the investigation of a missing person's report. It is essential to examine the remains under optimum conditions, transporting the heavy cement or concrete blocks to the medical examiner's office for evaluation. This allowed for MSCT exploration to be performed before disturbing the cement encasing the decedent or the bones, as efforts to free them could be directed away from the remains. A multidisciplinary team approach was essential and involved the extensive use of consulting professionals in the disciplines of criminalistics, anthropology, odontology, and radiology. Consultants in the disciplines of anthropology, odontology, and radiology are particularly helpful in establishing the age of the decedent, and the presence of pre-existing trauma. MSCT has also already been used with archaeological purposes. Soil samples containing particular materials have already been studied by MSCT to better characterize its contents. Jansen et al. reported the study of ancient roman glass fragments in situ in blocks of soil. Only one previous report of the application of MSCT in the evaluation of skeleton in soil matrix has been published by Chhem. Contrary to mummies and fossils, studies of ancient skeletal remains do not exist because of the lack of fascination they procured, of their recent and current character. However, MSCT seems to have a potential important role as a non-destructive imaging test for skeletal remains that are embedded in soil or concrete matrix and as diagnostic imaging test for paleopathological lesions and for the detection of burial goods.

The estimation of the PMI of the bones was not possible with the MSCT techniques.

It is the first time, that MSCT is used to study the inner of a concrete block for an anthropological purpose. As presented, this technique is useful for the forensic pathologist and the forensic anthropologist. Dry bone study identified more accurately the type of bones and their sides. This can be explained by the bad conservation state of the bone due to taphonomical processes, concrete erosive action on the bones and the fact that bones were those from an immature subject, more fragile than adult bones. Furthermore, the impossibility of making VRT 3D reconstructions made difficult the surface morphology analysis which can be helpful in such cases. One advantage of the MSCT is the non invasive in situ study, without risk of damage for the bone. In this case,

the extraction of the bones was difficult and many bones fractured during their concrete removal. This was due to the vibration of the hammer and the bad state of conservation of the bones.

Conclusion: This study represents an initial attempt to scan skeletal remains that remained embedded in a concrete block in order to prevent disintegration of bones and joints because of their fragility. This approach seems promising and may help in rescuing qualitative and quantitative data that are sometimes irreversibly lost during concrete removal. It is of the utmost importance if one wishes to keep, for example, rare hominid fossils surrounded by calcium rich ground for further study without taking the risk of damaging the original specimen.

Concrete Block, Forensic Anthropology, Multislice Computed Tomography

D56 Analysis of Non-Toxic Ammunition by Double Shot Pyrolysis Gas Chromatography/ Mass Spectroscopy (DS-PY GC/MS)

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After attending this presentation, attendees will understand how pyrolysis can be used in determining qualitative differences in smokeless powder.

This presentation will impact the forensic science community by providing a new testable method for the analysis of lead free ammunition where traditional methods might be lacking.

A Pyrolysis Gas Chromatography Mass Spectroscopy (Py-GC/MS) has been applied to the analysis of trace additive in smokeless gunpowder. The experiment used evolving gas analysis (EGA), single shot pyrolysis (SS-Py), and double shot pyrolysis (DS-Py) to determine the qualitative difference between conventional gunpowder and non-toxic gunpowder. Only 0.28 mg (about three grains of gunpowder) of the sample was needed for the analysis. The organic gunshot residue components, such as ethyl centralite and methyl centralite, which are important markers in determining the presence of gun shot residue, could be detected by double shot pyrolysis. Based on intensities and peak observations, gunpowder additive, such as diphenylamine, methyl/ethyl centralite, dibutyl phthalate, 2 nitro-diphenyl amine, and 4 nitro-diphenyl amine, were different. Differences between manufacturers can be determined. Differentiation between conventional and non toxic ammunition could only be seen in Fiocchi brand ammunition.

Double Shot Pyrolysis, Non Toxic Ammunition, Lead Free

D57 Battery and Abuse in the Elderly: A Review of 100 Cases

Amy Y. Carney, MS, MFS, 16226 Avenida Venusto, #B, San Diego, CA 92128*

After attending this presentation, attendees will have an understanding of the incidence and prevalence of elder abuse, the different types of elder abuse including physical, sexual, and financial, and the types of crimes committed against the elderly in 100 cases prosecuted through the San Diego District Attorney's office.

This presentation will impact the forensic science community by presenting key aspects of elder abuse and the legal issues surrounding it as well as highlighting the need for close collaboration between the nursing, medical, and legal communities.

Awareness of elder abuse is becoming more prevalent as the population of America ages. Since the 1970s when Congressional hearings on elder abuse were held in the United States, more funding and research has focused on elder mistreatment, originally under the umbrella of Family Violence. Multiple aspects of abuse in the elderly have been examined including tools for detection, assessment, and documentation. Studies have also been done on the circumstances surrounding abuse as well as theories of causation and characteristics of the abuser.

Physical, sexual, and financial abuse of the elderly is being identified and prosecuted at an increasing rate in the California court system. The purpose of this study was to examine the relationship between victims of elder abuse and those convicted of crimes stemming from the abuse.

A review of 100 cases of elder abuse prosecuted through the San Diego District Attorney's Office was done to answer questions regarding relationship between victim and offender, types of abuse, and criminal case outcome. All of the defendants had been convicted of crimes stemming from incidents of elder abuse. The relationship between type of abuse and type of abuser was also examined. Research findings are presented as well as recommendations for further nursing and medical awareness in cases of elder abuse, and cites the need for close collaboration between the medical and legal communities.

Elder, Abuse, Relationship

D58 The Characterization of Heroin Drugs Seized in Taiwan

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After attending this presentation, attendees will gain knowledge on the different regions, seasons, and planting schemes for opium cultivation bringing about basic changes of the ratio of codeine to morphine, so it is practicable to trace back to illicit heroin origins including planting origins, smuggling origins or black market origins.

This presentation will impact the forensic science community by discussing the probative value to determine the origins of different heroin seizures, even if there is no information about real opium planting or possessing origins.

Eighty heroin seizures of over 100 gram in Taiwan during the period of 2006-2008 were analyzed by gas chromatography with a flame ionization detector (GC-FID). In contrast to the methods of trace impurities identification by GC-FID, the ratio of total morphine content to total codeine content were calculated for each heroin seizure. The total morphine content refers to the amount of heroin and morphine related impurities converted back to morphine, and the total codeine content refers to the amount of codeine and 6-acetylcodeine. Different region, season, and planting schemes for opium cultivation bring about basic changes of the ratio of codeine to morphine, so it is practicable to trace back to illicit heroin origins including planting origins, smuggling origins or black market origins. Even if there are no information about real opium planting or possessing origins, the probative value to determine the origins of different heroin seizures is very valuable in suit pending.

Forensic Science, Heroin, Characterization

D59 Death Scene Investigation: The Role of Scene Re-Creation

Kathleen Diebold Hargrave, MA, Saint Charles, Jefferson & Franklin, Medical Examiner's Office, 3556 Caroline Street, Room C305, Saint Louis, MO 63104*

After attending this presentation, attendees shall have a basic understanding of both the mechanics of how, and the need for scene re-creations in the field of death investigation.

Attendees from the forensic science community shall be impacted by factors associated with scene re-creation and how critical it is in determining cause and manner of death in infant death investigations, as well as, the need to standardize and improve data collected at infant death scenes.

When an infant dies suddenly and unexpectedly after being placed down to sleep, a thorough infant death scene investigation cannot be accomplished without a re-creation of the sleep environment. The re-creation is a critical part of the medicolegal death investigation and is necessary for an accurate certification of cause and manner of death. The CDC's SUID Initiative is aimed at improving the accuracy and consistency of the reporting and classification of SUID deaths. Case examples will be presented demonstrating practical application of the scene recreation technique to be utilized during infant death investigations, as well as, extending this application for investigations of older children and adult deaths.

In 2007, there were 127 sudden, unexpected deaths of infants under the age of one year reported to the Child Fatality Review Program in Missouri. Based on autopsy, investigation and CFRP panel review, 15 were diagnosed as Sudden Infant Death Syndrome (SIDS), 59 Unintentional Suffocation, 25 Illness/Natural Cause, and 23 could not be determined. Four infants were found to be victims of homicide and one infant's death was determined to be an accident, resulting from exposure to excessive heat. Those five deaths are discussed under "Fatal Child Abuse and Neglect."

Of the 127 sudden, unexpected infant deaths in Missouri in 2007, a scene investigation was completed in 122 cases (96%); 60 (49%) of those were completed by a medical examiner or coroner or their investigator.

The SUIDI Reporting Form is one of the many tools available to professionals involved in the investigation and evaluation of all child deaths. The reporting form has been refined and updated over time, and provides a guide to the investigator, regardless of experience level, to consistently collect the information necessary for an accurate determination of the cause and manner of death.

The goals of the SUID Initiative are to develop tools and protocols to: standardize and improve data collected at infant death scenes; promote consistent diagnosis and reporting of cause and manner of death for SUID cases; prevent SUIDs by using improved data to monitor trends and identify those at risk and improve national reporting of SUID.

In some cases, even the most thorough autopsy and scene investigation do not produce a definitive cause of death, in 2007, the cause of death of 23 Missouri infants could not be determined, yet risk factors are present that are significant enough to have possibly contributed to the death. One such risk factor is an unsafe or challenged sleep environment. Recent studies of epidemiological factors associated with sudden unexpected infant deaths, demonstrate that prone sleeping and the presence of soft bedding near the infant's head and face pose very strong environmental challenges, by limiting dispersal of heat or exhaled air in the vast majority of cases. The extent, to which, such environmental challenges play a role in a particular sudden infant death, often cannot be determined. Therefore, a sudden unexpected infant death involving an unsafe sleep environment would be classified as undetermined**,** when unintentional suffocation is not conclusively demonstrated by the scene investigation.

In conclusion, this presentation will address practical applications on how to incorporate a scene recreation doll as an investigative tool to be utilized during infant death investigations. This tool will enhance an investigators ability to conduct a thorough infant death scene investigation.

Scene Re-Creation, Infant Death Investigation, SUID

D60 Disaster Victim Identification After Mass Fatality Events: Lessons Learned and Recommendations for Disaster Response Planning

Megan Bassendale, MSc, MA, 6678 Marine Drive, West Vancouver, BC V7W2S9, CANADA*

After attending this presentation, attendees will understand some of the challenges associated with the Disaster Victim Identification (DVI) aspect of three specific mass fatality incidents, the issues that are common between these events, and the lessons that can be learned from critical comparisons of the DVI response to these incidents.

This presentation will impact the forensic science community by highlighting areas that have been challenging in past DVI efforts and providing recommendations for procedures and protocols that should be incorporated into future disaster response planning in order to better prepare for DVI in the wake of an incident with mass fatalities.

The identification of deceased victims of a disaster is an essential aspect of disaster response. Although disaster response plans usually account for the recovery of a small number of victims in the immediate aftermath of a disaster, identification in the wake of a large-scale disaster can be much more complex and long term. Often disaster response plans do not comprehensively address this aspect despite warnings from experts about the lack of preparedness and useable guidelines to address this issue. Protocols need to be established prior to an event to overcome the challenges and facilitate an organized response to DVI in the aftermath of a mass fatality. These protocols should incorporate lessons learned from earlier events, which thereby necessitates critical comparisons of the response to past mass-fatality events to identify areas for improvement. In the past, a failure to document and learn following mass-fatality disasters has resulted in similar mistakes occurring time and time again, including a lack of appropriate planning for mass fatalities and a lack of operational protocols to address the needs of a mass-fatality situation.

This research was conducted through a comparative analysis of three contemporary incidents that resulted in mass death including: the World Trade Center attack in the United States in 2001, the tsunami disaster in Southeast Asia in 2004, and Hurricane Katrina in 2005, also in the United States. Literature and case studies on the DVI process of each incident was analyzed for specific factors and concepts that were challenging to each in order to develop categories that were common to all three disasters. For the tsunami, research was limited to the experience in Thailand because much of the published research is concentrated on this context; and for Hurricane Katrina, the experience in Louisiana was concentrated on for the same reason. Each of the incidents was analyzed to determine the main issues that were encountered in the DVI aspect of the disaster response. In order to consistently compare the incidents, the data was initially organized according to the number of victims, the breakdown of nationalities represented within the victims and the major issues and/or difficulties in the DVI process. All literature was reviewed using this approach. The data from the three incidents was subsequently compared to identify if there were similar problematic factors across the events. As a result of the analysis, problematic factors experienced by the different events could be categorized into three main fields: planning and preparedness, collection of antemortem data, and identification methodologies.

This research has resulted in key lessons and recommendations in a number of areas for practical actions to improve the capacity of authorities to deal with a mass-fatality situation. These include: (a) consideration of the logistical requirements of the DVI efforts; (b) development of SOP's to guide the process; (c) training of key players in the response efforts; (d) establishment of methods for the creation of an

accurate manifest list of deceased individuals; (e) development of a system to track and label information prior to an incident; (f) establishment of guidelines for the collection of relevant, accurate, and standardized antemortem data; (g) access and training in data-management systems prior to an incident; (h) development of operating protocols and procedures to guide the selection of the most efficient and effective identification technique; and (i) establishment of the details related to DNA analysis prior to an incident. Preparedness in these areas will result in a smoother identification process that will facilitate quicker and more efficient identification and return of human remains to the respective families.

Disaster Victim Identification, Mass Fatality, Disaster Response

D61 Household Furniture Tip-Over Deaths of Young Children

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After attending this presentation, attendees will understand the role of medicolegal death investigations in identifying childhood deaths due to household furniture tip-overs.

This presentation will impact the forensic science community by calling attention to household hazards that may be the cause of preventable childhood deaths.

Although many investigators have recognized that unsafe sleeping conditions such as bed sharing (co-sleeping) and/or compressible sleep surfaces play a causal role in many sudden, unexplained infant deaths, there is a dramatic increase in the incidence of accidental deaths when children reach the developmental stage of mobility. Accidental deaths in childhood result from falls, poisoning, drowning, fires/burns, transportation-related deaths, and deaths due to foreign body inhalation. The majority of these deaths occur in the child's residence, and many result from avoidable hazards in the home and/or lapses in supervision of the children by their caregivers - in some instances because of impairment of the caregivers due to exhaustion or substance abuse. Examples include poisonings resulting from a child having access to household products containing hazardous chemicals or to objects left within the child's reach that could be swallowed, and deaths due to hyperthermia when children are inadvertently left in closed vehicles.

Although the majority of childhood accidental deaths in the home relate to readily recognizable domestic sources of danger such as drowning deaths due to inadequate barrier mechanisms preventing the child from having access to residential swimming pools, other hazards are less well recognized. Childhood deaths due to tip-overs of household furniture or appliances are uncommon. The Consumer Products Safety Commission (CPSC) has warned the public of the potential for injuries and deaths due to pieces of furniture or television sets falling on young children. However, the forensic literature contains little information on childhood deaths resulting from furniture tip-overs.

Cases of nine childhood deaths will be presented that resulted from household accidents in which furniture or domestics appliances fell on the child, to elucidate the causes of death in such rare but potentially preventable circumstances. Three of these deaths resulted from bedroom dressers falling onto a child, one from the tip-over of a kitchen stove, one from a lounge chair, and four from television sets. All but one child was less than five-years-old. The cause of death was attributed to blunt head trauma in three cases and chest and abdominal trauma in one. Four deaths were certified as asphyxia due to chest compression, with the weight of the heavy object impeding the child's breathing. The cause of death in the remaining case was attributed to a combination of asphyxia and blunt head trauma. In all nine cases the death could have been prevented by adequate anchoring of the piece of furniture or by closer supervision of the child.

Childhood deaths due to traumatic asphyxia are uncommon. In these circumstances, the determination of the cause and manner of death must be based predominately on the investigation of the scene and circumstances of death, since the physical findings at autopsy are few and nonspecific. The medicolegal death investigator, in collaboration with the investigating law enforcement agency, plays a key role in elucidating the cause and manner of death in such cases. Findings indicate that a thorough, multidisciplinary approach correlating the scene investigation with autopsy findings is essential in reducing the incidence of deaths due such domestic hazards.

Tip-Over, Furniture, Childhood

D62 NamUs Human Identification and Reconciliation: Process and Implementation

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After attending this presentation, attendees will understand how the National Missing and Unidentified Persons System (NamUs) can be used in the process of human identification, what types of data can be stored and searched, available forensic services, and how potential matches with missing persons are included/excluded as a case moves towards resolution.

This presentation will impact the forensic science community by defining what the human identification process is for NamUs.

NamUs fills an overwhelming need in the United States for a central reporting system for unidentified human remains and missing person's records. There are as many as 40,000 unidentified decedents and approximately 100,000 missing persons in the United States annually (*The CJIS Link* Vol. 9, No. 3, October 2006, FBI Criminal Justice Information Services Division). NamUs consists of two databases that are fully searchable by law enforcement and majority searchable by the general public, allowing these groups to share information and work together across state and jurisdictional lines to more effectively resolve cases. The two NamUs databases are fully integrated to allow simultaneous searching of the Missing Persons (MP) records against cases in the Unidentified Decedents Database (UP) to locate comparable records and resolve cases.

The definition of the human identification process for purposes of NamUs refers to the reconciliation of antemortem information from missing persons with data derived from unidentified decedents. The reconciliation of data sets includes comparison of intrinsic biological data such as estimated age at death, biological sex, racial affiliation, living stature, known physiologic conditions, and other individualizing characteristics. Extrinsic information includes clothing manufacturer data, shoe size and make, vision prescription, last known address, height and weight from non-medical records such as a driver's license, or other work- issued identification and is also searchable.

Unidentified decedent files entered by medical examiner's and coroner's offices include the physiological or intrinsic characteristics of a person, as well as any available extrinsic factors including the location, search and recovery of the decedent, if recorded. A member of the NamUs Forensic Team can create a basic biological profile to include a wide range of identifiers and record any and every individuating characteristic for further study. In the case of dental structures, dentures and the like, NamUs forensic odontologists are available to chart the dentition in accordance with accepted practice. Tissue samples for DNA analysis can be prepared following the guidelines established by the University of North Texas Center for Human Identification, at no cost to agencies.

Missing persons files can be entered by families, law enforcement officials and other non-profit agencies and typically contain many basic biological characteristics as well as extrinsic information that is often highly detailed. To ensure accuracy and legitimacy, NamUs Regional Systems Administrators (RSA) review MP cases prior to publication. The NamUs Forensic Services Team coordinates with the RSA to compile detailed information regarding dental and medical records and potential sources of biological reference material. Review of these files by the members of the NamUs Forensic Team results in a written opinion that stored on the NamUs MP file.

Case managers review NamUs-generated potential matches, assessing points of similarity to determine next steps. All forensic services used to include/exclude any potential employ standard forensic methods, procedures and documentation in the course of case comparison. A final reconciliation report is made to the local coroner/medical examiner, justice of the peace and/or law enforcement agency for final evaluation and assessment of "positive identification." These agencies follow conventional practices and legal protocol for official notification to the family and generate the death certificate.

Several cases will be used as examples of how forensic services and the NamUs system have advanced the resolution of MP and UP cases. It is recommended that forensic professionals, medical examiners and coroners and law enforcement become familiar with this powerful and useful new tool that is available nationwide at no charge.

NamUs, Human Identification, Missing Persons

D63 Where Is Your Family Member?: Harris County Medical Examiners Office's Innovative Approach to Locating Next of Kin

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The goal of this presentation is to instruct those attending in the proper methods of locating Next Of Kin (NOK) in an effort to eliminate any NOK discrepancies.

This presentation will impact the forensic science community by providing tools to more effectively locate and notify NOK. The information provided will illustrate the various methods that are critical in conducting accurate NOK searches and demonstrate how each search method is utilized as a part of the thorough investigation of medical-legal cases.

The Harris County Medical Examiner's Office (HCMEO) located in Houston, Texas is the third largest county in the United States and is located on the gulf coastal plain. The county contains the Port of Houston, which is one of the busiest sea ports in the nation, the fourth largest airport system, and the world's largest medical center. Harris County is multicultural and highly diverse with an estimated population of 3.9 million that includes the third largest Hispanic/Mexican American population in the United States. Approximately 400,000 illegal immigrants reside in the city of Houston alone. The homeless population of an estimated 12-14,000 is exceedingly high in comparison to national data. Due to the large population, diverse community, and significant number of transient residents, it is often difficult and time-consuming to locate NOK. HCMEO has addressed this problem with the formation of the Identification and Tracking Unit and the development of an innovative electronic system that tracks homeless decedents and is used to maintain annual statistics on certain categories of cases. From 2007 through the first six months of 2009, 152 cases of homeless decedents were investigated. From 2004-2006 the average time required to identify a decedent was 23 days. The average time has decreased since 2007 to an average of three days. In 90% of cases NOK are notified of a death within 24 hours of the decedent's arrival to HCMEO.

HCMEO follows the legal order of succession when determining legal NOK as follows: decedent's written directive, legal spouse, common-law spouse, adult children, parents or siblings, and extended family members. This succession is followed to properly identify and locate NOK and to eliminate any NOK discrepancies. When a NOK discrepancy arises, the family is referred to the HCME General Counsel, a Harris County attorney. HCMEO is currently the only medical examiner's office in Texas staffed with an on-site attorney. The attorney reviews written directives and instructs families on how to seek legal counsel via a private attorney if necessary.

HCMEO has established procedures in place to ensure that NOK are notified promptly. Investigators are directed to conduct thorough searches at the scene to obtain any phone numbers, documents or address books containing NOK information. HCMEO accesses public information through the county via birth/death records, marriage licenses, divorce decrees, personal/real property records, various internet searches and criminal history documents. Due to the large influx of immigrants in Harris County, HCMEO consults and seeks assistance from the appropriate consulate on any foreign national. The consulate will verify foreign nationals, locate NOK, and obtain birth records and fingerprints. Public outreach through local, national and international media outlets is accomplished through the Critical Reach program, giving the public an opportunity to assist HCMEO with locating NOK. HCMEO employs three anthropologists who assist with identification of decedents via radiograph comparison. An odontologist provides dental identification consultations when required. Unknown decedent fliers, with photos when appropriate, are distributed through multi-lingual media outlets, consulates, homeless advocacy groups and law enforcement agencies. Law enforcement agencies provide criminal history searches which may include NOK contacts, last known addresses and previous law enforcement encounters. HCMEO works in conjunction with law enforcement agencies by requesting assistance in responding to a last known address to locate NOK and perform death notifications.

Over the years, HCMEO has reached out to the public in a sensitive and respectful manner to locate NOK and confirm decedent identification. In each case HCMEO ensures that the information provided to the public is presented in a sensitive manner out of the respect for the decedents and their families. This innovative process may be modeled at other medical examiner's offices to insure that decedents are properly identified and NOK located expeditiously.

Identification, Scene Investigation, Next of Kin

D64 Bridging the Communication Gap: A Collaboration with the Oakland Police Department Criminalistics Laboratory, CALICO, and Children's Hospital

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After attending this presentation, attendees will be informed of the benefits of collaboration between scientists, investigators, prosecutors, and children's advocates.

The presentation will impact the forensic science community by providing all parties with the tools to more effectively assess the different needs of the stakeholders involved in crimes committed against children.

The Oakland Police Department Crime Lab has developed an ongoing collaboration with organizations working with child victims of sexual assault. The crime laboratory collaborates with the police investigators, the Oakland Children's Hospital and CALICO – Child Abuse Listening, Interviewing & Coordination Center.

CALICO is a non-profit organization specialized in non-traumatizing and unbiased interviewing methods for child victims of crimes. Members of CALICO include prosecutors, child interviewers, and family service coordinators. Child advocates are also part of the case review process. The doctors and nurses at Children's Hospital document and collect all potential evidence from a child after an alleged assault. Both organizations are often the first contacts for children and their families and are a vital resource during a very stressful time. Collaboration between these groups has been in existence for many years. The crime laboratory was invited to join this group in 2008.

The crime lab's communication with these organizations and the case investigators elucidates our purpose and abilities with regards to the use of physical evidence. This has improved the overall outcome for victims of sexual assault by debunking common myths spread by the media and fictional television. Better communication also ensures potential evidence is not being missed. Likewise, understanding the exam and interview process can help the crime lab understand how they are only one part of a large process.

Communication, Children Victims, Sexual Assault

D65 Ruminations on Competencies, Taxonomies, and Rubrics for Forensic Science Education

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After attending this presentation, attendees will: (1) understand the distinctions among competencies, taxonomies, and rubrics; and (2) how they apply to forensic science in general and forensic science education in particular.

This presentation will impact the forensic science community by improving the educational rigor in forensic science education programs.

The problems inherent in the education and training of forensic science practitioners have been obvious since the advent of forensic science as a profession. The solutions advanced; however, have too often been dictated by considerations of convenience, cost, and control. Three key problems exist: the scientific basis underlying each discipline; the different cognitive decisions required of classification, individuation, individualization, and reconstruction; and the relative roles of academic credentials versus practitioner skills. Addressing these problems needs to begin with the student – what can he do when he meets the teacher, what can he do when he leaves the teacher, and is what he learned what he needs to do the job? This paper will address the use in forensic science education of three educational solutions – competencies, taxonomies, and rubrics – and how they relate to the key problems.

Competencies are the latest arrival on the scene – that combination of knowledge, skills, and abilities in a particular career field, which, when acquired, allows a person to perform a task or function at a specifically defined level of proficiency. It seems straightforward enough that a professional degree program should be designed to provide such a product until one considers two problems: forensic science examinations require logical thinking, creative thinking, and judgment, all difficult to teach and assess; and delineating competencies for forensic science practitioners leads to similar delineations for educators. That is, experience as practitioners and advanced degrees are both required, not one or the other.

Taxonomies were the earliest of the three approaches proposed to professionalize education. The best known of the taxonomies was developed by Bloom; however, it has two deficiencies when it comes to forensic science education. One, it does not distinguish between the two types of applications – technician and professional. Two, it does not include levels for attitude, work ethic, and integrity which are key elements of a desirable forensic scientist. A revision to Bloom's Taxonomy is presented that includes these.

Rubrics were proposed somewhat after taxonomies in an effort to correlate the assessments in a course to the material being taught and to standardize the grading process itself. However, as learned in proficiency testing, when judgment and creativity are involved the concept of assessment may be simple but the execution is complex.

Like many other facets of forensic science, the education and training of a professional practitioner is a complex adaptive system. The three approaches discussed interact among themselves and each will adapt as the field changes. Each of the three approaches has value standing alone but they have even more value in their combination. Competencies describe the desired end product while taxonomies provide the environment within which they are to be achieved and rubrics provide a road map linking the two and insuring that they are achieved. But, their real value lies in their ability for guiding communication for change among the agencies dictating the tasks, the professional associations setting standards for those tasks, and the educational community preparing students to meet those standards.

Forensic Science Education, Judgment Assessment, Standardization

D66 Ethical and Legal Issues of End of Life Between Past and Future in the "Globalized" European Mediterranean Culture: The Italian Experience

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After attending this presentation, attendees will gain knowledge of Italian issues relating to the consent/dissent expressed by the patients (it will briefly explained the judiciary cases of Piergiorgio Welby and Eluana Englaro) or by their relatives. It will also present the legal obligations to act of the medical doctor and the obligation respecting the good life of the patient in the wider context of multi-ethnic society (still in search of true integration) which is now situated on the Mediterranean European basin.

This presentation will impact the forensic science community by exploring the question of the patient consent, which often falls in the understanding or misunderstanding in the case of foreigners.

In the multi-ethnic context that has recently affected the role of the medical doctors has become particularly complex, because they have to make decisions using professional resources in the best possible way and, in particular, because called upon to perform the role of mediator transforming the social needs of citizens in request for services.

The protection of health is, in fact, the primary objective of any form of welfare but feelings of suspicion, disappointment, and anger begin to arise between medical doctors and patients. The immigration of the last decade into Italy, a traditional cross-road of culture between Europe and Central Asia and between Europe and Africa, has created problems of communication between medical doctor and patient, generating misunderstandings, distrust and error, with consequent increase of denouncements relating to professional liability.

As well known by Italian jurisprudence and doctrine, the lawfulness of the medical act comes from the consensus, defined as a final act of a process that requires adequate information and it is achieved through a good relationship between health professionals and patients, including the relatives. In Italy, the legal basis of the request for informed consent for the patient is governed by Acts 13 and 32 of the Constitution. The lack of explicit consent prevents any type of health care activities and determines very serious consequences especially in the Criminal Code, which states the patient's consent as a precondition to any medical action (act 50 of the Criminal Code). The contemporary age, with its globalization, has made inevitable the need to deal with the major ethical issues raised by contemporary medicine – especially those regarding the end of life – combining with the fundamental truths valid for all religious communities (especially Catholicism, Islam, and Jehovah's Witnesses), which are strongly present in Italy. Therefore, the statement of informed consent as a theory and rule of law appears troubled in these different communities. From the doctrinal point of view, Catholicism has always regarded the medical doctor as a "ministry of life," called to help the living, cure disease, relieve pain. Human life is understood as a gift from God and the patient is seen as a child of God and personification of Christ himself. For these reasons, the crimes against life, such as abortion, homicide, suicide, abandonment of minors, and all forms of violence were ever convicted.

On the contrary, today's Islamic world has a strong heterogeneity of its population, due to movements, currents, and trends that, in the ultra-millenarian history of Islam, have crossed the entire Islamic world. This has influenced the thinking and behavior of Muslims, leaving behind traces more or less sustained, being currently in continuous tension between the acceptance of instances and models from the West and the need to safeguard the tradition.

A Muslim doctor is traditionally awarded a paternalistic role in the relationship with the patient and also has the freedom to make the determination if the patient is incapacitated in cases of serious or terminal illness, because the patient is considered severely physically and mortally ill and unable to deliberately end his own life.

The phenomenon of migration from North African countries continues to create problems of communication that tend to weaken the relationship between doctor and patient generating misunderstandings, distrust and consequent medical malpractice.

In conclusion, the authors hope that a policy of full integration between different cultural matrixes is processed in order to achieve a peaceful coexistence between Italian public health and patients, respecting each other's freedom.

Informed Consent, End of Life, Religious Communities

D67 A Cause for Forensic Public Health: Prevention and Public Health in Two United States Forensic Journals

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After attending this presentation, attendees will understand the breadth and depth of prevention literature published by the forensic disciplines as reflected in the articles of two large United States forensic journals.

This presentation will impact the forensic science community by making attendees more aware of injury prevention and other widely available resources.

Interpersonal violence and unintentional injury exact high psychological, medical, and financial toll. Through analysis of 162 papers, literature review and personal interviews, it is found that the forensic community assists public health through data and advice provision and occasional (and rarely published) program implementation.

A full-text Medline search was instituted on January 2009 on two forensic journals (*Journal of Forensic Sciences and The American Journal of Forensic Medicine and Pathology*) for the terms "prevention" or "public health." The following data was collected: forensic discipline(s) involved (forensic pathology, forensic psychiatry, forensic sciences, forensic toxicology, jurisprudence/public policy, and criminalistics/criminology); primary author's location and affiliation; injury mechanism or forensic topic discussed; manner of death discussed; relevant public health service provided (provision of risk factors, advice or direct service); and prevention content.

By forensic discipline, the number of articles related to forensic pathology leads by a wide margin (69%) followed by forensic psychiatry (13%) and public policy/jurisprudence (10%). Forensic toxicology, various forensic sciences, and criminalistics/criminology were discussed in 4-7% of the total papers. One odontology and one anthropology article were included in the ten under forensic sciences.

The leading forensic topic was child fatality (18%). Firearms and asphyxia/hanging (14% each), substance abuse (13%), and blunt force injuries (10%) were the leading stand-alone (single modality) mechanisms. Death certification and standards were discussed in 16 or 10% of the papers.

In terms of prevention or public health service, most papers offered risk factor establishment (96 or 59%) or helpful theory/advice (76 or 47%). Only six papers described a direct service and three were jail suicide prevention programs.

Accidents were the most discussed manner of death at 61 papers (37%). Categories of intentional death – homicides and suicides – were mentioned in 19% and 18%, respectively.

Majority of the readership of NAME and AAFS is U.S.–based, thus the North American predominance.

By specific institutional affiliation, medical examiner's offices were the most common source of material (21%) followed by academic forensic departments, and hospital departments of pathology (11% each). As one group, hospitals, hospital departments, medical schools/medical centers produced 36% or more than one-third of the papers. Medical examiners, coroners, and law enforcement groups wrote 23%; government and nongovernmental agencies, 20%; and universities, including academic forensic departments, 19% of the papers, respectively.

Extracted from the articles' prevention content, the following prevention suggestions are found across different manners and causes of death:

1. Limit firearm use
2. Promote mental health
3. Uphold and improve standards in surveillance, reporting and investigation
4. Avoid drugs and alcohol

5. Increase social support of vulnerable groups
6. Support rehabilitative measures in the legal or prison system
7. Decrease environmental risk (through self-protection or behavioral, environmental or product modification)
8. Maintain education, awareness and advocacy of preventable harm

Any interested parties should consider becoming more aware of their potential for injury prevention and utilize widely available resources. It is hoped that forensic professionals can optimize their knowledge and participation in injury and violence prevention work.

Public Health, Prevention, Forensic Sciences

D68 Association Between Alcohol Dependence and Glutamate Acid Decarboxilase (GAD 67) Gene Polymorphisms in a Male Italian Population

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After attending this presentation, attendees will understand the proposed methodological approach in analysis of biological factors associated with alcohol use disorders.

This presentation will impact the forensic science community by providing novel insights into the biological understanding of alcohol dependence.

Alcohol consumption has been associated with personal, familial, and social problems including school drop-out, productivity losses at work, as well as driving impairment with road accidents. Alcohol consumption has also been considered as one of the major contributing factor in violent crime.

Facing alcohol related problems is highly related to alcohol use disorder prevention and treatment. A contribution to a better understanding of the biological factors associated with alcohol use disorder (abuse and dependence) can be found in genetic studies.

The essential feature of Alcohol Dependence (AD) is a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues to use the substance despite significant substance–related problems. In general, the development of AD of alcohol use disorder has been linked to environmental and biological factors. The role of biological factor has been widely published in studies relating gamma aminobutyric acid (GABA) to alcohol use disorder. Acute and chronic effects of ethanol have in fact been linked to a GABAergic system involvement.

Even though many studies have focused attention on GABA A receptor, this study concentrated on the glutamate decarboxylase (GAD), the rate limiting enzyme in GABA synthesis, believing it could be of potential interest in relation to AD development. In particular the isoform GAD 67, responsible for maintaining basal GABA levels as suggested by rodent studies (GAD67 knockout mice is usually lethal) was studied.

Based on these premise, a genetic association study was conducted in a rather homogeneous sample of individuals of Western European origin and of the Veneto Region in Italy, trying to provide novel insights into the biological understanding of the disorder.

Methods: The research has been structured as a case-control study. The patient group included 350 Caucasian males coming from Veneto region, North-east Italy, 140 of whom were alcohol dependent according to the DSM IV TR criteria, and 210 controls recruited from blood donors. Twenty-six SNPs localized in the coding and in the untranslated regions of the GAD 67 gene with a *Genotyping System* were analyzed. Fisher chi-square test for allelic and genotype distributions and Hardy-Weinberg equilibrium (HWE) analysis for cases and controls were performed. Ten SNPs at the GAD67 gene were valid for further statistics.

Preliminary results show a difference in genotype distribution (p=0.0030) between alcoholic subjects and controls of SNP rs 11542313 localized in exon 3 of the GAD 67 gene that is responsible for a silent mutation (HIS37HIS).

Discussion: This is the first genetic study regarding GAD 67 gene in relation to the condition of alcohol dependence in an Italian population coming from the same region (Veneto). These results put in evidence a statistical association between one SNP of GAD 67 and the condition of alcohol dependence (AD). In order to clarify the possible meaning of this association, further genetic analysis is being undertaken. In particular, investigation of other genetic polymorphisms both up and down stream from rs 11542313 that could interfere with splicing and/or GAD 67 mRNA stability will be researched.

Alcohol Dependence, Glutamate Decarboxylase, SNPStream

D69 Sex Offender Registration and Public Bias

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After attending this presentation, attendees will understand the need for additional research in the area of sex offender registration along with additional registries concerning the public heath safety.

This presentation will impact the forensic science community by discussing that additional research is highly encouraged. It is only with added research that any major impact can happen within the criminal justice/forensic science community. The current study allows the general public to become aware of the current registries that are in place. With future research into this spectrum, adults can become better educated about the world around them. The study also allows for the general public to find out if an offender; whether a sexual offender, drug offender, or an individual with a mental disorder, resides within close proximity.

In recent years there have been many public policy changes that have affected sex offender registration. Many of these changes have come about through significant media coverage of child abductions, molestation, and murders. There is now a mandatory registration for individuals who have been convicted of any sex offense. The objective of this study is to determine if there is a public bias towards having mandatory registration for sex offenders versus other potential mandatory registrations. While sex offender registration has been deemed necessary for public safety there may be other areas of public safety that have been ignored due to the public's zeal towards sex offenders. Areas that are often ignored and just as dangerous to the public's safety or health include weapons, sexually transmitted diseases, mental health diagnoses, and other violent crimes.

The study was conducted through the use of voluntary surveys using both qualitative and quantitative data analysis. The results were evaluated using descriptive statistics to show any potential public bias towards registering sex offenders. Surveys were passed out to the general public ages eighteen to thirty, with no preference towards race, gender, religion, relationship status, and education level. Data was obtained through the University of Colorado as well as through means of public venue.

The results from the survey showed a high percentage of respondents indicating the public's need for additional mandatory registration. Both male and female respondents had a very high percentage of yes responses for mandating sex offender registration. However, both male and female respondents also had a high percentage of yes responses for all weapon registries for the exception of tasers. All respondents had a high percentage of yes responses for other crimes

except for illegal drug use. It is important to note that at least 96% of all respondents felt murder should result in mandatory registration. Results from the survey showed the general public ages eighteen to thirty had a bias towards registering sex offenders versus having mandatory registries for other public health safety registries such as gun ownership, HIV (positive), STDs, illegal drug association, mental illness diagnosis, and hate crimes. Although there is a bias towards registering sex offenders, it is essential to note that a majority of respondents felt there needed to be a mandatory registration for offenders guilty of murder. A large percent of respondents also felt there needed to be a mandatory registration for specific violent crimes and for specific types of weapons. The survey results revealed the need for future research in this area as well as possible changes to current policies and procedures mandating federal registration. The sole purpose of this research study is to provide statistical analysis and to increase knowledge without changing current state and federal policies.

These three words are used throughout the study and used in the surveys which were passed out.

Mandatory in reference to the study means that upon sentencing the offender has to complete the registration in a timely manner regardless of the offender's opinion. As a result of the crime committed, the offender must complete registration in a timely manner. This term is a key component to the survey.

Registration in reference to the study means that the offender must supply their name, current address, convictions or other public health safety, along with date of birth, and a physical description of the offender. Registering an offender into a data base or system provides helpful knowledge to law enforcement and the public.

Crime refers to the offense of which an offender has been convicted; such as statutory rape, first degree murder, and so on. In the study and statistics found, each offender has committed a crime that has ultimately lead to the registration for their offense.

Additional research is highly encouraged. It is only with added research that any major impact can happen within the criminal justice/forensic science community. The current study allows the general public to become aware of the current registries that are in place. With future research into this spectrum, adults can become better educated about the world around them. The study also allows for the general public to find out if an offender; whether a sexual offender, drug offender, or an individual with a mental disorder, resides within close proximity.

Mandatory, Registration, Crime

D70 From Abstract to Publication: The Fate of Research Presented at an Annual Forensic Meeting

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After attending this presentation, attendees will have a better understanding of the fate of abstracts presented at forensic meetings and good predictive factors of publication.

This presentation will impact the forensic science community by emphasizing that publication in a peer-review journal remains the ultimate corroboration of research results.

Introduction: Abstracts presented at scientific meetings is a valuable way of conveying state-of-the-art knowledge and promising techniques, but publication in a peer-review journal remains the ultimate corroboration of research results. Indeed, peer-reviewed publications allow a more rigorous evaluation of the design, methods, results, and conclusions of a paper than abstract acceptance, since conference scientific committees decide on abstract acceptance or refusal based on limited information contained in the abstract itself. A possible measurement of the quality of abstracts presented in scientific meetings is the abstract to publication ratio, representing the proportion of abstracts published in peer-reviewed journals. This ratio has been studied for several international meetings, ranging from 8.5% to 78%. In forensic sciences, the fate of abstracts presented at international meetings has not yet been evaluated.

Material and Methods: All abstracts of published for the 2006 AAFS Annual Scientific Meeting in Seattle were searched in the PubMed database of the National Library of Medicine for subsequent corresponding published paper in peer-reviewed journals. Papers found on PubMed were closely compared to the proceeding abstracts to confirm correspondence of both. Furthermore, abstracts from three sections of the AAFS meeting, namely engineering sciences, jurisprudence, and questioned documents, were also searched through the FORS Forensic Bibliographic Database. Finally, for all published and unpublished abstracts, the following variables were compiled: section of the meeting, type of presentation (oral/platform or poster), number of authors per abstract and per paper, time span to publication, countries involved, and journal of publication.

Results: For the 58th Annual Scientific Meeting, 623 abstracts were presented at the meeting, from which 102 were subsequently published as a full paper in a peer-review journal. The majority of those papers were published in the meeting's official journal, the Journal of Forensic Sciences (64.7%).

Publication ratio: The overall publication rate was of 16.4%, ranging from 3.4% (for the Jurisprudence Section) to 28.8% (for the Toxicology Section). Although Criminalistics ranked second considering the publication rate (21.8%), in absolute numbers, it published more papers than all other sections (38 papers).

Type of presentation: In general, oral presentations were more likely to be later published than poster presentations, with respective publication ratios of 17.2% and 14.6%. However, this difference was not statistically significant ($p = 0.4219$). The only exception appeared in the Physical Anthropology section, with a statistically significant difference for the publication ratios of oral (18.9%) and poster (3.2%) presentations.

Number of authors: Overall, the average number of authors per abstract was of 2.9. This number of authors per abstract was higher for published abstracts (3.7) compared to unpublished ones (2.7). This difference was statistically significant ($p = 0.0001$).

Time span to publication: The time span to publication averaged 10 ± 9 months. Among the published articles, 13% were published before the AAFS conference, 52% were published within a year and 75% within 1.5 years.

Countries involved and International collaboration: As expected, American authors outnumbered foreigners at this American meeting (USA 76%, other countries 20%, and international collaboration 4%). Publication ratio; however, was highest for abstracts written in international collaboration (37%), followed by abstracts from non-USA authors (21%), whereas U.S. authors presented the lowest publication rate (14%). Statistical analysis revealed a strong association between the geographical source and the publication ratio ($p = 0.0021$; non-USA vs. USA $p = 0.0538$, international collaboration vs. USA $p = 0.0012$).

Conclusion: Forensic scientists are encouraged to publish their findings since abstracts that fail to attain subsequent publication remain valueless in forensic sciences, their data being hardly accessible and of dubious validity due to lack of rigorous peer-review. Since good predictors of publication are a higher number of authors and international collaboration, authors are incited to work in teams, locally and internationally, in order to increase the productivity of research. Research teams must be careful however to avoid gift authorship.

Bibliometry, Meeting Abstracts, Publication Ratio

D71 Analysis of 436 Cases of Sexual Assault

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The goal of this presentation is to describe victim, assailant, assault characteristics, medico-legal findings, and judicial outcomes.

This presentation will impact the forensic science community by establishing a collaboration with gynecologists during the day as is done during the night and weekend in order to improve the multidisciplinary care of victims. Researchers have also proposed the creation of a specific folder for the medical examiners in order to standardize the forensic medical examination for a better assessment of injuries and health status of the victim.

Introduction: Sexual violence now require multidisciplinary medical care, both in order to attempt to collect as quickly as possible the clinical and paraclinical elements that will be useful for justice, and for monitoring medical and psychological care of victims. In Lille, the care of victims is ensured in forensic consultation during the day but also during the night and weekend in collaboration with emergency gynecological and pediatric

Materials and methods: This study was based on 436 examined victims of sexual assault over 15 years established in February 2003 to February 2007 by forensic pathologists. Victims were referred from investigating police authorities. Two groups of victims were defined: a first group of victims examined during the day by a forensic pathologist (247 cases) and a second group of victims examined during the night and weekend by a forensic pathologist and a gynecologist (189 cases). Legal outcomes were obtained from courtroom proceedings.

Results: About 89% of the cases were female victims in the first group and 100% in the second group. Age ranged from 15 to 78 years and the mean age was about 27 years in the two groups. Vulnerability was present in 20% of the cases of the first group and 7% of the second group, including disabled and pregnant victims. There was a single assailant in the majority of the cases for the two groups (about 80%). The assailant was a stranger only in 27% for the first group and 40% for the second group. When the assailant is known, he's a family member in 8% for the first group and 16% for the second group. The victim's home was the most frequent place of sexual assault (38% for the first group and 29% for the second group). Vaginal penetration without condom was the most frequent type of sexual assault in the two groups. The period of medical care was less than two days in 36% for the first group and 94% for the second group. General body trauma was found in 33% of the first group and 44% in the second group. Genital trauma occurred in 16% for the first group and 29% for the second group. About 50% of the cases in the two groups, formal criminal charges were not filed due to insufficient evidence. 24% of the assailants were convicted in the first group, and 21% in the second group.

Discussion: In this study, as in the forensic literature, young, single, and active women are most often assaulted and by a known assailant in the majority of the cases. Sexual assault often occurs in the home of the victim or the assailant. The forensic examination found more damage if it is done shortly after the incident, but the absence of injury does not mean that there was no sexual assault. Concerning the judicial outcomes, the presence of general body and genital trauma were not necessarily associated with conviction. Physical evidence of trauma was neither predictive nor essential for conviction. But victim's examination must be performed as early as possible in order to collect the evidence needed to identify the assailant and initiate preventive treatment. When the time is important in relation to the facts, the care of victims should be a constant concern of medical examiners in order to enable the psychological reconstruction of these victims. Establishing a collaboration with gynecologists during the day as is done during the night and weekend in order to improve the multidisciplinary care of victims is proposed. The creation of a specific folder for the medical examiners is also proposed in order to standardize the forensic medical examination for a better assessment of injuries and health status of the victim.

Sexual Assault, Adults, Judicial Outcomes

D72 Body Packing as a Forensic and Radiological Challenge: Sensitivity, Specifity, and Accuracy in Detection of Cocaine Drug Containers by Different Modalities

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After attending this presentation, attendees will be able to tell which modality is best for radiological detection of body packs. The difference of body packing, stuffing, or pushing will be elaborated and the varying appearance of the packs in CT and conventional imaging will be demonstrated. Furthering the necessity of a tight collaboration of the custody ward, the forensic institute and the radiology department will be shown.

This presentation will impact the forensic science community by raising awareness of the difficulties in ante mortem imaging of body packers and the organizational problems in custody wards and the upcoming medicolegal issues.

Purpose: The goal of this study was to investigate the diagnostic value of unenhanced multidetector CT (MDCT), plain radiographs and statscan imaging of the abdomen for detection of concealed cocaine – filled packs in the alimentary tract of human transporters.

Materials and methods: Thirty two suspects of drug body packing (29m, 3f, mean age 27y, range 16-45 y) underwent radiological imaging: MDCT (n=14), plain radiograph (n=26) and Lodox (n=8). A total of 57 examinations were investigated (15 MDCTs, 32 plain x-rays, 10 Lodox) whereas some patients had more than one exam, according to clinical or forensic indication. The images were assessed retrospectively by investigators without special training or experience in reading images of drug carriers. Radiological findings were compared with listed evidence in the feces of each detained suspect. Sensitivity, specificity and accuracy for drug concealment were calculated for each modality.

Results: Cocaine-filled containers could be detected in 19 out of 32 patients. Twenty-eight examinations were true positive and nine false negative, whereas 19 were correctly identified as negative, and one was read as false positive. Lodox showed a sensitivity of 57%, specifity of 100 % and accuracy of 70%; plain radiographs 76%, 90%, 81% and MDCT 88%, 100%, 93%, respectively.

Conclusion: MDCT imaging showed the highest diagnostic accuracy and sensitivity in verification of body packing. Based on this fast disposable and reliable result of MDCT and the usually limited space at custody wards, forensic and of course medical issues do lead to an increasing number of (judicial warranted, if needed) MDCT examinations during the last years. Still there is the problem of radiation dose that could be addressed by the application of low-dose protocols for

the suspect's benefit. Obviously, the radiologist needs to be well schooled in the appearance of the drug containers in order to diagnose those correctly – therefore a tight collaboration with the custody ward, the associated forensic institute and the radiology department is desirable.

Body Packer, Radiology, Cocaine

D73 Aircraft Accident Investigation and Pilots' Autopsies in General Aviation: A Retrospective Study in France Between 2002 and 2007

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The goal of this presentation is to focus on how far medical aspects are taken in account in fatal air accidents investigations and, subsequently, whether they can or not be considered as a "cause" of accident.

This presentation will impact the forensic science community by showing the interest of improving the postmortem investigations in air crashes in France.

Introduction: The autopsies of pilots killed in an aircraft accidents are performed in the context of judicial investigation. Despite European Recommandation 99-3, the decision to perform or not an autopsy varies from a prosecutor to another. This study focuses on how far medical aspects are taken in account in fatal air accidents investigations and, subsequently, whether they can or not be considered as a "*cause*" of accident.

Material & Methods: A study conducted by the Institute of Forensic Medicine of Lille (CHRU Lille) on aircraft accidents occurred between 2002 and 2007. Data have been provided by BEA. Occurrences are sorted by probable cause and fatal accidents due to mechanical causes are eliminated. Other causes (i.e., revealing medical issue, loss of control, and unspecified causes) are included. Contents of *postmortem* examinations, autopsies, and toxicological reports are compared to pilots' *antemortem* medical examinations of fitness.

Results: The number of fatal accidents decreases from 51 in 2002 to 39 in 2007, except a spike in 2003 (54). About five fatal accidents per year are related to a medical disease. Nevertheless, a medical impairment as cause of an accident is questionable in 10 cases per year. It was also reported five cases of suicide. Most of the time, heart attack is suspected on the basis of pilot's medical past-history and similarities between the actual occurrence and incidents or serious incidents in which pilots have survived.

Discussion: This study reveals a lack of medical post-crash information related to: (1) the difference of aims between judicial and technical investigation; and (2) the lack of standard practices in forensic examinations. Despite Standard 5.9 of Annex 13 and European Recommandation 99-3, performing an autopsy of a pilot after a crash is not systematic. French civil aviation authorities have notified this difference to International Civil Aviation Organization that could mean a steady state for the next years. Thus, the medical cause is often established when medical findings and abnormal maneuvers are simultaneous. The lack of data can be a starting point for a discussion about the concepts of "*medical cause*" and "*air risk factor*" to initiate an improvement of *postmortem* data collection in air accident investigation.

Autopsy, Aircraft Crash, Pilot

E1 Keeping Safe From Youth Gang Violence in Our Communities

Cliff Akiyama, MA, MPH, Philadelphia College of Osteopathic Medicine, Department of Forensic Medicine, 4170 City Avenue, Philadelphia, PA 19131-1694*

After attending this presentation, attendees will be able to explain the organization of youth street gangs, examine the historical evolution of gangs in the United States, distinguish the behavioral differences and similarities between gangs, compare and contrast activities of various gangs, and determine gang implications for medical examiner/coroner, forensic science, and law enforcement personnel.

This presentation will impact the forensic science community by providing current trends and timely data on youth gangs; offer strategies on how to recognize and interpret various tattoos and graffiti associated with different youth gangs, which could assist the medical examiner/coroner, death investigator, and detective in the positive identification of the decedent out in the field and/or in the autopsy room. Most importantly, it is imperative that the medical examiner/coroner, forensic science, and law enforcement communities understand the "signs and symptoms" of various youth gangs in order to keep themselves and those around them safe when investigating the deaths of these gang members.

Youth gangs throughout the United States continue to terrorize the neighborhoods that they claim as their own, causing the citizens in these gang infested neighborhoods to live in constant fear of their lives every single day. As a result of the recent influx of gang violence and gang related homicides in all communities, the safety of those first responders and investigators at the scene are put in jeopardy, leaving the medical examiners/coroners, death investigators, and detectives as possible targets of intramural shootings just because they are at the scene. Throughout the United States gang violence has risen over 20% over the last year. Sadly, every single state has gangs and the problem is getting much worse in areas that would never have thought about gangs a year ago. Gangs are not just an urban problem, but a suburban and rural problem too. There are over 24,500 gangs in the United States with a total gang membership of 750,000. Ninety-four percent are male and six percent are female. The ethnic composition nationwide include: 47% Latino, 31% African-American, 13% Caucasian, 7% Asian, and 2% "mixed race" according to the Office of Juvenile Justice and Delinquency Prevention of the U.S. Department of Justice. This study identified eight distinct manifestations of youth gang violence and nine ethnic differences and similarities among African American, Latino, and Asian American gangs. A sample of the findings include: distinct cultural differences between African American, Latino, and Asian American gangs; drugs; weaponry; killing over turf/territory; extortion; defacing property/graffiti; women in gangs.

Youth Gangs, Youth Violence, Personnel Safety

E2 Methamphetamine: Peanut Butter to Ice

Sanford A. Angelos, MSc, MEd, Aris Associates Ltd., PO Box 10130, Chicago, IL 60610-0130*

After attending this presentation, attendees will understand the different forms of methamphetamine. The analysis of the samples will determine how to charge the defendant and which sentencing guidelines apply.

This presentation will impact the forensic science community by providing key aspects of how the collaboration of the forensic scientist and the attorney is vital for appropriate court outcome. The attorney's understanding of the analysis of a methamphetamine sample will result in the proper charging and sentencing.

Methamphetamine is still a major drug of abuse. Although recent regulation of pseudoephedrine by most states has decreased the number of clandestine laboratories, it is still a significant problem. The 2008 availability and seizure data indicate a strengthening in domestic methamphetamine availability and domestic methamphetamine production, and an increase in the flow of methamphetamine into the United States from Mexico (*National Methamphetamine Threat Assessment 2009*, National Drug Intelligence Center, December 2008).

Legally, methamphetamine is a schedule II controlled substance (21 C.F.R. 1308.12(d)(2); 49 F.R. 12734 (7/791)). The salts, isomers and salts of isomers of methamphetamine are controlled (21 C.F.R. 1308.12(d)) with the term isomer meaning the optical isomer (21 C.F.R. 1308.02(d)). Thus, any amount of any form of methamphetamine is a schedule II controlled substance unless it is one of the listed pharmaceutical preparations. The Federal Sentencing Guidelines for methamphetamine have separate levels for (1) a substance containing methamphetamine; (2) actual methamphetamine; and, (3) ice (S.G. 2D1.1) Actual methamphetamine is a measure of purity and is defined to be pure, uncut, unadulterated, (*U.S. vs. Patrick* 983 F.2d 206(1993)), and does not include the weight of impurities, (*U.S. vs. Spencer* 4 F.3d 115(1993); *U.S. vs. Stoner* 927 F.2d 45(1991)). The amount of actual methamphetamine is determined by multiplying the net weight of the sample by the percent purity determined by the forensic chemist.

Ice is a special form of methamphetamine. It is a slang term for a very pure form of methamphetamine that is almost clear crystal chunks – like ice (frozen water), or rock salt. However, the Federal Sentencing Guidelines defines "ice" as *d*-methamphetamine hydrochloride at 80% or greater purity. The definition of the term specifies the isomer and the salt form of the molecule. Both of these must be specifically, unambiguously determined by the forensic chemist. The definition does not describe the appearance of the sample. Thus methamphetamine known as peanut butter because of its color and tacky consistency can be charged as "ice" if it is *d*-methamphetamine hydrochloride at 80% or greater.

The legal definition of ice has a variety of possible legal consequences. For example ecstasy tablets often contain multiple drugs along with the MDMA. It is not uncommon to find methamphetamine. Charging decisions a prosecutor faces includes whether to charge a case as possession of ecstasy, or the more serious charge of methamphetamine. This determination can be made after a discussion with the scientist as to the chemical makeup of the drugs seized.

Methamphetamine is a generic term, which specifies neither the isomer nor the salt form of the molecule. Both of these must be specifically identified by the chemist so that one may unambiguously know the exact form of the molecule. The attorney's understanding of the analysis of a methamphetamine sample will result in the proper charging and sentencing.

Methamphetamine, Ice, Sentencing Guidelines

E3 Cold Cases, Missing Persons, and NamUs: Initiatives of the National Institute of Justice

Charles M. Heurich, MFS, National Institute of Justice, Department of Justice, 810 7th Street, Northwest, Washington, DC 20531*

After attending this presentation, attendees will have a greater understanding of the programs that the National Institute of Justice (NIJ) funds regarding these topics and how funding is available to assist state and local agencies in these areas. Attendees will also be educated on the purpose and use of the National Missing and Unidentified Persons System (NamUs).

This presentation will impact the forensic science community, particularly the jurisprudence section, by spreading information about the programs supported by the National Institute of Justice regarding solving cold cases and identifying the missing.

Since 2005, the National Institute of Justice (NIJ) has initiated programs dedicated to assisting state and local law enforcement agencies and crime laboratories solve cold cases and identify the missing and unidentified. This presentation will discuss NIJ's Solving Cold Cases with DNA and Using DNA to Identify the Missing programs, their goals, and show success stories associated with them. In 2007 NIJ made public the National Missing and Unidentified Persons System (NamUs). The presentation will also discuss the two databases incorporated into this system, how they can be used, and success stories associated with the use of NamUs.

Cold Cases, Missing Persons, NamUs

E4 FBI Evidence Response Team

Thomas Lintner, BS, Federal Bureau of Investigation, Emergency Response Team Unit, 2501 Investigation Parkway, Room 4310, Quantico, VA 22135*

After attending this presentation, attendees will have a better understanding of how the FBI handles crime scene investigation and mass fatalities.

This presentation will impact forensic science by disseminating important information on the abilities, and limits of the FBI's Evidence Response Teams.

The FBI Evidence Response Team does both crime scene investigation and mass fatality operations. The program consists of ERTs in all 56 FBI field offices. These highly-trained and equipped teams, totaling about 1,200 personnel, operate at a high level of competence to ensure evidence is collected in such a manner that it can be introduced in courts throughout the United States and the world. ERT's strive to be the model for crime scene processing from the standpoint of safety, expertise, training, equipment, and ability.

This presentation will provide an overview of the program from a national perspective. It will also discuss the latest technical advances in crime scene operations. One or more major cases will be presented as a teaching tool, illustrating the capabilities of the FBI Evidence Response Team. Lawyers will learn what evidence can reasonably be expected to be obtained - and the limits of the sciences.

Crime Scene Investigation, Mass Fatalities, FBI ERT

E5 Clandestine Laboratory Capability: Actual vs. Theoretical

Sanford A. Angelos, MSc, MEd, Aris Associates Ltd., PO Box 10130, Chicago, IL 60610-0130*

After attending this presentation, attendees will understand the different methods a forensic chemist will use to determine the capacity of a clandestine methamphetamine laboratory. The analysis of the samples and evidence provided will determine how to calculate the capacity and ultimately the amount of methamphetamine to charge the defendant and which sentencing guidelines apply.

This presentation will impact the forensic science community by providing the attorney with the tools necessary to collaborate with the forensic scientist in determining the capacity of a clandestine laboratory – which is vital for an appropriate court outcome. The attorneys' understanding of how a forensic chemist determines the capacity of a clandestine laboratory through the analysis of a methamphetamine sample and the other evidence necessary will result in the proper charging and sentencing.

This past year there has been a decreased in the number of clandestine laboratories; however, it is still a significant problem. "Domestic methamphetamine production will most likely increase moderately in the near term." The expected increase is due to the resurgence of small-scale methamphetamine production to meet the need caused by the reduced Mexican methamphetamine production, although there has been a relocation of some Mexican methamphetamine producers from Mexico to California. While recent regulation of pseudoephedrine by most states has limited the amount available, there has been a new emergence of large-scale pseudoephedrine smurfing operations throughout the country. Smurfing is the officially accepted law enforcement term for individuals or criminal groups circumventing state and federal pseudoephedrine sales restrictions by making numerous small-quantity pseudoephedrine product purchases from multiple retail outlets, all creating conditions conducive to a moderate increase in domestic methamphetamine production (*National Methamphetamine Threat Assessment 2009*, National Drug Intelligence Center, December 2008).

There are two main types of clandestine methamphetamine labs. The first is the "super" lab sometimes referred to as Mexican National Labs. They are large, highly organized laboratory operations that can manufacture ten or more pounds of methamphetamine per production cycle. To date, super labs are concentrated in southern California and Mexico. The other type is small-scale laboratories, often referred to as "mom and pop" or "Beavis and Butthead" labs. These laboratories usually manufacture only one to four ounces of methamphetamine per production cycle. Their operators typically produce enough drugs for their own and close "associates" use, and just enough extra to sell to others to finance the purchase of production chemicals. There is a third far less common type of clandestine laboratory that has emerged in recent years. It is being called a "dirt lab." They are very small-scale lab operations that seek out areas where super labs dump their toxic waste, dig up the soil, and try to extract the residual methamphetamine.

The more common small-scale laboratories currently use one of three synthetic methods to convert ephedrine or pseudoephedrine to methamphetamine. The first of these is the hydriodic acid (HI) and red phosphorus (red P) method; the second is commonly referred to as the "Cold Cook" (the iodine (I_2) and red phosphorus method); and the third is known as the "Birch Reduction" method (using anhydrous ammonia (NH_4) and either sodium (Na) or lithium (Li) metal). All of these procedures require either ephedrine or pseudoephedrine as the primary precursor. Additionally, each of the three procedures can have several variations. The Cold Cook method is sometimes heated in the microwave or placed in a pressure cooker. Clandestine laboratory operators use several different ratios of ephedrine, iodine, and red phosphorus (e.g., 1:2:3, 1:1:2 and 2:1:1 are just three). The Birch

Reduction method is occasionally encountered using pseudoephedrine and lithium, dry-mixed together with anhydrous ammonia sprayed on the mixture to form a paste. This procedure decreases the actual yield, but is used because it is very rapid. Given the ease of clandestinely manufacturing methamphetamine and the similarities in the varieties of chemical syntheses procedures, recognition and positive identification of the manufacturing process can present challenges.

Production capability can only be based on the precursor chemicals. A precursor is incorporated into the final compound therefore only *l*-ephedrine or *d*-pseudoephedrine can be considered. All the other chemicals are either reagents or solvents that assist in the reactions but not added to the final product. Therefore, amount of the reagents cannot be used to determine production capability without a specific recipe. The forensic chemist can use three different methods in determining the clandestine laboratory's manufacturing capacity**.** The **Actual Yield Determination** which is ideal requires that the forensic chemist must have the amount of precursor used, and the amount of finished product with its purity determined. The 'recipe' or synthesis formula providing details as to the amount of precursor and the amounts or ratios of reagents used and the procedure is optional but very helpful. The absence of this information would require the chemist to use the second **Reconstructed Yield Determination** method. Here the forensic chemist will use scientific assumptions to fill in the needed information. This information is obtained from notes indicating weight of final product; lists of the operator's sales; sales receipts of chemical purchases; statements including elocutions; and agent's reports.

However, the recent Supreme Court decisions have moved the clandestine laboratory capacity determination from the sentencing phase where the preponderance of the evidence and qualified reasonable expectations are allowed to the trial in chief or guilt phase where the standard is beyond a reasonable doubt with some factual qualified assumptions. Thus, the **Theoretical Yield Determination** which calculates the 100% yield from the primary precursor is the only beyond a reasonable doubt method. Production capability is based on the precursor chemicals and calculated at 100% yield and 100% purity. Yield and purity are two independent concerns both expressed as a percentage. When calculating the theoretical yield of any reaction it is always at 100% purity.

Methamphetamine, Clandestine Laboratories, Sentencing Guidelines

E6 Bad Lawyering and Wrongful Convictions

Keith S. Belfry, JD, 1400 Alworth Building, Duluth, MN 55802*

After attending this presentation, attendees will recognize the value of competent and ethical lawyering and forensic testing, but will also understand that misconduct of prosecutors, forensic scientists and/or defense counsel (ineffective counsel) can result in the wrongful conviction of the innocent.

This presentation will impact the forensic science community by showing how testing methods, results, and interpretations, if not done neutrally, dispassionately, and without bias and proper validation, can assist in the rendering of legal harm of innocent people.

Both lawyers for the prosecution and defense have certain ethical and legal obligations in all criminal cases to protect against wrongful conviction of the innocent. Coupled with this is the obligation of any forensic expert, involved in a criminal prosecution or defense, to provide information that is scientifically sound and not to advocate. This presentation will examine samples of conduct that have lead to the wrongful conviction of the innocent and provide an understanding of what should have been done to protect those innocent individuals.

In 1987, an 18-year-old man was arrested and convicted of three counts of sexual intercourse without consent on an 8 year-old girl and was sentenced to three, forty-year concurrent terms in prison. In the year 2000, after being rejected for parole release because he would not participate in the prison's sexual offender treatment program, the case was re-investigated.

The re-investigation discovered that the State's case included "fraudulent" forensic testimony from the state's forensic expert concerning hair samples. The expert testified that the head and pubic hairs found at the scene were "indistinguishable" from the Defendant's and gave a statistical probability of a non-match (1/10,000) without any having any standard by which such a statistical conclusion could be rendered. Semen found in the victim's underwear could not, at the time, be typed and thus the testimony of the state's forensic expert became critical to the State's case.

Moreover, the identifications of the Defendant by the victim were highly suspect. The Defendant participated in a videotaped lineup which was shown to the victim after she could not identify the Defendant in a "live" lineup. After these two separate identification procedures, she indicted her confidence was 60 to 65% of her pre-trial identification of the Defendant. At trial, she indicated "she was not sure". Even under those circumstances, the Court permitted the identification of the defendant before the jury.

The Defendant's trial lawyer never challenged the pre-trial identification methods or her in-court identification. The Defendant's lawyer failed to conduct any investigation of the case, hired no expert to refute the state's forensic expert, filed no pre-trial suppression motions, made no opening statement to the jury, did not prepare a closing statement, and failed to file an appeal after the conviction of the Defendant.

The Defendant was ultimately exonerated by DNA testing. The forensic scientist headed the state's major crime lab and had testified in hundreds of cases in two states. The scientist was investigated by a committee of forensic scientists, and the committee concluded that his statistical evidence was "junk science." Before his release, the Defendant spent fourteen-and-a-half years in prison for a crime he did not commit.

When the Defendant in this case was released, he was the 111th person in the United States to be exonerated from a wrongful conviction; more have followed. Bad lawyering (ineffective counsel) plays a large part in wrongful convictions, as does the misconduct by the prosecution, police and forensic scientists.

Wrongful Convictions, Ineffective Counsel, Prosecutorial Misconduct

E7 These Tips Don't Lie: Jurors Absorb More Than They Think

Katherine Ramsland, PhD, DeSales University, 2755 Station Avenue, Center Valley, PA 18034*

After attending this presentation, attendees will be able to identify specific cognitive processes that influence how jurors listen and make decisions, and will describe the "encoding advantage" for courtroom presentations.

This presentation will impact the forensic science community by showing that people unfamiliar with cognitive research in social psychology fail to realize that most people possess minimal comprehension of the milieu that shapes their beliefs. For effective evidence presentation, courtroom personnel can benefit from a better grasp of the complex influences on juror thought processes.

In June 2009, the U.S. Supreme Court ruled that lab analysts must appear in court to explain and defend their work. This means that crime lab directors must deal not only with the National Academy of Sciences Report's stricter controls but also the art of addressing a jury. However, it's unlikely that such training will include the subtle yet significant mechanisms of cognitive processing that memory research has revealed.

Although the idea of heuristics, or cognitive shortcuts, has long been studied in social psychology, people unfamiliar with this research believe that decision making is rational and easy to articulate. Post-decision queries about juror perceptions mistakenly assume they're fully aware of how they think. However, most people possess minimal comprehension of the milieu that shapes their beliefs.

The field of social cognition finds that "cognitive schemas" structure how people listen, remember, and decide. Being subtly programmed with social narratives via news, film, television and other media, they subconsciously "script" situations in which they find themselves. These internalized plots guide how they attend to some things and ignore others, despite their best intentions. They may even retain false beliefs despite evidence to the contrary, or hear things that were never said. It's not that they're stubborn; it's that they're human.

Cognitive strategies simplify life's information bombardment so people can focus on what matters most. These mechanisms form their beliefs, and subsequent information is filtered through them. Facts that are plausible, satisfying and consistent with what's already known are most quickly absorbed and most easily remembered. The same processes are at work for people who sit on juries. They're not blank slates. While they might want to listen without prejudice, they cannot fully purge what's been absorbed through their automatic mental mechanisms. Thus, these inner narratives will influence how they hear, anticipate, and accept, or reject the information presented.

Since jurors rely on structured schemas, attorneys and experts cannot assume that their courtroom logic will be sufficiently potent; they must also include the right elements for credibility, clarity, and closure. Research shows that if information is missing or ambiguous, listeners will interpret the narrative according to what feels right to them. They may even fill in holes themselves or transform facts to suit their beliefs. Thus, their personal frame of reference may override accurate recall of evidence and distort the logic. The presentation will demonstrate with examples.

Justice demands good decisions. People who seek justice must learn how jurors listen, remember, and think. A tight, satisfying narrative acts like glue. It confers an encoding advantage that makes the evidence more easily recalled during the final decision process. In summary, if a story gets rolling that makes sense and feels complete, its psychological momentum can shut out all else. It's one thing to say that the best story wins; it's another to understand what "best" actually entails. Effective courtroom presenters will proactively devise a narrative frame that acknowledges how most people process information.

Jury, Heuristic, Encoding

E8 Case Studies of Wrongful Convictions: Canthe NAS Recommendations Change Results?

Pamela A.W. King, JD, 400 South Broadway, Suite 15, Rochester, MN 55904*

After attending this presentation, attendees will understand how in some cases, the failure of the prosecution and defense bar, as well as the inaction of the bench, has lead to the introduction of improper forensic science. These failures have resulted in documented cases of wrongful convictions. The presentation will explore why these problems persist and what steps all participants in the criminal justice system from labs to lawyers can play in assuring that forensic science is being used properly in criminal proceedings.

This presentation will impact the forensic community by demonstrating the importance of participation by all professionals within the criminal justice system, to improve the quality of forensic science presented in any criminal proceeding. By examining the past mistakes, we can learn how to improve the criminal justice system and avoid similar mistakes in the future.

Wrongful conviction cases provide a good starting point for looking at how problems with inaccurate or invalid forensic science arise in courtroom. A number of exoneration cases have highlighted that there are areas of the criminal justice system where improvement can be made to assure more accurate results. Many of these cases involve unvalidated or improper forensic science including lack of validation studies to test the validity and reliability of the science being presented, inaccurate testimony about forensic evidence, and in a few cases misconduct involving fabricating of data and failing to disclose exculpatory data. While some of the blame may properly be laid at the feet of the scientists involved, the prosecution and defense, as well as the judge, bear responsibility as well.

The facts that lead to these wrongful convictions should serve as reminders for why forensic scientists, lawyers, and judges must strive for accuracy and act with due care in presenting forensic evidence in court. Failure to do so not only increases the possibility of wrongful conviction, but leads to the erosion of public confidence in the criminal justice system. The responsibility to assure the quality of the forensic science presented in a criminal proceeding lies not only with the forensic scientist but with the lawyers and judges.

Yet, the questions surrounding how these mistakes can be avoided in the future are complex. How should science be used in the courtroom to assure accuracy? What constitutes proper validation and who should decide? Is a new kind of oversight needed in and among the various disciplines in forensic science? Should forensic science, like the practice of law, be a self governing profession and if so, who should implement such a program? These are some of the many questions asked today, in an effort to improve forensic science and avoid wrongful conviction. This presentation will look at some of the recommendations made by organizations, including the National Academy of Sciences and the American Bar Association and consider how the recommendations may or may not have changed the results in wrongful conviction cases.

Wrongful Convictions, Criminal Justice, Forensic Science

E9 Admissibility Issues After the National Academy of Sciences Report

Paul C. Giannelli, JD, Case Western Reserve Univiersity Law School, 11075 East Boulevard, Cleveland, OH 44106*

After attending this presentation, attendees will appreciate the significance of the National Academy of Sciences Report on admissibility issues.

This presentation will impact the forensic science community by highlighting the probable judicial response to the National Academy of Sciences Report on forensic science.

Several developments have contributed to a reappraisal of the way courts deal with expert testimony in criminal cases. First, the advent of DNA evidence dramatically changed the legal landscape. Indeed, one judge called it the "single greatest advance in the search for truth... since the advent of cross-examination." The second development was the Supreme Court's landmark decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.* If DNA evidence revolutionized forensic science, *Daubert* and its progeny revolutionized the admissibility of evidence based on forensic science. A third development involved the abuse of scientific evidence. These developments provide the backdrop for the National Academy of Sciences 2009 Report on Forensic Science: *Strengthening Forensic Science in the United States: A Path Forward*. Within months, the Supreme Court cited the report in *Commonwealth v. Melendez-Diaz*, noting that "[s]erious deficiencies have been found in the forensic evidence used in criminal trials" and "[f]orensic evidence is not uniquely immune from the risk of manipulation." This presentation

considers how the Report may impact litigation, including challenges to forensic evidence as well as possible limitations on the admissibility of expert testimony.

National Academy of Sciences Report, Admissibility, Issues

E10 The NAS Report: An Update on the Judicial, Legislative, and Executive Branch Responses

Kenneth E. Melson, JD, Bureau of Alcohol, Tobacco, & Firearms, 99 New York Avenue, Northeast, Suite 5S 100, Washington, DC 20226*

After attending this presentation, attendees will have learned about the judicial reaction to the National Academy of Sciences Report on the status of forensic science, the legislative response to the report, and the executive branch's work to improve forensic science through the subcommittee on forensic science.

This presentation will impact the forensic science community by providing important information as to the most current responses to the NAS study on the status of the forensic sciences.

The National Research Council of the National Academy of Sciences (NAS) issued a report during the 2009 AAFS Annual Meeting examining the state of the forensic sciences. As a result, has anything changed? A number of courts have ruled on defense *Daubert* motions that used the NAS Report as the main thrust of their attack. Although not uniform across all courts as to all disciplines, the judicial response has not been a surprise. Is that response the result of judicial precedence, practicality, or a real exercise of its gatekeeping function? The Legislative Branch of the federal government has taken some action, but has it put their money where the need is, and was the reauthorization of the Justice for All Act truly helpful to the forensic science community? The Executive Branch reacted to the NAS Report at the highest levels of government by forming the Subcommittee on Forensic Science, part of the National Science and Technology Council in the Executive Office of the White House. The Subcommittee brought the federal, state, and local forensic science stakeholders together to develop the strategic process of improving forensic science across the broad spectrum of disciplines, including issues such as validation studies, standards development, terminology refinement, quality management oversight, and personnel competency and proficiency. This presentation will give the audience an insight into the current state of forensic science from the viewpoint of a presenter who is involved in the relevant legal issues, laboratory oversight, and the Executive Branch response to the NAS Report.

A Path Forward, NAS Report, Subcommittee on Forensic Science

E11 The National Academy of Sciences Report and the Law Commission Consultation Paper: Differences and Similarities Between the United States and England and Wales

Carrie Rowland, MSc, FBS, 2850 Presidential Drive, Suite 160, Fairborn, OH 45324; and Dan E. Krane, PhD, Wright State University, 3640 Colonel Glenn Highway, Department Biological Sciences, Dayton, OH 45435*

After attending this presentation, attendees will have gained insight into the charges and recommendations of both the United States based National Academy of Sciences Report *Strengthening Forensic Science in the United States: A Path Forward* and the United Kingdom based Law Commission's consultation paper, *The Admissibility of Expert Evidence in Criminal Proceedings in England and Wales (A New Approach to the Determination of Evidentiary Reliability)*. Charges and recommendations, as well as the similarities and differences between the two documents will be outlined and briefly discussed.

This presentation will impact the forensic science community by bringing awareness to the proposed concerns and recommendations set forth in the National Academy of Sciences Report and the Law Commission's Consultation Paper and how each of those jurisdictions plan to strengthen the forensic science community.

In February of 2009, the U.S. based National Academy of Sciences (NAS) released its 254 page report, *Strengthening Forensic Science in the United States: A Path Forward,* to address challenges currently faced by the Forensic Community, specifically, the lack of resources, need for additional research, lack of mandatory standardization and the necessity of more education. At the urging of the crime laboratory community, a congressionally mandated committee was formed by the NAS in the fall of 2006 and charged with addressing eight primary tasks encompassing those challenges. The findings of the committee, as published in the 2006 NAS report, suggest that nation's forensic science enterprise does not have a unified plan, lacks national direction and therefore calls for major reform. Likewise, in April of 2009, the U.K. based Law Commission published a 98 page consultation paper, *The Admissibility of Expert Evidence in Criminal Proceedings in England and Wales (A new Approach to the Determination of Evidentiary Reliability*) after claiming that the "current law governing the admissibility of expert evidence in criminal trials is unsatisfactory." The consultation paper provides a number of provisional proposals established to reform the law governing the admissibility of expert evidence in criminal proceedings in England and Wales. The intent of this presentation is to explore the differences/similarities of these two documents crafted to reform the forensic communities in two distinct jurisdictions.

NAS Report, Law Commission Consultation Paper, Forensic Science

E12 What Attorneys Need to Know About the State of Forensic Science Today: A Report on the Proceedings of the Cyril H. Wecht Institute of Forensic Science and Law's CLE Seminar, "Does Forensics Need Fixing?"

Frederick W. Fochtman, PhD, Duquesne University, Bayer School of Natural and Environmental Science, 340 Fisher Hall, 600 Forbes Avenue, Pittsburgh, PA 15282; and Benjamin E. Wecht, MA*, Cyril H. Wecht Institute of Forensic Science & Law, 305 Hanley Hall, Duquesne University, 600 Forbes Avenue, Pittsburgh, PA 15282*

After attending this presentation, attendees will possess a more comprehensive and current understanding of the scope of the problems and challenges facing the admissibility and reliability of forensic evidence and experts; and be able to converse more knowledgeably about the legal and judicial impact of the National Academy of Sciences Report.

This presentation will impact the forensic science community by extending the reach of the community's understanding of problems and challenges facing the admissibility and reliability of forensic evidence and experts; and conveying the consensuses and lingering disagreements to have emerged from the interdisciplinary discussions held at the September 11 seminar.

In this oral presentation, the director the proceedings of the Institute's September 11 continuing legal education seminar, "*Does Forensics Need Fixing?*," in which panels of eminent prosecutors, defense attorneys, judges, legal scholars, and forensic experts will have discussed the legal and judicial implications of the findings and

recommendations of the National Academy of Science's recent publication, *Strengthening Forensic Science in the United States: A Path Forward* will be reviewed. From rules and standards governing the admissibility of forensic evidence and the appellate review of trial court decisions, to limitations in the adversarial process and in the legal community's understanding of scientific principles and methodologies, the spectrum of issues discussed by these panelists will be of interest and importance to trial attorneys, judges, forensic scientists, and all those who work with scientific evidence and experts.

Forensic Evidence, Forensic Experts, Wecht Institute

E13 Crime in the University Setting: An Internal Perspective on the Investigation Into UCLA's Body Donor Scandal

Brandi Schmitt, MS, University of California, Office of the President, 1111 Franklin Street, Oakland, CA 94607*

After attending this presentation, attendees will have gained a basic understanding of how crimes committed in a university setting are investigated using examples from a nationally publicized criminal case. Attendees will be introduced to the roles of university counsel, police, and audit staff and how others charged with investigative functions perform their duties and interact with city, county and state officials, as well as external counsel, during on-campus investigative proceedings.

This presentation will impact the forensic science community by educating attendees about criminal investigations in a university setting. Specific procedures and challenges involved in the collection, preservation, and processing of evidence from an institutional whole body donation program will be described. Additional information will be presented to help attendees understand the criminal investigation, charges, perpetrators, and convictions as well as nuances of the laws, rules, and regulations governing whole body donation programs and legal implications arising from recent state and national proceedings of a similar nature.

In March of 2004, The University of California at Los Angeles (UCLA) voluntarily closed its Willed Body Program amid local and national press stories alleging corruption and improper activity with donated human remains. This was one of many scandalous stories erupting nationally at the time that related to human tissues, organs, and bodies donated for transplant, education, and research, and was not the first time UCLA's program had been linked to related problems. Shortly thereafter, and under injunction by the Los Angeles County Superior Court, the university undertook a painstakingly detailed process of simultaneously investigating allegations at UCLA and proactively reorganizing and modernizing the policies, procedures, and practices of the four remaining donor programs located at the University of California's Schools of Medicine at Davis, Irvine, San Diego, and San Francisco.

Behind the stories in the local and national news and the very public closure of the program, are the facts of the case resulting from problems identified through the university's own internal investigation. Sensationalized headlines insinuating improper activity with donated specimens fueled public outrage and often clouded the fact that the primary criminal indictments of the then alleged perpetrators were conspiracy to commit grand theft, embezzlement, and tax evasion. Evidence was collected by institutional personnel and by investigators external to the UC system and included documents, financial transactions, witness statements, expert testimony, and biological samples from donated bodies and body parts. Some aspects of the investigation and litigation were conducted externally by university-contracted litigators as well as by the district attorneys assigned to the case and defense attorneys hired by or assigned via the court to the accused.

Universities often operate as small cities in and of themselves. Many have and rely on institutional resources such as police and counsel to prevent and investigate crimes internally. When a crime expands from the more mundane campus offense to one of local and national importance, the system's interface with non-university investigative personnel and cases become increasingly complex. These complexities will be highlighted through details of the investigations behind the case and convictions from *The People of the State of California v. Henry Reid and Ernest Nelson*.

Body Donation, Embezzlement, UCLA

E14 Forensic and Justice Issues in American Polygamous Sects and Rejectionist Groups

Michael Welner, MD, The Forensic Panel, 224 West 30th Street, Suite 806, New York, NY 10001*

After attending this presentation, attendees will be familiar of a range of mental health and other forensic science issues unique to American polygamous sects and other native groups that disavow jurisdiction of criminal and civil laws.

This presentation will impact the forensic science community by discussing the fact that the subcultures and their relationship to the justice system are often well concealed by design, with belief systems and ways of operating that engage numerous criminal and civil issues, touching on child, domestic, financial, and even death investigation. Better understanding is needed to properly examine such situations and to recognize wider forensic issues that may be at play.

An estimated 200,000 Americans live in polygamous cults. Those who comprise this population remain elusive in recognition of the illegality of this practice. Groups who reside in cloistered communities with unique laws alien from our own, or who otherwise live beyond detection may orient around religion or rejection of the U.S. Government. Polygamists and rejectionists share a common quality – lifestyles that seriously breach laws of the land and a sense of entitlement to a parallel society.

Numerous forensic issues lend themselves to polygamous sects and rejectionist organizations. Exploitation of members for sexual or financial gain, and competition for power in such fiefdoms, present common challenges. This presentation examines the significance of brainwashing, child exploitation, and domestic violence in the context of forensic investigation and victimology.

Psychopathology and group leaders are also reviewed and the importance of motivation in such groups is reviewed through a range of justice issues. Attendees will gain familiarity with considerations of abuse, questionable death, mind control, and fraud that distinguish themselves in such groups, drawing from real examples that span religions and ideologies. Participants will learn to identify key forensic and justice issues that might otherwise remain unexplored and unresolved, with significant consequences.

Domestic Violence, Brainwashing, Financial Fraud

E15 The Independence of Medical Examiners and Forensic Pathologists in the Criminal Justice System

Lindsey C. Thomas, MD, and Susan J. Roe, MD, Minnesota Regional Medical Examiner's Office, Regina Medical Center, 1175 Nininger Road, Hastings, MN 55033; and Christine Funk, JD, 919 Vermillion Street, Suite 200, Hastings, MN 55033*

After attending this presentation, attendees will understand some of the inappropriate influences that can be put on expert witnesses, and how the defense attorneys involved may respond.

This presentation will impact the forensic science community by presenting one of the challenges to adequate access to expert witnesses and demonstrating how one group responded to this threat.

For a number of years there have been attempts by certain prosecutors and law enforcement officials to at restricting forensic pathologists in the state of Minnesota from testifying for the defense, including subtle and overt intimidation tactics. These have included requests to terminate the employment of forensic pathologists who testify for the defense, delays in signing medical examiner contracts until there is acquiescence to an agreement agreeing that medical examiner staff would will not testify for the defense in Minnesota, and withdrawal of support [what kind of support?]. for a medical examiner's re-appointment. These efforts intimidation tactics have largely been bycome from county attorneys, and sheriffs, and state law enforcement personnel. As a result of this climate of hostility and intimidation, forensic pathologists in Minnesota have been reluctant to assist defense attorneys. This and this has led to increased costs for defendants and the public, sinceas defense experts from out of state have had to be consulted in several cases.

The Minnesota Regional Medical Examiner's Office (MRMEO) acts as medical examiner for __eight Minnesota counties. In 2008, an MRMEO assistant medical examiner began consulting with defense attorneys on a case in another county which is not served by MRMEO. During the trial in November 2008,, theat assistant ME's Chief received an email from the county attorney of one of their counties served by MRMEO, who had no involvement whatsoever in the pending case. This email stated,stating, "If you continue to do so [consult with and testify for defense attorneys], I am giving you the courtesy of letting you know that neither the Sheriff or I will be in a position to continue to support your appointment [as county medical examiner]." Additionally, t The email also stated, "there are many other forensic experts out there who do not have the added credibility of being a sitting medical examiner in another jurisdiction who can assist in the criminal defense of persons charged with a crime. Refer these requests to them." At this point in the trial, the assistant medical examiner forensic pathologist was serving as an in-courtroom consultant and was likely to be a rebuttal witness. As the result of this threatening email, which was forwarded to the defense attorneys involved, the assistant medical examinerforensic pathologist withdrew from the case. Shortly thereafter the county attorney who sent the email sent an a second email directly to the presiding judge, as a "Clarification of Earlier Email" stating, "it was not my intent to stop her from doing so [testifying for the defense] or to influence or affect her testimony in this case in any respect."

After the trial, the state public defender submitted a complaint to the Minnesota Office of Lawyer's Professional Responsibility. They That office investigated the complaint and ultimatelydetermined that the County county Attorney attorney had violated Rule 8.4(d) of the Minnesota Rules of Professional conduct, which prohibits a lawyer from "engaging in conduct that is prejudicial to the administration of justice". By stipulation, he the county attorney admitted the allegations of the petition. As a result, the Minnesota Supreme Court issued; there was a public reprimand and imposed a $900 fine.

As a direct result of this case, several changes have occurred in the state of Minnesota. Wwhile the Professional Responsibility case was pending before the Supreme Court, the board of the Minnesota Coroners' and Medical Examiners' Association authored a letter stating their its positions on the independence of medical examiners; these will be discussed during the presentation, but the conclusion was, "for preservation of a fair and just judicial system, it is imperative that medical examiners remain independent officials, and be available for consultation for both prosecuting and defense attorneys in Minnesota."

There are also on-going discussions with other involved organizations, including the MN Minnesota County Attorneys Association, the Minnesota Association of Criminal Defense Lawyers, the Minnesota state chief judges, Innocence Projects, the Minnesota Attorney General's Office, and others.

This presentation seeks to share the Minnesota experience and the changes in the culture which stemmed from the case. Thise presentation takes a careful look at how the adversarial systemhostility of certain prosecutors, the limited resources of the public defender's office, the need for available defense experts, and the lack of an abundance of qualified forensic pathologists collided to create a "perfeperfect storm" for change in the way defense consulting is done in Minnesota.

Independence, Expert, Influence

E16 The Medical Examiner in the 21st Century

Charles V. Wetli, MD, 2 Berkery Place, Alpine, NJ 07620-0398*

After attending this presentation, attendees will comprehend the functions and qualifications of medical examiners, be aware of their limitations, understand the necessity of independence from law enforcement, and be better equipped to examine and cross-examine the medical examiner.

The presentation will impact the forensic science community by making participants aware of the significance of office accreditation and the appropriate application of technological advances.

Medical Examiner Systems arose in the late nineteenth century from the Coroner System of England created centuries ago. In the first half of the twentieth century medical examiners were generally pathologists with varying degrees of training and experience. The development of formal training programs lead to formal board certification in forensic pathology, the creation of forensic nurses, and the creation and certification of medico-legal death investigators. Inspection and accreditation of medical examiner offices were also instituted. The momentum of these developments is being carried into the twenty first century, with board certification being a virtual requirement for the practice of forensic pathology, and more offices are seeking accreditation by the National Association of Medical Examiners. A few states have gone so far as to require all medical examiner offices to be so accredited. Medical examiner involvement in the procurement of organs and tissues for transplantation is becoming more frequent and commonplace as they are invited to be on advisory panels and provide input into the Uniform Anatomical Gift Act to facilitate functioning and communication with procurement agencies.

Attempts by law enforcement agencies to control, subjugate, or curtail medical examiner functions have been met with a great deal of resistance, and it is expected that medical examiners will continue to assert their independence by continuing to provide assistance to criminal defense attorneys as well as to prosecutors. In addition, there appears to be a trend to incorporate at least some, if not all, functions traditionally associated with crime laboratories to achieve independence, neutrality, and objectivity. The decisions and procedures of medical examiners are increasingly coming under legal scrutiny: from denial of organs and tissues for transplantation to conclusions expressed on death certificates, and the imputation of police actions in deaths occurring during police apprehension and arrest.

Technological advances are supplementing the low-tech autopsy: the use of DNA technology and application of radiological imaging techniques have proven to be helpful adjuncts. Serious problems are occurring with over-reliance on these techniques ("Virtopsy") and the generation of computerized autopsy reports.

Expect to see greater independence, more accountability, and more uniformity in death investigation and certification as advancing technology is incorporated into existing and future medical examiner systems.

Medical Examiner Systems, Forensic Pathology, Accreditaion and Certification

E17 But What if It's Not Child Abuse!

B.G. Brogdon, MD, University of South Alabama, University of South Alabama Medical Center, Department of Radiology, 2451 Fillingim Street, Mobile, AL 36617*

After attending this presentation, attendees will have learned of a host of physical conditions that might be confused with child abuse and the necessity that they be recognized to prevent unfounded accusations.

This presentation will impact the forensic science community by alerting all those disciplines involved in the issue of child abuse to 20+ musculoskeletal entities that could be mistaken for intentional trauma, thus seriously disrupting families, social services, and the legal system.

One hundred and fifty years ago Ambroise Tardieu, a French physician published a paper on the abuse and maltreatment of children. In his 32 cases, Tardieu set forth all of the salient features of child abuse – sociologic, demographic and medical – except, of course, for the radiologic. He described the typical injuries, recognized that caregivers were the perpetrators and observed the emotional responses of victims. His work was republished in a book on wounds a year after his death nineteen years later. On neither occasion is there evidence that much attention was paid to his revelations or for the next 65 years. It was only then that the seminal work of the pediatric radiologist, John Caffey, and the provocative name, *The Battered Baby Syndrome*, proposed by the pediatrician, Henry Kempe, finally attracted the widespread interest of the lay public, the medical profession and the legal community.[1] This led to increased vigilance for evidence of child abuse, and laws were passed mandating compulsory reporting of suspected abuse to authority. Thus, overzealousness and over-reporting is encouraged and may lead to serious consequences in unsubstantiated cases.

Many congenital, developmental, infectious, and accidental traumatic entities have been reported as mistaken for child abuse and neglect. In a large series of 504 referrals for possible abuse, slightly more than half proved to be unsubstantiated, and 7% of those had been initially misdiagnosed as abuse.[2] Most mistaken diagnoses of abuse or neglect are related to dermatological or neurological conditions or to growth disorders.

Caffey's description of the skeletal and cerebral radiological findings in child abuse have stood the test of time and are well-known in both medical and legal circles. Yet there are musculoskeletal conditions that resemble somewhat the lesions of intentional trauma, and others, more farfetched, that might be mistaken for child abuse by the untrained or inexperienced observer. Some of these are well known, others quite rare. Since radiological findings often are central to the successful prosecution or defense of physical child abuse, it is important that these imitators be recognized; the unfounded diagnosis and/or allegation of child abuse can cause cruel multigenerational distress for the families involved and wastes time and resources for social services and the judicial system.[3]

More than two dozen of these "mimicking" conditions – congenital, developmental, infections, metabolic, iatrogenic, accidental, anomalous, or peripartum – will be presented in order to acquaint the attendees with the magnitude of these diagnostic dilemmas. Most include findings of metaphysical abnormalities, fractures, subluxations or dislocations, periosteal reactions, bone distruction, or combinations of these abnormalities anomalies, and injuries. Considerable experience and expertise is required in distinguishing the unfortunate from the felonious finding.

This presentation is designed primarily for clinicians, pathologists, anthropologists, attorneys, and child advocates.

References:

1 Brogdon, B.G. Forensic Radiology, CRC Press, Boca Raton, 1998, 282-88.

2 Wardinsky, T.D. Viscarrondo, F.E., Cruz, B.K. *The mistaken diagnosis of child abuse: a three-year USAF Medical Center analysis and literature search*. Military Med. 1995; 160:15-20.

3 Kirschner, R.H., Stein, R.J. *The mistaken diagnosis of child abuse: a form of medical abuse?* Am. J. Dis. Child. 1985; 139: 873-875.

Child Abuse, Skeletal Abnormalities, Forensic Radiology

E18 A Scientific Approach to Infant Head Injury Evaluation

John Plunkett, MD, 13013 Welch Trail, Welch, MN 55089*

After attending this presentation, attendees will be able to: describe the differences between infant and adult neuroanatomy contributing to the differences in impact injury mechanisms; describe the differences between skull deformation and whole brain differential acceleration contributing to infant head injury; and describe the role of formal biomechanical reconstruction of an event with a history of a fall.

This presentation will impact the forensic science community by giving prosecuting and defense attorneys the tools to evaluate an infant head injury when the history is a fall.

There is often a history of a fall or clinical evidence for an impact in an infant or a toddler with head injury. Unfortunately, there is scant objective information to assist a prosecuting or defense attorney who needs to evaluate the history. This presentation will describe an approach to injury evaluation of such an event.

The analysis should include: a determination of whether the injury is acute or remote; potential pre-existing conditions placing the child at increased risk for impact injury from a fall; biomechanical reconstruction; and evidence after appropriate evaluation indicating that the history is incorrect.

This presentation will discuss the above considerations. In addition, described in this presentation are: the basic mechanical differences between infant and older child head trauma; Federal Head Injury Criteria; and examples of reconstruction of falls will be provided. Take-home messages will include:

Any head impact may be associated with diffuse as well as focal injury. "Diffuse" rather than "focal" injury does little to assist in determining the ultimate mechanism. Pre-impact motion rarely has anything to do with the mechanism, morphology, and/or outcome for infant head injury, i.e., the "translational fall" is a myth. Bridging vein rupture is an unlikely mechanism for most cases of infant subdural hemorrhage or traumatic brain injury.

Finally, the default diagnosis will be suggested for an infant with an unexplained head injury is "I don't know", not "Non-accidental injury."

Infant Head Injury, Falls, Biomechanics

E19 Shaken Baby Syndrome: Issues and Concerns for Attorneys

Katherine H. Judson, JD, New Mexico Public Defender Department, 505 Marquette Avenue Northwest, Albuquerque, NM 87108*

After attending this presentation, attendees will have a better understanding of the unique legal problems related to a diagnosis of shaken baby syndrome. The presentation will include research that suggests a new approach to the diagnosis of shaken baby syndrome may be in the interests of justice.

This presentation will impact the forensic science community by offering a perspective on this syndrome that is sometimes overlooked. If shaken baby syndrome is misdiagnosed, or if causation issues are not critically addressed, the resultant mistake may mean accusation, conviction, or incarceration of innocent individuals. Further, if these grave injuries to children are actually caused by other means, it is in the best interest of society to understand the exact causes of such injuries, instead of placing blame inappropriately.

At a time when evidence-based medicine is the norm and many aspects of forensic science are being rethought and reexamined, it is troubling that many experts fail to examine evidence suggesting fundamental flaws in the shaken baby syndrome theory. Findings of shaken baby syndrome rest on many assumptions that must be critically examined in the face of new evidence that tends to discredit previous thought on the subject. Attorneys must be aware of new research that suggests not only that it may be more difficult than previously thought to determine the identity of the alleged abuser in such a case, but also that the triad of symptoms frequently mentioned by investigators may not be indicative of abuse in the first place. In light of recent research, it is appropriate to consider a new approach to litigating cases involving infant head injury.

While attorneys are not and should not be expected to act as experts in medicine or biomechanics, such complex medical evidence and emotional subject matter demands that attorneys be familiar with the concepts and principles underlying a finding of shaken baby syndrome, as well as research that challenges those principles. When crafting arguments, an understanding of the science behind this complicated issue is essential. Findings of shaken baby syndrome must be approached with a critical eye. It is in the interest of justice to avoid the circular logic and examiner bias that sometimes plagues cases of this nature, and to do that, professionals must be well-informed and objective.

Recent research raises concerns with both the weight and admissibility of evidence of such a diagnosis. An analysis of the admissibility of a finding of shaken baby syndrome will be presented with special attention to the factors set forth in *Daubert v. Merrill-Dow Pharmaceuticals*. Shaken baby syndrome is a unique and dangerous diagnosis because it presumes a legal conclusion as well as the intent and identity of the perpetrator. Special attention should be given to cases where the syndrome is diagnosed on the basis of subdural or retinal hemorrhages alone in light of new information that suggests these symptoms can have myriad other causes. Without corroborating evidence that suggests abuse, it is even more likely that a misdiagnosis could be made, which is likely to result in a wrongful conviction.

Child, Homicide, Investigation

E20 The Legal Aspects of Using Remote Sensing Technology as a Method to Locate Mass Graves and Prosecute International Crimes

Samuel F. Algozin, JD, 5633 Waverly, Montreal, ON, H2T 2Y2, CANADA*

After attending this presentation, attendees will possess knowledge of the domestic and international laws governing the use of remote sensing data as a method to locate mass graves and prosecute international crimes. Attendees will gain an understanding of how to introduce such evidence in court and how courts have utilized such evidence.

This presentation will impact the forensic science community by providing a thorough overview of the law governing remote sensing activities, and remotely sensed imagery of mass graves may be utilized to prosecute international crimes.

This presentation examines the legal aspects, both domestic and international, of using remotely sensed imagery of mass graves to investigate and prosecute war crimes. Forensic scientists point to remotely sensed imagery as an emerging method to locate and investigate mass graves. Combined with on-site investigations, aerial and satellite imagery may be utilized to investigate potential war crimes and other large scale human rights violations. In the ex-Yugoslavia, investigators used satellite imagery to investigate mass graves and as evidence in war crimes trials. In Iraq, investigators used satellite imagery and aerial photography to locate mass graves. Remotely sensed imagery has been used to track population displacement in Darfur, thus providing possible evidence of genocide and crimes against humanity. On the domestic level as well, officials use airborne remote sensors in criminal investigations.

First, this presentation explains the international and domestic legal regimes governing the collection and dissemination of remote sensing data. International instruments such as the Outer Space Treaty and the Convention on International Civil Aviation set out rules and general principles which States and private entities must adhere to while engaging in remote sensing activities. Individual nations also have domestic laws which govern the collection and dissemination of remotely sensed imagery. This presentation provides an analysis of these legal regimes, and examines the extent to which the law may impinge upon the use of remote sensing technology as a method of investigating mass graves.

Second, this presentation examines how remotely sensed imagery may be used to investigate and enforce international criminal law. Remote sensing is already utilized in public international law as a method to verify and enforce States' Treaty Compliance. The technology has also already been used as an enforcement tool of international criminal law. The International Criminal Tribunal for the ex-Yugoslavia has used satellite imagery to investigate mass graves and prosecute war criminals, relying on the satellite imaging technologies of western intelligence services. At the International Criminal Court, prosecutors have introduced satellite imagery to the court in pre-trial proceedings to attempt to establish evidence of war crimes. This presentation examines how remote sensing technology may be used by international criminal prosecutors, international criminal tribunals and NGO's to investigate mass graves and prosecute large scale war crimes and human rights abuses.

Lastly, this presentation sets out how remotely sensed imagery of mass graves may be utilized in domestic and international court proceedings. This presentation provides a summary of the standards for admitting such imagery as evidence before domestic courts and international tribunals. On the domestic side, this presentation will focus upon the admissibility standards of United States and Canadian courts. This presentation also sets out the standards for admitting such evidence before international criminal tribunals. The presentation will provide a

review of international criminal case law and explain how courts have used evidence of mass graves and remotely sensed imagery to hold war criminals accountable.

Law, Mass Graves, Remote Sensing

E21 Indian Premier League vs. Asif: A Tale of Jurisdictional, Legal, and Scientific Conflict

A. Robert W. Forrest, LLM, Office of HM Coroner, 37 Marlborough Road, Broomhill, Sheffield, S10 1DA, UNITED KINGDOM*

After attending this presentation, attendees will have learned about the cultural, scientific, jurisdictional, and legal issues that can be encountered when assisting a sporting franchise dealing with an allegation of "doping" for the first time.

This presentation will impact the forensic science community by discussing the problems that can arise when assisting a court or tribunal in a novel case and of the need to keep focused on the duty of the expert to the Court even in difficult circumstances.

Cricket is a sport popular as both a spectator sport and a game that can be played at all levels throughout the former British Empire outside of North America. Recently the game has been commercially revitalized by the introduction of 20/20 cricket, where each side has 20 overs and a game can be completed in a day. Another development is that players at all levels, amateur and professional, now incorporate strength training in their training schedules.

The Indian Premier League (IPL) is a franchise operation with consortia first bidding to establish teams, usually with a regional base such as the "Mumbai Indians", and then participating in a very active auction to attract the best players, mainly but not exclusively from South Asia. The blend of exciting 20/20 Cricket, elite players and a knockout competition has proved commercial very successful in both the 2008 and the 2009 seasons.

Mohammed Asif, "the player," is a Pakistani medium paced bowler who has played in the Pakistani domestic game, for Leicestershire in England and internationally. In 2008, he was a member of the Delhi Daredevils team. He had previously been suspended after an adverse finding of nandrolone in his urine in 2006. He attributed this to the use of protein supplements. He was initially banned for two years after a hearing before the Pakistani Cricket Board (PCB) in November 2006. He appealed and in December 2006 a differently constituted PCB tribunal dismissed his ban on a 2-1 majority decision. Despite this, he was dropped from the Pakistani national team shortly before they left for a tour of the West Indies in March 2007 because of concerns that if he were to be tested on that tour he would still give a positive result for nandrolone

In July 2008, it was announced that he had provided a sample of urine that had been reported as providing an adverse finding in respect of the presence of nandrolone metabolites. A vigorous defense was mounted at the hearings held at the Board of Control for Cricket in India (BCCI) headquarters in Mumbai. The jurisdiction of the tribunal over IPL players was challenged. The collection procedure, sample storage, and transport were challenged. The precision of the assay was challenged, the point being made by the defense that the tribunal could not be sure that the concentration of nandrolone metabolites exceeded the threshold value set by the World Anti-Doping Organisation (WADA). The possibility that the urine was "active" with micro-organisms producing metabolites otherwise characteristic of nandrolone metabolism was raised together with the points being made about sample storage.

The entire of the first session of the hearing was taken up with jurisdictional issues. The day before the second hearing Islamic terrorists attacked Mumbai, with the hearing being cancelled. An application was then made to change the venue, on the basis that the player was at risk as a result of anti-Islamic feeling in Mumbai.

The hearing was eventually reconvened in Mumbai and, as the hearing recommenced, a report was disclosed from an Ophthalmologist in Karachi, which indicated that the player had been treated with KeratylÒ Eye drops (Chauvin Bausch & Lomb, Montpellier, France) for a corneal abrasion. Keratyl contains a 1% solution of nandrolone sulphate. Keratyl has been reported to produce positive results for the presence of nandrolone metabolites in urine. (*Avois L, Mangin P, Saugy M. Concentrations of nandrolone metabolites in urine after the therapeutic administration of an ophthalmic solution. J Pharm Biomed Anal. 2007, 9;44(1):173-9*).

The decision of the Tribunal was that the adverse analytical finding was accepted and the player was banned from participation in sport until September 21, 2009.

Cricket, Doping, Nandrolone

E22 Rule 702, *Daubert* and *Frye* – Loose Gatekeepers?

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The goal of this presentation is to provide an examination and discussion about whether the scientific standards currently used in the court system today are appropriate for determining whether or not a particular scientific method is good or junk.

This presentation will impact the forensic science community by taking a candid look to determine if the current method for admitting science in the court system needs to be overhauled or not.

Over the years, many presentations have been given explaining and defining the different standards the courts use in determining whether or not particular fields and techniques are scientific, but there does not appear to have been a fundamental examination of the admissibility standards allowing scientific evidence into court. Do *Frye*, *Daubert*, or Rule 702 genuinely allow for and instruct in the rigorous scientific inquiry one would expect when deciding whether a particular scientific method is suitable for a court of law? If not, then the question remains as to what the suitable standard is. There is the additional issue of even if the standard is suitable, do the parties have enough of a scientific background to insure that it is properly applied. This session seeks to explore these issues.

The panel begins with a brief overview of the tension between science and law as well as a look at the legal standards currently in place. Fundamentally the issue boils down to a misunderstanding of the scientific method. Lawyers and laypeople tend to believe that science is there to provide certainty, and scientists believe that science provides answers with an associated level of uncertainty. Even those lawyers who recognize the uncertain nature of scientific inquiry feel penned in by the demands of the legal system.

Next, there will be two presentations from a lawyer and judicial perspective on the presentation of scientific evidence. This presentation will discuss a lawyer's perspective on conducting a *Frye* hearing. Issues such as when to conduct a *Frye* hearing, what to present and what not to present, and how to approach different types of Judges will be discussed.

The confusion among lawyers and judges about what is scientific, what an expert is, and how "gatekeeping" ought to work. The relationship between trial and appellate levels when it comes to reviewing matters of scientific and expert testimony will be explored. Given that there are differing standards between the application of empirical "scientific" disciplines will also be discussed, and expert testimony based on knowledge, training and experience, a discussion of their application and misapplication is intended to both enlighten participants as to the judicial process, and give some ideas as to the pitfalls and problems to be avoided when presenting testimony to the

court. A discussion of what appeals courts look at on appellate review will conclude the presentation.

These issues will be examined from a more scientific viewpoint with presentations from an engineering sciences viewpoint.

The session will end with a roundtable discussion of the issues brought forth by the presentations.

Daubert Frye, Scientific Legal Standard, Scientific Method

E23 "...Horse to Water" — How to Educate Legal and Forensic Communities Concerning the Processes and Importance of Expert and Scientific Evidence in the Law

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The goal of this presentation is to expose the issues and methods by which those constituting the "forensic" in "forensic science" might be educated to understand the systems, processes, and nature of evidence produced by the application of scientific, technical and experiential expertise for use in court.

This presentation will impact the forensic community by educating attendees who have ever wondered why good forensic evidence is misunderstood, or why bad evidence is not caught by the legal process will be exposed to the need for and ideas about educating the legal community. This is a two-way street, with the education of experts and scientists about the legal system, its intellectual and professional process and reasoning being essential to achieving the goal of fair and just resolution of disputes being equally essential. Top experts in the processes of science, the law, and professional understanding will provide insight and a plan for action.

Forensic science is rarely the first-hand evidence presented in a case. It explains, illustrates, and compares the circumstances of the evidence through the lens of its skilled practitioners, with a purpose of assisting greater understanding of the evidence. If the goal of forensic science is indeed "assisting law enforcement officials, enhancing homeland security, and reducing the risk of wrongful conviction and exoneration", as the National Academy of Sciences (NAS) stated in the executive summary to their report, an emphasis on ensuring that the recipients of the knowledge and expertise of the forensic practitioner are equipped to use the information they are given is paramount.

At the heart of the National Academy of Science report is the recognition that the individuals who work in the legal profession as involved in the criminal justice system do not always have a full understanding of the scientific evidence that is presented for them to evaluate. The NAS report recommended an evaluation of the use of forensic evidence in criminal and civil litigation, to include:

The collection and flow of evidence from crime scenes to courtrooms
The manner in which forensic practitioners testify in court
Cases involving the misinterpretation of forensic evidence
The adversarial system in criminal and civil litigation
Lawyers' use and misuse of forensic evidence
Judges' handling of forensic evidence

While individuals in the system may be able to understand forensic issues, the system itself is broadly failing to educate its participants. Thus, the issue of education needs to be addressed at the systemic or institutional level. The presentions in this session are designed to address different aspects of this problem, and talk about issues pertaining to educating the participants at the institutional level where all participants gain the knowledge necessary to understand this area.

The first topic to discuss is institutionalizing the scientific education of the judicial bench. In addition to being fact-finders in some cases, judges also are charged with making the legal determination of whether particular types of evidence are acceptable and reliable applications of knowledge, science or technical skills. This role unambiguously requires some knowledge of scientific principles and the scientific method. It also includes the need to evaluate competing assertions of technical sufficiency in obtaining results sought to be introduced as evidence. The two presentations in this area will discuss how to institutionalize judicial learning in this area and perhaps more importantly, if this is even realistic.

The second presentation pertains to institutionalizing forensic knowledge among public defender offices. In the criminal justice system, government agencies usually have primary access and control of evidence in any given case. Prosecutors therefore have an institutional advantage owing to better access to the crime labs and other forensic resources controlled by the state and law enforcement that defense attorneys simply do not have. Consequently, defense attorneys have to be better trained to be able to handle forensic evidence in and out of the courtroom. A presentation about the challenges of institutionalizing forensic knowledge in public defender agencies as well as discussing different models for spreading this information throughout public advocacy agencies at and above the trial level will be given.

The third presentation pertains to how laypeople perceive scientific and forensic evidence. Research regarding how jurors perceive scientific evidence will be discussed as well as findings and the lessons and pitfalls that they show about the process of educating lay people in the forensic arena.

The final presentation pertains to the role of how the forensic scientist has a role and should approach their job in dealing with the legal aspect of their practice. Keeping in mind that the word "forensic" itself implies the relationship between expertise and its practice for evidentiary purposes, a relationship with the courts is implicit in being a "forensic scientist". Two-way communication between scientists and lawyers have languished. Many state-employed scientists have been shown to believe their job is to promote the state's interest, not the impartial application of science. Such a narrow view is inimical to a system that prevents wrongful convictions and seeks to enable righteous exonerations. Education in ethics and professionalism among the scientific community needs to approach common ground with the same subjects in the legal community. As it is imperative that lawyers have to understand science and its processes, scientists have to have a better understanding of their role in both science and law beyond preparing to give testimony. Until both sides have a clearer understanding of the limitations of each other's disciplines, as well as their respective goals, there will continue to be a great divide between the two groups

Experts, Lawyers, Antagonism

E24 NAS Solutions: Do They Solve Anything?

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The goal of this presentation is to provide a frank, informed, and honest discussion of what certification, accreditation, and a National Institute of Forensic Science Agency as prescribed by the National Academy of Sciences (NAS) Report would actually accomplish.

This presentation will impact the forensic science community by providing a greater understanding of the issue surrounding National

Institute of Forensic Science, certification, and their ability to bring change and reform to the way forensic science is conducted.

One of the problems identified with the field of forensic science is the fact that standards of practice vary widely throughout the country and even sometimes widely within a state. The report recommends correcting this problem through requiring standardization at both a local and at a national level through the creation of the National Institute of Forensic Science, whose job it would be to promulgate forensic science standards.

At first blush, these recommendations seem to be nothing more than long overdue common sense reform. After all, our food, our consumer products, and even the legal profession are regulated by government bodies. Regulation seems like the logical and natural way to protect the public from possible harm due to substandard work.

However, whether or not this is the case is far from clear. Crime laboratories currently have a fairly robust regulatory environment. With ASCLD-LAB standards moving firmly into adopting ISO standards well before the advent of the NAS report, one would think that the NAS report would find very little to criticize within the field of forensic science.

However, it is precisely this accreditation environment that appears to fall short of assuring that the science presented to the court system has been validated and shown to be reliable. Critics assert that accreditation provides a false sense of security for the work conducted by a given lab, and that the process of accreditation is more concerned with assuring that procedures are in place and are followed than with assuring that the procedures are the correct ones for assuring quality work.

This presentation will discuss the pros and cons of accreditation and certifications.

This session also seeks to address the related topic of the establishment of NIFS, the proposed new federal agency that would regulate forensic science. NIFS would set standards for the use of forensic evidence in the courtroom, support training and education, and conduct validation research. Once again, on its face the notion of researching and setting standards for forensic evidence seems uncontroversial, and like a good idea. However, critics assert that NIFS would also have the ability to set standards for evidence to be admitted in courtroom and giving any one agency the power to allow or disallow evidence in courts across the land must be viewed with a healthy skepticism. This session will also discuss the pros and cons of the establishment of NIFS.

NIFS, Accreditation, Certification

E25 Research on Forensic Science Error Rates Under Ideal Conditions and Under the Conditions of Practice

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After attending this presentation, attendees will learn about the difficulties of doing research on error rates under ideal conditions, and also the difficulties of doing research about error rates prevailing under the non-ideal conditions of real practice.

This presentation will impact the forensic science community by leading to changes in normal practice to obviate the need for research about error rates under non-ideal conditions of practice.

Research concerning "error rates" in the forensic identification disciplines that rely centrally on human evaluation is very important, but it can help only if a program of research is undertaken on a task-specific level consistent with the demands of *Kumho Tire v. Carmichael* (which may have been what the NAS Committee had in mind by the use of the phrase "relevant error rates"). However, it is too early to tell whether the NAS Report will foster such research, or whether it has created an environment where a lot of "faux research" will be undertaken, designed and directed toward giving the appearance of data blessing the status quo (and whether such research will absorb most of any research money newly made available by virtue of a kind of research program "Gresham's law"). Finally, the research that can be done on error rates under ideal conditions is the easiest part of the task. It is much harder to do research on error rates under normal conditions of practice, which are of course the only truly meaningful ones. What is needed is not to await such research, but to adopt sequential unmasking protocols to eliminate the need for such research by bringing the conditions of practice more in line with the ideal.

Research, Error Rates, Forensic Science

E26 The Error Odds Method of Objectively Assessing Bioengineering Based Claims of Causation: A Bayesian Approach to Test Validity Quantification

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The goal of this presentation is to demonstrate the Error Odds test, a method of objectively assessing the validity of forensic applications of bioengineering methods and conclusions

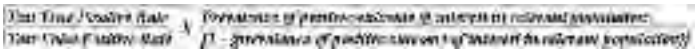
Bioengineering has seen increasing use in civil and criminal forensic settings in recent years as a means of objectively assessing injury risk. A lack of a validating gold standard for the method makes the technique highly susceptible to evidentiary challenges such as *Daubert*, et al. This presentation will impact the forensic science community by demonstrating how the ability to quantify the probability that a positive bioengineering test result is a true rather than false positive can have a substantial impact in guiding fact finders with regard to the admissibility and weight assigned to such testimony.

The National Research Council of the National Academy report on forensic science included a list of 13 recommendations.[1] The third recommendation addressed the lack of research pertaining to accuracy, reliability, and validity in forensic sciences, and recommended the development of quantifiable measures of the uncertainty in the conclusion of forensic analyses as a form of quality control. Uncertainty is quantified by probability, as the one is the complement of the other; *i.e.*, [1-probability] = uncertainty, and [1-uncertainty] = probability.[2] In compliance with the NRC recommendations, the present abstract is a description of a measure of test validity for the application of forensic bioengineering analyses and conclusions.

A relatively recent trend in civil and criminal litigation is the investigation of injury causation using a biomechanical or engineering reconstruction of the forces of an injury mechanism, which are then compared with human injury tolerance levels as a means of quantifying injury risk. The results of such analyses are typically presented as probabilities that either support or refute medical observations of injury, or that assign a probability to an alternative hypothetical explanation; e.g., the effect of seat belt use on the risk of a traffic crash injury in an unbelted occupant. Courts have been reluctant to accept such testimony in some cases, in part because it is difficult to assess the validity of the opinions and in part because outside of the forensic arena (e.g., academic, industry, or government applications) bioengineering is exclusively used to explain how medically observed injuries occur, and never to cast doubt on such observations. There are other problems associated particularly with the bioengineering approach to refuting injury causation, most notably the fact that the opinions are rendered in terms of injury *risk*, a prospective rather than retrospective forensic tool. Regardless of how small of a risk a particular injury mechanism may present, low risk cannot serve as a basis for concluding that an event did not occur; when assessing an individual outcome of traumatic event an

injury is either present or it is not. Another problem with the bioengineering approach to injury causation is the fact that risk assessment arises from observational or historical data, and not experimentally derived theory. As an example, the biomechanical literature on femur fractures in traffic crashes indicates a minimal to absent risk of fracture in frontal collisions of less than 25 mph speed change, yet real world observations demonstrate femur fractures occur in collisions with a delta V of as little as 10 mph delta V and a fracture risk of 0%.[3]

A means of objectively assessing the validity of a bioengineering assessment of injury risk is the Error Odds test, a "Bayesian" method of conditioning probability.[4] Bayes' Law is means of conditioning probability given specific circumstances surrounding the probability. Conditioning of probability simply refers to how a probability is modified when certain conditions are accounted for. For example, given no information beyond the fact that a crime has been committed, the probability that it was committed by a man is approximately 80%. If the probability that a crime has been committed is conditioned by the knowledge that the crime took place in a women's prison then the probability it was committed by a man is substantially less than 80%. The Error Odds application of Bayes' Law is designed to be applied to positive forensic test results, and it incorporates three metrics associated with the test; the true positive rate of the test (the rate at which the test detects the condition of interest when it is present), the false positive rate of the test (the rate at which the test erroneously identifies the condition of interest as present when it is not), and the base rate of the condition (the prevalence of the condition among relevant test subjects). The Error Odds is calculated using the simple formula below:



The result of the calculation is the ratio of true positive tests to false positive tests given the base rate of the condition in a population like the test subject. It has been postulated that an Error Odds result of more than 10 (indicating that for every 11 positive test results 1 will be a false positive) is a minimum threshold for a test to be considered valid.[5] Several examples of the application of the Error Odds test as a means of validity assessment will be presented.

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Bayes' Law, Forensic Epidemiology, Error Odds test

E27 Damned If You Do: The Story of a Miscarriage of Justice and the Conflicting Roles of Lawyers and Forensic Scientists

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After attending this presentation, attendees will have a keen(er) understanding of the different roles and objectives of forensic practitioners and lawyers, and better appreciate the dangers and potential for injustice when forensic practitioners are subjected to pressure for a result in a high profile emotional case, or lawyers fail to understand or present forensic findings.

This presentation will impact the forensic science community by raising the awareness of practitioners about the traps created when law and science meet in and out of the courtroom, and two different sets of objectives and methods of proof collide.

There is an inherent conflict between the approaches to investigation and proof by lawyers and forensic scientists that most of the time this goes unnoticed. When the conflict surfaces, there is confusion and disagreement about the proper approach which should be taken: where are the boundaries? What is a proper request of a forensic scientist? What should a forensic scientist refuse to do? What should they do before or in court if they believe vital information is not being disclosed? What is the duty of a prosecutor in the face of potentially exculpatory forensic evidence?

A Western Australian case which has rocked the justice system and those within it, from judges to police to prosecutors to forensic scientists will be examined to illustrate these questions.

In May 1994, Perth jeweler, Pamela Lawrence, was murdered. Andrew Mallard, a drifter with psychiatric issues was charged and sentenced to a life term. A journalist mounted a campaign for his exoneration but he had served 12 years of a life sentence before the High Court of Australia quashed his conviction.

The results of potentially exculpatory forensic pathology experiments were not disclosed to the defense, exculpatory information in a chemistry report was removed at the request of police, and questions were not asked of experts at trial which may well have disclosed exculpatory material. Later, a palm print found at the scene identified another man, Simon Rochford, then serving a sentence for the murder of his girlfriend. There were striking similarities in the injuries suffered by Mrs. Lawrence and Mr. Rochford's victim.

The subsequent Corruption and Crime Commission Inquiry recommended disciplinary action be considered against police involved in the case including two who had become assistant commissioners, and a senior prosecutor who had become Deputy Director of Prosecutions. Potentially exculpatory forensic evidence had been altered, not disclosed to the defense or was said to have been avoided at trial.

Many of the questions posed in this presentation seem incapable of resolution. Different perspectives produce different answers. Whilst the miscarriage of justice is clear, the solution is not, and the fear is that many other convictions are based on such a dangerous approach and remain undetected.

Miscarriage of Justice, Forensic Ethics, Legal Ethics

E28 Miscarriage of Justice: Peter Montoya - The Shooter Who Didn't Shoot

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The goal of this presentation is to provide insight into the value of utilizing expert witnesses to review and rebut inaccurate and misrepresentative theory and firearms evidence, and how the failure to

do so resulted in the conviction and imprisonment of man which was overturned based on ineffective assistance of counsel at trial and new evidence proving that he could not have been the shooter, and that the prosecution's expert ballistics opinions should have been challenged prior to trial via *Daubert* or similar motion.

This presentation will impact the forensic science community by showing how police testified to scientifically invalid ballistics theory, misrepresented their own police training, and failed to apply the generally accepted standards for firearms investigations in order to obtain a wrongful conviction. This presentation will illustrate how the witness statements and the physical evidence were not adequately challenged by defense counsel at trial.

In February 1999, a shooting took place in Salt Lake City, Utah which resulted in a young man being accused of firing a semi-automatic pistol into the rear of a Honda which contained three young men. The driver was killed, the rear passenger was wounded, and the front passenger was not injured. Prosecutors presented evidence that three or more shots were fired; two entering the back window and one entering the right rear quarter panel.

At trial in 2000, Peter Montoya was convicted of homicide and two counts of attempted homicide in a Utah court. The state presented firearms and ballistics testimony from the lead detective and a Utah State Trooper which purportedly proved that Montoya, who was seated in the front passenger seat of a Ford Pickup truck, leaned out the window and fired gunshots from a 9mm semi-automatic pistol as the driver of the truck was turning right and accelerating.

Police had information that the shooter was the driver of the truck, not Montoya; however, this was not pursued by defense counsel nor was a ballistics expert hired to review the evidence and theory of police.

To offset any claim by the defendant that the driver was the perpetrator, a Utah Trooper testified that police are trained to use their weak hand to shoot only if the strong hand is injured and that accuracy while shooting with the weak hand was limited to five feet and inferred to the jury that it was impossible for the driver to have been shifting, turning, and shooting simultaneously.

The police version of events went unchallenged until 2005 when a Salt Lake City attorney took the case seeking a new trial based on inadequate defense by trial counsel.

The initial goal was to ascertain if the number of purported shots fired was accurate. However it was found that there were many more significant misrepresentations of the ballistics evidence which were scientifically invalid and witness statements provided a different version of events including that the driver of the truck was the shooter. The driver had been killed in a shootout with police shortly after the shooting which left police with only Peter Montoya to accuse of being the shooter.

A reconstruction based upon data contained in the crime scene diagram, photos, and witness statements revealed that only the driver could have fired the pistol at the Honda and that it was scientifically impossible for the gunshots to have come from the passenger side of the truck.

Critical factors in the reconstruction were:

1. Location of the vehicles in relation to each other at the time of the gunshots.
2. Physical attributes of both vehicles.
3. Entrance angle of gunshots on the Honda.
4. Location of glass fragments on the roadway.
5. Location of discharged cartridge cases.
6. Victim witness description of truck acceleration noise.
7. Trajectory of gunshots.

The testimony of the Utah Trooper that accuracy was limited to a distance of five feet when shooting with the weak hand was impeached by learning that in his own training he was required to qualify using his left (weak) hand at a distance of seventy five feet or fifteen times the distance he stated would be inaccurate.

Had the passenger fired the pistol, the discharged cartridge cases would have been on the right side of the truck not on the driver's side.

The angle of entry and the continuing trajectory of the gunshots was scientifically impossible to have come from the truck's passenger side due to the relative location, height, and position of both the truck and Montoya.

Using an exemplar manual shift vehicle and driver, a shooting reconstruction was video recorded showing the driver was capable of shooting with either hand while driving and turning the truck without shifting.

In December 2006, testimony was given in a Utah Court on behalf of Montoya's Motion for Post Conviction Relief. The state did not introduce any rebuttal evidence to the new findings.

The court overturned the conviction on the new scientific evidence, the ineffective assistance of counsel at original trial, and ordered Mr. Montoya released after seven years behind bars for a crime he did not commit.

This case illustrates the importance of ensuring that the theory and evidence involved in shooting incidents be evaluated for reliability and validity and presented at trial in an objective manner based on scientific principles and not in an inaccurate or misrepresentative manner. It is clear and convincing that this conviction was based on invalid, unscientific, and subjective theory and testimony which was disproven by the real facts.

Angle & Trajectory, Discharged Cartridge Case Ejection Pattern, Location of Shooter From Physical Evidence

E29 Snitch Testimony: Taking Care of Number One

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After attending this presentation, attendees should recognize that jailhouse informants are a great danger to our criminal justice system, and understand why the use of snitch testimony should be scrutinized at all stages of the criminal justice process.

This presentation will impact the forensic science community by increasing attendees' knowledge about a system which has been found to be the leading cause of wrongful convictions in United States capital cases. Although forensic practitioners should strive for quality science in all applications, after this presentation, attendees will have a keener appreciation for the importance of validated and proper forensic science, lest false snitch testimony be cloaked in apparent forensic corroboration.

The use of informants by police and prosecutors has been likened by one commentator to the marketplace: snitches trading information for leniency (avoidance of arrest, reduced or dismissed charges, reduced sentences), or for money. For years it has been an era of non-regulation. Although the harm of deceitful snitch testimony has been most prominently identified in studies of the many death row exonerations, its use in our criminal justice system is not restricted to capital cases. Use of informants in drug enforcement, for example, has sky-rocketed, especially in federal court and in states which have dramatically increased penalties over the course of the decades-long "War on Drugs."

Information coming from an accomplice or a jailhouse snitch with something to gain, especially when uncorroborated, carries a high risk that false testimony will not be detected by the police or by the prosecutor before being presented, that it will not be successfully attacked on cross-examination, and that it will result in a wrongful conviction. Once the government incorporates the snitch information into its case, it becomes harder to be objective. The prosecution becomes a stakeholder in the validity of the snitch information. This presentation will examine not only why snitches lie, and how they manage to lie so convincingly, but also the relationship between the snitch and law enforcement/prosecution.

Some wrongful conviction cases will be reviewed to illustrate how dangerous and destructive snitch testimony can be, including a notorious

murder case out of Winnipeg, Manitoba, in which a man endured three trials, two appeals. and almost four years in custody before obtaining an acquittal, and then spent another fifteen years seeking exoneration. A major contributing cause to this man's wrongful conviction(s) was testimony from three jailhouse informants (chosen by the government from a group of at least eleven snitches that had lined up to help themselves by the time of the third trial). One of these snitches benefitted by having twenty six counts of fraud withdrawn by the Crown, and by obtaining release from custody with the understanding that he would appear to testify at the man's third trial. When the snitch failed to appear at the third trial, the court allowed his testimony from the earlier trials to be read in. Another of the snitches had a significant criminal record, including a conviction for perjury.

A Commission of Inquiry followed shortly after the Winnipeg Police Service announced, 18 ½ years after the murder, that it had identified another suspect. The presentation will include a review of recommendations of that inquiry relating to the use of jailhouse informants as witnesses in criminal prosecutions, and other remedies, as stark as prohibiting such testimony altogether, which have been proposed following studies of numerous wrongful convictions.

Wrongful Convictions, Snitch Testimony, Unreliability

E30 Discovering Related Individuals in STR DNA Databases

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After attending this presentation, attendees will have a better understanding of the makeup of allele frequency databases, issues with the presence of population substructure, how population substructure is currently being identified, and new methods of identifying population substructure that could be used for better quality control of allele frequency databases.

This presentation will impact the forensic science community by providing awareness of a new method of identifying the presence population substructure in forensic DNA databases that is far more reliable than the Hardy-Weinberg and linkage equilibrium tests that are currently being employed.

Allele frequency databases form the basis of the statistical weighting of forensic DNA profiles. An ideal allele frequency database would be representative of an underlying population and consist of randomly-chosen, unrelated individuals. Hardy-Weinberg and linkage equilibrium tests have been heavily relied upon to establish that the populations that have been sampled to establish allele frequencies are free from significant amounts of population substructure. Population substructure can lead to increased homozygosity and can misrepresent the allele frequencies present in the actual population. However, Hardy-Weinberg and linkage equilibrium are known to be weak statistical tests and are subject to the fallacy of denying the antecedent. For example, the presence of rain indicates the presence of clouds. However, a lack of rain does not indicate that no clouds are present. Loci that deviate from Hardy-Weinberg equilibrium expectations may be an indication of population substructure. However, loci that are consistent with Hardy-Weinberg equilibrium expectations may also be from populations with substantial amounts of substructure, but are not identified as such.

Kinship analyses in which each individual in a database is compared with every other individual to identify pairs of possible relatives is a more sensitive means of assessing population substructure. While Hardy-Weinberg and linkage equilibrium are intended to identify overall population substructure, kinship approaches have the potential to identify smaller clusters of related individuals that might skew allele frequencies, yet are unlikely to be identified by tests for Hardy-Weinberg or linkage equilibrium.

For this study, the Federal Bureau of Investigation (FBI) and National Institute of Standards and Technology (NIST) African American, Caucasian, and Southwest Hispanic allele frequency databases were examined with kinship analyses to determine if they contain pairs of individuals that are likely to be close relatives. Both the FBI and NIST population databases appear to contain pairs of closely related individuals. An exploratory study of Hardy-Weinberg and linkage equilibrium was also carried out to characterize the limits of the ability of these tests to identify the presence of related individuals in a database.

DNA Database, Population Substructure, Kinship Analysis

E31 Can Cold Hit Cases Be Tried Fairly?: Confrontation Clause and DNA Analysis

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After attending this presentation, attendees will have a better understanding of the implications of the recent U.S. Supreme Court case *Melendez-Diaz* which disapproves the use of sworn statements in drug analysis based on the defendant's right to confront testimonial statements. Based on the broad language of the case, it appears that all scientific evidence will be impacted by the right to confrontation of the analyst that actually conducted the analysis.

The presentation will impact the forensic science community by providing a road map for the legal requirements of testimony regarding DNA evidence.

In the recent U.S. Supreme Court case *Melendez-Diaz v. Massachusetts*, 557 U.S. ___ (2009), the court held that the forensic drug analysis was "testimonial" evidence as defined by the Sixth Amendment and therefore subject to cross examination at trial. Justice Scalia explains the meaning of testimonial, describing the signed affidavits in the case as falling squarely within "the 'core class of testimonial statements'" set forth in *Crawford v. Washington*, 541 U. S. 36, 51-52 (2004). Justice Scalia elaborated:

> The fact in question is that the substance found in the possession of Melendez-Diaz and his codefendants was, as the prosecution claimed, cocaine—the precise testimony the analysts would be expected to provide if called at trial. The "certificates" are functionally identical to live, in-court testimony, doing "precisely what a witness does on direct examination." (*Id*. at 4 [citations omitted]).

The question now for the forensic science community is the extent and nature of the requirements of the Confrontation Clause to all scientific evidence. The far reaching language of Melendez-Diaz appears to apply to all types of evidence from drug testing to fingerprint analysis to DNA testing to medical examiner reports.

In the context of cold hit cases where many if not all witnesses who collected and analyzed scientific evidence are deceased or otherwise unavailable, a fair trial may not be possible. The Confrontation Clause may require that important witnesses such as the medical examiner who conducted the autopsy or the crime scene technician who collected blood evidence at the scene, testify so that defendant's can challenge not only the factual basis of the evidence – how it was collected for example—but also the validity and reliability of the opinion of the expert who actually conducted the analysis.

However, not all chain of custody witnesses necessarily fall under the class of testimonial witnesses:

> Contrary to the dissent's suggestion, post, at 3–4, 7 (opinion of KENNEDY, J.), we do not hold, and it is not the case, that anyone whose testimony may be relevant in establishing the chain of

> custody, authenticity of the sample, or accuracy of the testing device, must appear in person as part of the prosecution's case. . . "gaps in the chain [of custody] normally go to the weight of the evidence rather than its admissibility." It is up to the prosecution to decide what steps in the chain of custody are so crucial as to require evidence; but what testimony is introduced must (if the defendant objects) be introduced live. (*Id.* at 5 n.1).

One open question of particular concern is whether or not medical examiners who conducted the autopsy in homicide cases will be required to testify. Although the autopsy report itself may be considered a business or government record that on its face complies with the hearsay exceptions for those types of documents, the Sixth Amendment may still require that the medical examiner be called to testify. The dissent argues that there are better ways to check the veracity of a particular test such as retesting a sample, however, in a footnote, Justice Scalia rejects this arguments noting that some forensic analysis such as autopsies or breathalyzer tests can only be done once and that samples can be lost or degraded. (*Id*. at 12, n.5). The implication being that if the testing or examination cannot be repeated, then the only way to ensure a fair trial and comply with the Sixth Amendment is for the defendant to have the opportunity to confront the analyst.

Cold Hit, DNA, Confrontation Clause

E32 Beer, Wine, and Forensic Science

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After attending this presentation, attendees will gain a general understanding of how observer effects can influence the human decision-making process in general, and specifically, how confirmation bias and context effects can compromise the interpretation of a forensic analysis. Attendees will learn how an administrative and analytical work flow designed to unmask domain-relevant information in an appropriate sequential manner can effectively minimize the potential for bias.

This presentation will impact the forensic science community by educating the forensic consumer about how bias can enter the enter the system, how it can affect a forensic analysis, and how to minimize these effects.

The National Academy of Sciences (NAS) Report clearly articulates the need to "… minimize, to the greatest extent reasonably possible, potential bias and sources of human error in forensic practice". The committee also encourages "… research programs on human observer bias and sources of human error in forensic examinations …" including "… studies to determine the effect of contextual bias in forensic practice". They add that, "Unfortunately, at least to date, there is no good evidence to indicate that the forensic science community has made a sufficient effort to address the bias issue; thus, it is impossible for the committee to fully assess the magnitude of the problem". They also suggest that the "development of such research programs can benefit significantly from other areas, notably from the large body of research on the evaluation of observer performance in diagnostic medicine and from the findings of cognitive psychology on the potential for bias and error in human observers".

Observer effects are rooted in the universal human tendency to interpret data in a manner consistent with one's expectations. This tendency is particularly likely to distort the results of a scientific test when the underlying data are ambiguous and the scientist is exposed to domain-irrelevant information that engages emotions or desires. Even in disciplines such as DNA, in which instrumental data customarily produces high resolution patterns, analysts often must resolve ambiguities, particularly when interpreting difficult evidence samples such as those that are very small, contaminated, degraded, or contain inhibitors.

The idea that cognitive bias is inherent to the human condition has now gained wide acceptance in the forensic community. However there remains resistance to instituting measures to minimize the chance for such bias to influence the decisions, judgment, and conclusions of the forensic analyst. Some suggest that the scientist is somehow different from others, and can, with sufficient education and experience, develop an immunity to the influence of external motivators. Others suggest certain quality assurance measures can mitigate the effects of domain-irrelevant information. It is instructive to examine other realms of human endeavor, both professional and general, to see examples of how biasing information can affect cognition and judgment. This presentation will discuss examples ranging from medicine to marketing.

The full potential of forensic testing can only be realized if observer effects are minimized. This risk can be minimized by preventing analysts from having information unnecessary to the proper analysis of an item, and proceeding through interpretation in a step-wise fashion, with additional information revealed only after traits of the questioned item have been characterized and documented.

It is understood that at least some of the resistance to implementing sequential unmasking procedures derives from a fear that the criminalist will be denied information required for an intelligent and optimized analysis. It is not suggested that forensic scientists be blind to information that might afford them the greatest opportunity to generate reliable information from evidentiary samples. Nor do they ascribe to the perspective that complete and enduring ignorance of case specific information is a good idea. However, a sequential unmasking procedure must be used to shield the analyst from task-irrelevant information when initially interpreting results in order to minimize observer effects. Discussion on why such procedures can and should be adopted immediately by all forensic testing laboratories will be presented.

Sequential Unmasking, Observer Effect, Context Effect

E33 Examining of the Case of the Deventer Murder in the Netherlands

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After attending this presentation, attendees will have a new understanding of the forensic and legal practices in the Netherlands. Attendees will also obtain a better understanding of the case review process, the necessity for chain of custody, and the potential for alternative interpretations of DNA evidence.

This presentation will impact the forensic science community by creating an awareness of forensic practices outside of the United States, the importance of the chain of custody, the ability to make statements made about the provenance of a DNA profile, and the potential for alternative interpretations of DNA profiling results.

The Deventer moordzaak (murder) has become one of the most controversial criminal cases in the history of the Netherlands. On September 23, 1999, Jacqueline Wittenberg was stabbed to death. Law enforcement focused their investigation on Mrs. Wittenberg's attorney and the executor of her will, Ernest Louwes. A knife was found approximately one mile from the scene of the crime that was determined to match Louwes by means of a sniffer-dog test. Ernest Louwes was tried and convicted in 2000 on the basis of that evidence. Subsequent analyses demonstrated that the knife could not have been the murder weapon due to its shape and dimensions. In addition, sniffer-dog evidence was discredited in the Netherlands and found to be inadmissible in court. Ernest Louwes, who had already begun a 12-year prison sentence, was acquitted of all charges. Law enforcement then sought to perform DNA testing on the remaining murder evidence. Four years after the murder, a box containing the items of evidence was retrieved from the police station attic and sent to the Netherlands Forensic Institute for DNA analysis. It was concluded that DNA associated with the victim's blouse was a mixture from which Ernest Louwes could not be excluded. In addition, one cutting was a single-source sample matching Mr. Louwes. In the presence of the DNA evidence, Ernest Louwes was re-tried and convicted. His sentence was completed in April 2009, yet he still maintains his innocence and is fighting for a new trial in an effort to be exonerated.

The case has continued to be controversial in the Netherlands largely because there are viable alternative interpretations of the DNA testing results. The Netherlands Forensic Institute claimed that the quantity of DNA present in the samples that were tested could only have been transferred as "the result of violent contact." However, the samples containing DNA foreign to the victim contained approximately 200pg or less of template DNA not associated with the victim. In addition, very little can be said about the locations in which DNA was observed due to the handling of the garment. Prior to DNA testing, the surface of the blouse was examined using micro-adhesive tape in an effort to obtain hair and fiber evidence. The blouse was also folded while still wet and stored in an envelope. Both actions could cause the transfer of DNA from one area of the blouse to another. Finally, there was an opportunity for the innocent transfer of DNA from Mr. Louwes during a business meeting with the victim the morning of the day she was murdered. A review of this case raises interesting questions regarding a number of issues that may reduce the weight that should be attached to the forensic DNA profile evidence including: improper storage and handling of evidence samples, inferences based on the quantity of DNA recovered, and the interpretation of mixture samples with small amounts of template DNA.

Deventer Murder, DNA, Case Review

E34 Cold Hit Statistics and Database Access

Bicka Barlow, JD, Office of the Public Defender, 555 7th Street, San Francisco, CA 94103*

After attending this presentation, attendees will learn about why cold hit DNA cases require a different statistical analysis. Additionally, disclosure of CODIS database information will be discussed and attendees will learn more about privacy issues and the statistical analysis that can be done on the data.

This presentation will impact the forensic science community by challenging some long held beliefs regarding the use of statistics in cold hit DNA cases.

Even though both reports from the National Research Council on DNA evidence (known as NRC 1 and NRC 2) propose two statistical methods that should be applied to matches found through a database search, the forensic community has ignored these recommendations. Forensic labs in the United States have continued to use the Random Match Probability (RMP) statistic in cold hit cases. A review of academic journals shows that there is a split in the statistical community regarding what is the appropriate statistic method. However, all sides agree that the RMP is not the correct statistic because it does not take into account the manner in which the defendant was identified.

The purpose of applying a statistical analysis to matches is to provide a jury with a way to give weight to the match. The RMP provides a measure of the probability of a coincidental match, meaning that the defendant did not leave the biological material but matches purely by coincidence. Many people - including DNA analysts - misunderstand this number to mean the probability that anyone besides the defendant left the DNA. This is called the prosecutor's fallacy and a case addressing this issue has recently been taken up by the U.S. Supreme Court.

The discussion around the appropriate statistic to be used in cold cases centers on how one measures the probability of a coincidental match given the manner in which the match is made. Unlike in "probable cause" cases where the defendant is already a suspect, in a cold hit case the defendant only becomes a suspect based on a match. There are three groups in this debate, only two of which will be described in detail. All alter the RMP statistic to account for ascertainment bias.

One camp adopts the NRC 1 approach. This method uses the RMP but only on loci that are not used to identify the defendant in the first place. For instance, the database search would be done with nine loci and once a possible suspect is identified additional testing would be done and the RMP applied only to those additional loci. Although there are 13 core loci that are routinely used by labs in the CODIS system, additional loci have been identified and are in use that allow testing up to 15 loci.

Another camp adopts the NRC 2 approach. This method also uses the RMP but then takes into account the number of people who were searched in the database. So the RMP for the evidence profile is 1 in 1 million and 300,000 profiles are searched to find one match, the NRC 2 number would be one in three. In other words, the probability of choosing a person who matches the crime scene evidence from a database of innocent people, is one in three.

The third approach is Bayesian. The statistic applied is approximately the same as the RMP.

Many statisticians believe that one way to determine the appropriate measure would be to study the CODIS databases. Due to the huge size of these databases, the statistical value of the research would be much higher than any previous study. Questions relating to the heterogeneous nature of the database which include mixed racial groups and relatives can be addressed through statistical modeling.

Privacy issues also are extremely low. No individual information is necessary and the data could be treated in the same manner as all human data used for research is handled.

Cold Hit, Statistics, CODIS Database

E35 A Maggot in the Justice System

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The goal of this presentation is to provide attendees with an overview on a number of entomological tools that may be helpful in solving crime. The research presented here is novel and maybe useful to both law enforcement and the judiciary when conducting an enquiry.

This presentation will impact the forensic science community by highlighting to what extent forensic entomology can aid in crime solving. Forensic entomology is regarded as the "gold standard" for estimating time since death.

Based on the experience of any scientist everything is falsifiable and facts are but fleeting moments on a sliding scale. To the lawyer the Forensic Entomologist (FE) like many experts presents an interpretation of an event(s) based on an existing set of principles interpreted in the context of expertise and past training. Of course the result is a probability not a certainty. Experience with many lawyers is they do not really understand what is done in analyses. This paper will hopefully enlighten the judiciary of a number of recent and informative research studies.

Forensic entomology is the study of insects pertaining to legal investigations. The occurrence of decomposing remains within an environment provides a temporary habitat and food resource opportunity for numerous insect species. Insect succession patterns are also closely linked to the progression of carcass decomposition and as such, while a continuous process, decomposition can be defined into distinct stages which are linked to specific insect groups used as markers for the estimation of postmortem interval (PMI). The following topics concerning PMI that will be briefly discussed include:

Other Useful Insects Attracted to Cadavers - This study considered annual, seasonal and shorter-term variation in patterns of insect succession onto decomposing remains at two contrasting locations in Western Australia, *bushland* and *agricultural*. Forensically relevant data detailing the seasonal pattern of insect succession onto decomposing remains for Western Australia are briefly discussed. An additional focus of discussion has been directed towards Hymenopteran parasitoids that frequent decomposing remains and parasitise Diptera colonisers. Parasitoids can be used to provide an extended PMI timeframe in cases where traditional forensic indicators have completed their development

Restricted Access Environments - This research was conducted in two parts, insect accessibility into trash containers and vehicles. Bodies dumped in trash containers or suicide victims ensconced in vehicles how do they decompose and most importantly for the FE what insects are involved in the decomposition process. Most suicides conducted in vehicles happen in isolated areas where the vehicle is parked in wooded areas for the purposes of concealment. Decomposition rates are compared between the pig in the vehicle and two other pigs (one pig sacrificed by CO poisoning and the other by head bolt) decomposing under normal conditions. A model has now been determined which adequately explains how temperatures change in vehicles.

Trash containers are becoming popular repositories for homicide victims but little is known about how bodies decompose in such environments. Research conducted in Knoxville, TN will highlight how humans decompose in wheeled trash containers and the significant disruption to the expected faunal succession.

Entomotoxicology, Drugs, GSR, DNA - Finally, a brief overview of an alternate detection method for gunshot residue (GSR). This research involves blowfly larvae as analytical specimens for the detection of GSR. The results indicate the detection of lead, antimony and barium and suggest bioaccumulation of these elements within the larvae.

Entomotoxicology, Decomposition in Restricted Environments, Developmental Life Cycles

E36 Don't Cut Off Your Nose to Spite Your Trace

Vincent J. Desiderio, MS, New Jersey State Police, Central Laboratory, 1200 Negron Road, Hamilton, NJ 08691*

After attending this presentation, attendees will have a better understanding of the significance and importance of non-DNA evidence for the investigation of criminal activities.

This presentation will impact the forensic science community by providing an important discussion on the relevance of fingerprints, shoeprints, firearms, tool marks, and trace evidence for use not only as inculpatory evidence but also exculpatory.

The report that everyone has been waiting for has finally been released. It has been just about one full year since the National Academy of Sciences has spoken and the effects of the report have yet to be fully realized. By now, the recommendations contained therein are certainly known to a vast majority to those who might be interested in its results. Forensic scientists have poured over it to see if their respective fields are above and beyond the recommendations contained therein and if not, they have been hard at work making strides to abide by any suggestions. The legal community is also hard at work figuring out how best to use the words contained within to either defend their clients or see to it that the best techniques available were used to bolster their cases.

Two particular areas of forensic analysis appear to be shouldering the greatest burden: the so-called identification sciences and trace evidence. Long regarded to be infallible and well established in the law enforcement community, both of these analytical disciplines have been under attack as to the efficacy of their scientific validity for some time now. The challenges that have been proffered significantly pre-date the report and in fact may have provided some of the impetus for the National Academy of Sciences (NAS) inquiry. Amongst these challenges there has been a disheartening trend in which many members of the legal community are going to great lengths to exclude the use of potentially valuable types of evidence. Some of the hardest hit areas include fingerprints, shoeprints, firearms, tool marks, and the various disciplines of trace evidence, most notably hair examinations.

It is argued that these disciplines all provide relevant information in a scientific fashion. They are valid, certainly more so than eyewitness testimony, and it would therefore be irresponsible to throw out these disciplines in their entirety. That being said, there is certainly a need for greater scrutiny on what is being written in reports and presented in courts of law. As valid as the findings may be, there is great responsibility in offering such results. This responsibility falls on all of those that are involved in this process, the scientists performing the work and the attorneys either presenting the information or those questioning it.

During the course of this presentation, it will be argued that were it not for a diminutive minority of cases, there would be no basis for attacking these disciplines. High profile missteps and biased analyses of data are leading to the false impression that these forensic disciplines are entirely unreliable. If the data were looked at in their entirety, any individual should undoubtedly find that such evidence has been used in far greater numbers to exculpate potential suspects than it has to falsely imprison them. Additionally, in those cases involving false imprisonment, the forensic evidence often played a minute role that, in many circumstances should have been completely overshadowed by investigative misconduct and coerced confessions. It could even be argued in some cases that there was exculpatory forensic evidence that was ignored because it did not fit a prosecutorial scenario.

Unbeknownst to some, there are already several mechanisms in place that are continually increasing the scientific rigor involved in these various disciplines. Some such mechanisms include accreditation, standardization, and certification. Numerous groups exist within the forensic community who are concerned with increasing the level at which forensic scientists operate. Some of their primary concerns

include the assurance that quality work is being produced, accepted methods are being utilized, scientists performing the work are at an acceptable level of knowledge and that knowledge is maintained, and reports are not overstating the value of any given evidence. Some of these groups include the American Society of Crime Laboratory Directors (ASCLD), the various working groups including but not limited to the Scientific Working Group on Materials Analysis (SWGMAT), and the Technical Working Group for Fire and Explosives (TWGFEX), ASTM International's E-30 committee on the forensic sciences, and the American Board of Criminalistics.

Attorneys hold great sway over what is and is not let into courts of law. Given the current climate towards the identification sciences and trace evidence, the potential exists to do irreparable damage. Instead of proceeding down such a dangerous path, attendees should use any of the numerous constructive routes they can follow to ensure that quality forensic science is being utilized. By educating themselves on the caveats of the various disciplines, enlisting their own experts for review, and questioning opposing experts on their personal and/or their laboratories level of participation in accreditation, standardization, and certification; they should be able to determine if the science that is being presented is worthy of the courtroom. These are surely better ways to raise the forensic bar than haphazardly tossing aside potentially relevant evidence.

It cannot be forgotten that the American legal system is here for all of our sake. It would be a travesty if the application of fingerprints, shoeprints, firearms, tool marks, and trace evidence were excluded from use. All of these disciplines have been used to both inculpate and exculpate an uncountable number of participants in the legal system. From the litigious perspective, one never knows when such evidence will help or hinder the cause of either side. It would therefore be wise to exercise caution when considering the wholesale expulsion of such time-tested disciplines. As with any scientific endeavor, the more data that is collected, the more one can be certain that any given hypothesis is true. This author would not want to be a participant in any system that does not look at all of the facts, especially those of a physical nature when deciding innocence or guilt.

NAS, Identification Sciences, Trace Evidence

E37 Digital Forensics — What Lawyers Need to Know

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The goal of this presentation is to describe the fundamentals of digital forensics and the types of questions examination of digital evidence can answer, with an emphasis on what lawyers need to know to make strategic decisions about the digital evidence in their cases and to navigate this relatively new discipline of forensic science.

This presentation will impact the forensic science community by providing the attendees with the fundamentals for making that assessment, both in support of their client's claims and in anticipation of opposing counsel's counterclaims. In addition, this presentation will discuss when it makes sense to call in a digital forensic expert, what to look for when choosing an expert, and the questions to ask to ensure an expert has performed his or her due diligence before reaching a conclusion.

Desktop, laptop, netbook, flash drive, Playstation, cell phone, PDA, iPod, and digital camera. Although this sounds like a birthday wish list it is just as likely to be the list of evidence collected in one's latest criminal or civil case. The ubiquitous nature of digital media and the breadth of information that can be gleaned from them, if properly examined, have led to a dramatic increase in the number of digital media items collected in investigations. This presentation will describe the fundamentals of digital forensics and the types of questions examination of digital evidence can answer, with an emphasis on what lawyers need to know to make strategic decisions about the digital evidence in their cases and to navigate this relatively new discipline of forensic science.

The analysis of digital evidence can provide a wealth of information about both the content of the data and contextual information regarding how the digital media was used and the activities and knowledge of the user. Having a basic understanding of how data is stored on the media and the types of information that can be extracted through a digital examination will assist in one's ability to understand the questions that can be answered and to also assess the evidentiary value of the digital evidence.

Was the iPod carried by a suspect in a rape case previously used by the victim? Who is sending the anonymous harassing e-mails to the CEO? Is the key document in a contract dispute case authentic? Did the CFO view and therefore have knowledge of the spreadsheet e-mail attachment containing the company's fraudulent financial information? Was confidential data stolen from a company by the hackers who gained unauthorized access to their network? These are all questions that may be answered through digital forensic examinations.

As the number of type of digital devices turning up in criminal and civil cases continues to grow, so too does the importance of a lawyer's ability to assess the evidentiary value of the digital evidence and make informed strategic decisions. This presentation will provide the attendees with the fundamentals for making that assessment, both in support of their client's claims and in anticipation of opposing counsel's counterclaims. In addition, this presentation will discuss when it makes sense to call in a digital forensic expert, what to look for when choosing an expert, and the questions to ask to ensure your expert has performed their due diligence before reaching a conclusion.

Digital Forensics, Computer Forensics, Digital Media

E38 Moving Towards Using Statistics for Fingerprint Evidence in the Courtroom

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The goal of this presentation is to inform the audience of the current state and views of fingerprint evidence, share concerns within the communities regarding statistics and fingerprint evidence, inform the audience of current research initiatives and share available data, and elicit feedback and comments from the jurisprudence community regarding their views on fingerprint statistics in the courtroom.

The presentation will impact the forensic science community because in the past the jurisprudence community has not heard about current research and statistical tools for fingerprint evidence, and the practitioner community has not heard from judges and attorneys how to use these tools, or even if they want these tools introduced into the courtroom.

Since the early 1900s it has been suggested that fingerprint evidence could be presented probabilistically to express the uncertainty associated with the inference of a source attribution to a questioned impression. However, this approach never gained widespread acceptance from the practitioner community. In fact, the forensic fingerprint community has generally eschewed, even banned, the use of probabilities to express fingerprint evidence, asserting that the inherent biological uniqueness of friction ridge skin prevented duplication of ridge arrangements. Any use of probabilities would thus allow for "some probability" of duplication. Practitioners have also noted that proposed theoretical models did not correctly or completely capture expert processes, and thus use of such statistical tools was limited or inaccurate.

Recent advances in technology, computing power, and fingerprint database development have begun to make these arguments obsolete.

Furthermore, the National Academy of Sciences (NAS) Report clearly supports a move towards the use of probabilities to express fingerprint evidence, not completely unlike DNA evidence. The NAS Report recommends basic understanding and knowledge in probabilities and statistics for all forensic scientists.

The first half of this presentation will discuss changing attitudes amongst practicing fingerprint experts towards a probabilistic approach and the use of likelihood ratios (LRs) to express fingerprint evidence. Attention will be paid to recent papers, research, and discourse on the topic. In the second half of the paper, some examples will be provided of how transition towards a new approach to traditional evidence can be accomplished. Obstacles, counterviews, and lessons learned will also be presented. Finally, some data from recent experiments and forthcoming publications will be shared with the audience.

At the end of the presentation, attendees may provide comments of the legal community on this matter. There has been much debate amongst the legal scholars, the practitioners, and academics. The presenters have yet to really hear from what their clients (the courts) truly want and need. There remains uncertainty on how attorneys will deal with a statistical approach to fingerprint evidence. These are questions that would be exceptionally helpful in coordinating efforts towards a more transparent and objective probabilistic approach.

Fingerprints, Statistics, Testimony

E39 Report on the Progress of National Institute of Forensic Science Legislation in Congress

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The goal of this presentation is to describe the content and progress of legislation proposed in Congress to create a National Institute of Forensic Science (NIFS) based on the primary recommendation of the National Academy of Sciences (NAS) Report, *Strengthening Forensic Science in the United States: A Path Forward*.

This presentation will impact the forensic science community by discussing how the creation of a NIFS has the potential to greatly enhance the reliability of the criminal justice system's use of forensic evidence to identify criminal offenders. All the participants of the criminal justice system – police, prosecutors, defense attorneys, judges, juries, and indeed, forensic analysts themselves – need and deserve to have the clearest understanding possible of the extent and the limits of the crime scene forensic evidence. That the evidence is accurate and scientifically valid is essential to both the public safety and the promise of fair and reliable criminal proceedings.

In 2006, Congress tasked the National Academy of Sciences with identifying the needs of the forensic community. In February 2009, the NAS released their unprecedented, wide-ranging report on forensic science, *Strengthening Forensic Science in the United States: A Path Forward*. This report confirmed that many of the forensic sciences used in criminal investigations and presented as evidence at trial have been developed without the benefit of rigorous scientific testing and found basic scientific deficiencies in many disciplines.

Chief among the NAS Committee's recommendations is the need for creation of a National Institute of Forensic Science (NIFS), a science-based, independent body responsible for leading research efforts; establishing and enforcing scientific standards; ensuring that forensic science professionals and laboratories are properly credentialed and accredited; and promoting the development of improved forensics tools. The creation of this new body has potential to fundamentally alter – for the better - the entire criminal process. A NIFS that is responsible for scientific research, review and oversight, including the development of national standards for quality assurance and control, will make these tools more – not less – effective for law enforcement and courts. To guarantee reliable criminal justice outcomes, we must ensure that all types of forensic evidence used to secure an arrest or conviction are based on valid and reliable science.

The Innocence Project initiated a conversation about legislation that directly reflects the primary recommendation of the NAS report – the creation of a NIFS, its approach to research and standard-setting, support for technology innovation, accreditation, and certification, compliance and enforcement, training and education support, needs assessments for the forensic science community, and oversight. This presentation will discuss the content and progress of the legislation in its current form as it stands in Congress.

Society as a whole benefits when the best possible evidence drives criminal investigations and prosecutions. Public safety can be increased by improving the accuracy of criminal investigations and promoting science-based prosecutions. When unvalidated forensic evidence wrongfully implicates someone as a perpetrator, everyone shares in the cost. When a crime's true perpetrator is not identified, communities are less safe, and the jobs of law enforcement are made that much harder.

National Institute of Forensic Science (NIFS), Legislation, National Academy of Sciences Report

E40 Pollution Solution? Suggested Identification and Possible Amelioration of a Potential Source of Contamination in Forensic Examinations

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After attending this presentation, attendees should be aware of the potential of attorneys as sources of contextual bias that can contaminate forensic examination, and also have some ideas to consider in terms of putting the Section's forensic house in order to prevent future pollution of the forensic environment.

This presentation will impact the forensic science community by raising awareness of the potential of attorneys as sources of contextual bias that can contaminate forensic examination, and also provide some ideas to prevent future pollution of the forensic environment.

The seventeenth century French innovation of using mercury nitrate in the felt making process led to poisoning among hat makers, a form of contamination that spread to England and America with the felting technique, causing symptoms bizarre enough to be used by Lewis Carroll in creating the Mad Hatter, and widespread enough in the industry's environment to be known as the Danbury Shakes around Connecticut's nineteenth century hat making center. French legislation dealt with this source of pollution in 1898, but a legislative remedy in the United States took until 1941. A more egregious (or at least more recent) case is the mid-twentieth century Japanese experience with Chisso-Minamata Disease that ended with a court case revealing years of corporate executives ignoring what they knew to be ongoing environmental contamination from methyl mercury in the waste water of their acetaldehyde plant. Other stories might come to mind (e.g., relating to asbestos or tobacco) where the individuals at the source of the contamination did not realize the consequences of their normal course of business actions, progressing through denial to cover-up, ending with correction through the courts, or legislation, or both. In the early twenty-first century those who knowingly contaminate are subject to substantial fines or lengthy terms of imprisonment under environmental protection laws or various anti-terrorism act, or even worse consequences as defendants in a civil suit.

In the twentieth century most public (or litigated) concerns about contamination compromising forensic examinations were focused on the physical side of the examinations: process induced issues (e.g., the collection and handling of material during scene processing or cross-contamination in a laboratory), or intrinsic problems (e.g., mixed DNA

samples). While they have not been completely eliminated, awareness of the potential sources of contamination has certainly ameliorated them, and will hopefully reduce them to a negligible level.

In the first years of the twenty-first century the focus has shifted to the human side of the examinations and problems caused by the introduction of contextual bias. The symptoms of this form of contamination are said to affect the independence, the impartiality, and even the judgment of the forensic examiner, which in severe cases can result in erroneous results. The much more common perception of the source of contamination is that blatantly extraneous information given (or forced upon) the forensic examiner by a detective, or agent, or even a prosecutor.

The most popular current responses by those who consider contextual bias to be a real threat to forensic impartiality have taken the form of "target hardening" to swaddle the laboratory expert in layers of bureaucratic protection from direct access to potentially domain non-relevant information. As with terrorism, however, target hardening is expensive, inconvenient, and never as satisfactory or permanent a solution as elimination of the source of the problem.

There have been some recent studies (rigorously controlled and otherwise) that appear to suggest that forensic practitioners might have a certain level of acquired immunity to this kind of contamination. For the forensic document examiner this is not that surprising because the basic texts of their field have discussions and warnings against this very problem that are absorbed by fledgling examiners from the first days of their training. Furthermore, the awareness of the problem is enhanced by virtually every telephone inquiry from an attorney.

Attorneys, and especially trial lawyers, are trained to be persuasive, to lay out their facts (if they have any) and their arguments (which they always have) in a way to convince the listener, be that a judge, a jury, or the person sitting next to them in a bar. That is just what they do, and they do it when speaking to prospective expert witnesses. While this may have been excusable in the past as mere advocacy with no intention to introduce contextual bias, it is now moving into the realm of willful ignorance to deny the potential of such behavior to contaminate a forensic examination.

Certainly the members of the Jurisprudence Section of the American Academy of Forensic Sciences and other well informed lawyers are fully cognizant of this issue. Those section members that are law school professors are surely passing this information along to their classes, and it is hard to believe that everyone graduating from law school in 2020 and aiming for courtroom practice would not be aware of these issues.

If an over-confident detective or an over-eager prosecutor is the source of contextual bias, then she or he should be punished. However, what of the over-zealous defense attorney who can also be a source of contamination when retaining an expert for the defense. Some might argue about the duty of the defense attorney to the defendant, but surely there are limits; the location of those limits should certainly be left to the legal community to determine, but that community must consider if knowingly introducing contextual bias into a forensic examination is within or beyond acceptable behavior.

It must also be remembered that a great deal of forensic practice takes place in civil matters. Indeed, many more resources are deployed in a medium to large civil case than in most capital cases. Just consider the asbestos, Agent Orange, and tobacco litigation of the past generation, and also recall that all three cases in the *Daubert, Joiner, Kumho* trifecta were civil cases. It would be for the legal community to determine what limits, if any, should apply to the behavior of an attorney in a civil matter.

Some years ago a Code of Professionalism was proposed by the Jurisprudence Section for the guidance to the Section's members in their professional relationships with forensic experts. Item 6 of this code included a pledge to "not withhold nor suppress any relevant facts, evidence, documents or other material… that may be relevant to the expert's opinion." If the members of the Jurisprudence Section consider contextual bias to be a real and serious threat to the fair and impartial conduct of forensic examinations and the accuracy of the results of those examinations, then the members might consider adding a provision to the Code to "not inform an expert of any facts, evidence, documents or other material… that may not be relevant to the expert's opinion." The level of sanctions used to enforce such a code would, of course, reflect the level of concern of the members about contextual bias as a real problem that has real potential to distort forensic results.

Judges, attorneys (prosecutors and the defense bar as well as civil litigators), along with scientists and other scholars or experts whose work has addressed forensic science issues and who are actually concerned that contextual bias is some sort of clear and present danger to getting accurate results from impartial forensic examinations will show the level of that concern by urging their Bar Associations to consider attempts to cause contextual bias as serious ethical violations worthy of disbarment, and urge the legislatures to consider such behavior by attorneys or non-attorneys to be akin to obstruction of justice or subornation of perjury.

Contextual Bias, Jurisprudence, Forensic Examinations

E41 Avoiding Wrongful Convictions: Proving the Corpus Delicti

John J. Lentini, BA, Scientific Fire Analysis, LLC, 32836 Bimini Lane, Big Pine Key, FL 33043*

After attending this presentation, attendees will have an appreciation for a class of criminal cases where the association between a suspect and the scene is not at issue. Rather, the issue in these cases is what happened at the scene. A proposal for avoiding the miscarriages of justice that accompany these kinds of cases will be put forward.

This presentation will impact the forensic science community by giving defense attorneys several options for eliminating prejudice and improving the scientific quality of trials. Current trial tactics involving bootstrapping weak science with character assassination may be curtailed as a result.

The Sixth Amendment to the United States Constitution begins with the phrase, "In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the State and district wherein **the crime** shall have been committed". These words were written a simpler time, when the existence of a crime was usually not debated. It is unlikely that there were many criminal prosecutions for which there was not an obvious *corpus delicti.* Even today, in the vast majority of criminal trials, the issue before the jury is "Whodunit?" rather than "What happened?"

It is not surprising, therefore, that the recent National Academy of Sciences Report, *Strengthening Forensic Science in the United States: A Path Forward*, dealt almost exclusively with forensic science issues related to associating a suspect with a crime scene, rather than issues related to determining what happened.

In almost all cases where "What happened?" is at issue, the defense takes the position that "It was an accident," or, "It was self-defense". When these defenses are raised in shooting incidents, the entire trial revolves around what exactly happened, but in other cases, the evidence is far more subtle and open to debate. There is no doubt that in these cases, the prosecution should have the burden of proving beyond a reasonable doubt that a crime actually took place, but far too often, when faced with weak scientific evidence, the prosecution focuses on character assassination of the defendant to bootstrap weak or nonexistent evidence that a crime actually took place.

The Goudge Inquiry in Canada (www.goudgeinquiry.ca) focused on 20 cases of alleged shaken baby deaths, in which the cause of death was known, but the manner of death was ruled a homicide based on debatable interpretations of injuries detected at the autopsy. The following excerpt from the report sums up the problem:

The interpretive nature of forensic pathology - both in evaluating the findings made at the autopsy and determining what, if any, conclusions can be drawn from them - reinforces the limitations of the science. Even when the controversy does not divide the pathology community, there are diagnostic challenges that limit what a pathologist can reasonably say about an individual case, and the level of confidence or certainty with which he or she can say it.

There is another kind of crime for which the same problems exist, and that is arson. The problem is magnified by the fact that while any forensic pathologist can determine the *cause* of death, in order to determine *manner* of death, he or she must rely on the opinion of a fire investigator, possibly one with little or no scientific education. Thus the highly educated and trained forensic pathologist relies on someone with much less education and training to determine the manner of death. In fact, the bottom line of the Goudge Inquiry can be translated directly to the problem of fire investigation ever simply by substituting "fire investigator" for "forensic pathologist" and "fire scene" for "autopsy."

The interpretive nature of fire investigation-both in evaluating the findings made at the fire scene and determining what, if any, conclusions can be drawn from them-reinforces the limitations of the science. Even when the controversy does not divide the fire investigation community, there are diagnostic challenges that limit what a fire investigator can reasonably say about an individual case, and the level of confidence or certainty with which he or she can say it.

Cases involving the death of children are always very emotional, and when a criminal case is brought, that is exactly where the prosecution tends to focus. In arson trials, particularly when the science is weak, the prosecution may spend the first few days of trial proving that the accused mother or father is a monster because if this was in fact a set fire, then a monstrous act has been committed. Unfortunately, by the time the defense goes on, the jury is already persuaded by the character assassination evidence that the fire was intentionally set, even if there is serious doubt about that fact. The same kind of dynamic takes place with shaken baby trials.

In both arson and in shaken baby cases, there is usually little doubt about the identity of the perpetrator, only about the *manner* of death. If the fire can be shown to have been intentionally set, there is little doubt about the identity of the perpetrator. It is a survivor who provided the fire investigator with an account of an accidental fire. If the shaken baby can be shown to have been shaken to death, the perpetrator is the person holding the baby. The question of "Whodunit?" is settled.

Because it is incumbent upon the prosecution to prove beyond a reasonable doubt that a crime actually took place, it only seems fair that **before** the prosecutor begins proving who is responsible for this horrible act, he or she should be required to prove that it was in fact a horrible act. Put forward for your consideration is the following language which is suggested should be the law:

In all prosecutions involving homicide, unless the manner of death is stipulated, the State shall have the burden of proving beyond a reasonable doubt that the manner of death was homicide prior to any evidence being presented regarding the guilt or innocence of the defendant.

And similarly,

In all prosecutions involving arson, unless the cause of the fire is stipulated, the State shall have the burden of proving beyond a reasonable doubt that the cause of the fire was incendiary prior to any evidence being presented regarding the guilt or innocence of the defendant.

Several states already have statutes or case law regarding fires and a presumption of accidental cause unless proven otherwise. When mere money is at stake, Federal Rule 42 (b) allows for bifurcation to prevent prejudice:

The court, in furtherance of convenience or to avoid prejudice, or when separate trials will be conducive to expedition and economy, may order a separate trial of any claim, cross claim, counterclaim, or third party claim, or of any separate issue…

Other then the near impossibility of passing legislation over the screaming opposition of the prosecution and insurance defense bars, there should be no reason that trials where the manner of death or the cause of the fire are in dispute should not be bifurcated so that the state is first required to prove the *corpus delicti*.

Short of passing legislation, bifurcation might be accomplished by requesting that the judge bifurcate the trial, and short of that, the judge can be requested to issue a jury instruction telling them that before they begin debating the guilt or innocence of the defendant, they first decide whether a crime has in fact been committed.

Bifurcation, Arson, Shaken Baby

E42 When Two Worlds Collide: The Interface of Science and the Law

Christopher P. Montagna, MS, MPA, Foren-Tech, 83 Bradford Lane, South China, ME 04358*

After attending this presentation, attendees will have an understanding of how the interface between science and the law has lead to misunderstanding and at times contentious interactions between the scientist and the attorney.

This presentation will impact the forensic science community by opening a discussion on ways to gap the divide between science and the law by providing insight into the training of the scientist as expert witness, address issues raised by the recent National Academy of Sciences (NAS) Report, and seek to clarify that, what is perceived as unsound science may in fact be flawed follow-through.

Scientists learn that the word science comes from the Latin word scientia meaning knowledge. This knowledge is attained through study and/or experience in employing the scientific method. The key to any scientific endeavor is to provide empirical (derived from experiment and observation) and unbiased conclusions. Once forensic science is chosen as a career path, one learns that the term forensic means, "pertaining to law." This knowledge (science) is applied in a legal setting. That is, a setting established by or founded upon official or accepted man-made rules.

It is this interface between science and the law that has lead to misunderstanding and at times contentious interactions between the scientist and the attorney. Forensic scientists are precariously balanced at the apex of two worlds – science and law. They teeter on the line between what is scientifically right and what is legislatively legal. As such, things can be legally right but scientifically ambiguous or wrong.

The presentation will address the key topics necessary to bridge the gap between the two disciplines: education, communication and ethics. Understanding and applying these key concepts will provide a broader understanding of how science fits in with the law.

Science, Law, Jurisprudence

E43 Forensics for the Defense

O'Brian C. Smith, MD, Conscience and Science in Medicine, LLC, Conscience and Science in Medi, 9639 Rosemark Road, Atoka, TN 38004*

After attending this presentation, attendees will be presented three (3) cases involving complex medical and legal issues beyond the typical scope of homicide trials. The benefit of deconstruction and differential

diagnoses are used to evaluate and test prosecution claims; realizing initial medical opinions are sometimes made using bad facts, superficial observations or lack of research. To remedy this requires an integrated approach to investigation which will establish strong points for the defense.

This presentation will impact the forensic science community by proving a better understanding of the value of integrating the forensic and medical sciences into investigations and their contribution to the provision of justice.

Case One: Alleged Shaken Baby Syndrome - The manner of death for this child was determined to be homicide by the medical examiner who accepted verbal turnover reports from physicians at an advanced pediatric hospital that the child suffered non-accidental trauma. Highly manipulated laboratory data, inappropriate for this circumstance was used to indicate a normalcy for this child's laboratory report. The channelized thinking that followed produced an absence of inquiry into the childs' significant past medical history. Four physicians were prepared to testify to the non-accidental nature of the child's injuries. The father was tried for murder in the first degree, but was resolved by diversion.

Case Two: Homicide vs. Accidental - A young couple with a shared history of alcoholism and adultery entered into a domestic dispute resulting in the woman being forced to sleep in their garage. Some physical violence was admitted by the husband and a delay of treatment after discovery occurred while the spouse sought informal medical assistance. At trial the prosecution maintained all injuries were the result of deliberate violence despite a seriously flawed autopsy, inadequate documentation and failure of the treating physicians and the medical examiner to recognize a chemical pattern of derangements in the victim sufficient to cause death. The husband was convicted of second degree murder.

Case Three: Homicide vs. Suicide - An older couple with a history of domestic discord was investigated by police as a homicide, despite the adamant denials of the surviving husband. He was originally charged with second degree murder during a preliminary hearing, but the prosecution elevated it to first degree via the grand jury. Past discord and bad acts were given great authority despite an absolute dearth of evidence towards homicide, missed investigatory efforts, and disregard of exculpatory evidenced coupled with interference by the prosecution with the defense expert. The case resulted in a conviction for criminally negligent homicide, the lowest of any charge involving death.

Jurists for the defense are often faced with a prosecution theory developed through its endless resources of money, facilities and experts. But there are times when defense experts may broaden the view of the case and significantly impact the outcome, both at trial and in the appellate phase. The focus is on the process of deconstructing the proffered case by assessing the strengths and weakness in the state's use of its forensic capabilities; the need to develop sound differential diagnoses and alternative explanations, and ensure the standards of care have been met.

Forensics, Ethics, Deconstruction

E44 Rights of Expert Witnesses From an Attorney's Perspective

Harry L. Miles, JD, Green, Miles, Lipton & Fitz-Gibbon LLP, 77 Pleasant Street, PO Box 210, Northampton, MA 01061-0210*

After attending this presentation, attendees will have learned about the differences in language, philosophy, and pragmatic approaches to presenting scientific evidence; the rights and obligations of the experts who present it; and, their relationships with the attorneys who engage them and the clients on whose behalf they work.

This presentation will impact the forensic science community by proving an awareness of how members of the forensic community interact with colleagues, what to expect, and how to work together under the umbrella of the criminal and civil justice systems in the United States.

This presentation will seek to raise the awareness of experts to their rights and obligations as forensic scientists in the judicial system. The material will be presented from the perspective of the practicing lawyer who has to find, engage, pay, educate and be educated, and work comfortably with expert witnesses. The participants also will discuss what happens when attorney-expert or expert-client relationships sour; what traps are there for the unwary during depositions and trials; how to avoid or counter those traps; and how to advocate for a client without breaching a scientist's ethical boundaries.

Expert Witnesses, Rights and Obligations, Testimony

E45 A Judicial Perspective on Ethics for Forensic Experts: Basic Instincts and Beyond

Stephanie Domitrovich, JD, PhD, Sixth Judicial District of Pennsylvania, Erie County Court House, 140 West 6th Street, Room 223, Erie, PA 16501*

After attending this presentation, attendees who are experts will have a judicial perspective on the court's expectations as to their ethical roles and responsibilities to themselves, the court, their clients, and their communities.

This presentation will impact the forensic science community by teaching experts how judges and others view the expert's ethical roles and responsibilities.

This presentation will examine expert witnesses' ethical responsibilities and roles as to professional and personal integrity as well as to community expectations and restrictions. This presentation will cover: the expert's important role of independence and objectivity; coping and working with lawyers in preparation for trial; confidentiality and conflicts of interest as to whom do experts owe their primary loyalty; and handling discovery issues as to communication with adverse counsel, production of documents, and depositions where there is conferring off the record and instructions or directions are given by counsel. Best practices approaches will be discussed as to trial conduct regarding ex parte communications and excluded evidence so as not to back door court's rulings in motions in limine. The role of the expert as to specialized knowledge and assisting the triers of fact as educator as well as the expert's liability for negligence will be examined. Also discussed will be how unethical experts are sanctioned through: the parties of the litigation; by and of lawyers; by juries; by professional organizations; and by "outing" where the court excludes the expert's testimony on admissibility grounds in a written opinion and goes beyond mere exclusion as in the *Kumho* case. The malpractice of expert witnesses–emerging trend or aberration–will also be presented regarding professional liability standards as well as legal and policy rationales.

Ethics and Experts, Judicial Perspective, Forensic

E46 Drake vs. Portuondo: Notorious Case of Prosecutorial Misconduct, Charlatan Expert, and Forensic Fraud

Gil Sapir, JD, PO Box 6950, Chicago, IL 60680; and Victor M. Salas, JD, John Marshall Law School, Law Library, 1315 South Plymouth Court, Chicago, IL 60604*

After attending this presentation attendees will have a better understanding of the legal and ethical obligations, and consequences, of abusing expert witness testimony.

The presentation will enable the forensic science community to comprehend the impact of scientific evidence, its integrated ethical issues and how it can affect the outcome of judicial proceedings.

The prosecutor has a duty to seek justice, not merely convict. To attain this objective, the prosecution often relies upon expert witness testimony. The expert witness' existence is created and perpetuated by the legal system. The Rules of Evidence codified consulting and testimonial evidence. An expert does not testify in court without being properly qualified to do so. A summary of Federal Rule 702 - 706 is that a qualified expert may give his or her opinion to help the court understand evidence or to establish a fact in issue. States have similar rules. These evidentiary requirements apply to all experts including those who work full time for a government agency.

Use of expert witness testimony is a path through which a party can present their theory of the case to the trier of fact. Expert witness testimony is the most persuasive of all witnesses[1]. This presentation will briefly review general types of ethical violations through expert witnesses in the second federal habeas corpus case of *Robie J. Drake v. L.A. Portuondo*, 553 F.3d 230 (2nd Cir. 2009)(Drake II).

Drake II addresses brazen prosecutorial misconduct, medical quackery – "picquerism, fraudulent use of a charlatan expert witness, perjured testimony, and distortion of facts to obtain two murder convictions. The principal parties are Peter L. Broderick, Sr. (Prosecutor) and Richard D. Walter (expert witness).

Broderick failed to exercise due diligence in investigating Walter's credentials and testimony. He used false evidence, employed misleading questions, while essentially vouching for the credibility and truthfulness of his expert witness, and wrongfully bolstered Walter's testimony especially in summation arguments. The trial was carefully orchestrated.

Walter grossly exaggerated most of his qualifications and outright lied about others. He created blatantly bogus and prejudicial testimony on "picquerism" to provide motive. "Picquerism, is a fictional syndrome of sexual dysfunction or criminal profile whereby the perpetrator realizes sexual satisfaction from penetrating a victim by sniper activity or by stab or bite wounds ... it is a derivative misspelling of the French verb piquer, which means, among other things, to stick or poke ... and is medically speaking, nonsense ... quackery"[2].

The jury relied upon Walter's sensationalistic and pseudo-scientific explanations of picquerism to convict Drake of the double murders. Drake received two consecutive prison terms of 25 years to life.

The impartiality of forensic science is used to convict the guilty and protect or exonerate the innocent. An expert witness' testimony is frequently prejudiced by ideological and personal biases. Expert witness fraud and ethical violations are not isolated random incidents. This is true of prosecution and defense witnesses in state and federal litigation. The vase majority of witnesses testify truthfully. However the appearance of "mountebanks" is too numerous to suggest that it is a remote occurrence. Personal opinions too often corrupt an expert witness's testimony.

The predominant categories of unethical conduct are negligence and deliberate dishonesty. The most common types of expert misconduct regarding unethical testimony usually involve subtle but deliberate deviations from the truth, or parts of it. There are no degrees of honesty. The ethical conduct of witnesses, especially experts, is a serious issue confronting the judicial system. The most dangerous lies are those that most resemble the truth. Unfortunately, violators of ethical conduct are seldom held accountable for their detestable conduct.

Unethical and illegal behavior is practiced by individuals who possess indicia of expertise (licenses, academic degrees, certifications in their specialty, professional memberships, etc.) and by those who fabricate or purchase their credentials. Fraud is not self-correcting. Unfortunately, violators of ethical conduct are seldom held accountable for their detestable conduct.

Walter was never disciplined or prosecuted for perjury in the *Drake* case. However, based upon the January 23, 2009 opinion by the Second Circuit Court of Appeals, Richard D. Walter will have difficulty refuting the Court's moniker of charlatan.[3]

The events in the Drake case are a sordid and reprehensible affair.

1 Justice Blackmun, Daubert v. Merrell Dow Pharmaceuticals Inc., 509 U.S. 579, 595 (1993)

2 Drake v. Portuondo, 553 F.3d 230, 235 (2nd Dist. 2009)

3 Drake v. Portuondo, 553 F.3d 230, 245 (2nd Dist. 2009)

Forensic Fraud, Expert Witness, Charlatan

F1 Orthodontic Surgery and Professional Liability: The Homozygote Twin Case

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After attending this presentation, attendees will learn the importance of psychological support when a patient is undergoing maxillo facial surgical intervention to reposition one or both jaws. This allows to evaluate the expected/desired versus predictable/obtainable results.

This presentation will impact the forensic science community highlighting how somatic features modifications are involved a patient with unrealistic expectations should be discouraged from surgery.

Patients with dental and skeletal malocclusion may need not only several fixed orthodontic appliances but, under certain conditions, also one or more maxillo facial surgical interventions to reposition one or both jaws. This is the case when facial discrepancies are beyond the corrective range of a traditional orthodontic appliance and therapeutic results later may be considered a compromise. Nevertheless orthognatic surgery of jaws requires a full evaluation of expected/desired versus predictable/obtainable results. For this reason, in some cases, a compromise reached without surgery may be more appropriate.

Orthognatic surgery cases need a correct diagnosis and planning through frontal and lateral X-ray images of the patient along with cephalometric assessment and a jaw model study. As facial somatic features would be modified by the treatment, it is essential to provide psychological support to these patients before and after surgery, even when an aesthetic improvement is expected and/or effectively obtained. In some cases patients may have unrealistic expectations and should be discouraged from surgery.

A professional liability lawsuit of an orthodontic case, where the patient underwent several maxillofacial surgical interventions, is presented. The patient, unhappy with the results obtained consulted other orthodontists in order to achieve a more satisfactory outcome. The subsequent treatment resulted in increased temporomandibular discomfort and the patient requested a medico legal evaluation wishing to sue the dental and maxillofacial surgeons. An odontologist assisted by an orthodontist completed an expert witness report. Following the assessment it was determined that there were no indications for such interventions on the jaws, along with other examples of professional negligence: no psychological assessment or indications as to the aesthetic results post surgery were given. Unfortunately, the patient killed himself four years after the last surgery and the medico legal assessment was completed through the orthodontic study of his homozygote twin brother. This presented the same type of malocclusion but had never applied any orthodontic device, signifying the brother had he had not received any “corrective” jaw treatment.

Professional Liability, Orthodontics, Maxillo Facial Surgery

F2 Ethics in Forensic Dentistry

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After attending this presentation, attendees will understand some of the rules and principles of general and medical ethics. Attendees will be able to apply this knowledge to cases in forensic dentistry.

This presentation will impact the forensic science community by enhancing awareness of ethical issues in actual cases and offering techniques to resolve ethical conflicts.

Ethics is the process of determining right and wrong conduct. Three common approaches to decision making in bioethics are: (1) Principalism, (2) Moral Rules, and (3) Casuistry. Not only can a disciplined ethics analysis help to distinguish right action from wrong action in difficult cases, but it also provides a basis to understand *why* one action is morally preferable to another.

Ethical issues usually arise when one’s own interests come into conflict with the interests of others. In forensic dentistry there are instances where ethics and law may conflict. One has a prima facie ethical obligation to obey the law, but arguably a greater obligation to do the morally correct thing. A legal resolution is not necessarily ethically justified, nor is an ethical resolution necessarily legally permissible. Ethics considers obeying the law a prima facie obligation, while law attempts to achieve ethical harmony.

Forensic dentistry includes but is not limited to bite mark analysis, dental autopsy, expert witness, and mass disaster disciplines. When testifying as an expert witness one should not be concerned about the legal or social outcome of a trial, but rather only about providing truthful, informative testimony. In bite mark analysis as well as in the other areas of forensic dentistry, the dentist must strive to be impartial. In order to eliminate bias, many professionals believe that a dentist should either collect or interpret the evidence but not do both on the same case. Others claim that a competent forensic dentist would not have a conflict of interest in performing both tasks.

Ethical analysis should be initiated when ethical principles or rules are in conflict. Cultural beliefs and customs must be taken into consideration in making ethical choices, but this does not mean that because a particular culture accepts a particular action, it is morally correct.

Each expert should have the knowledge to analyze his or her case and arrive at a justifiable outcome. This presentation will illustrate several methods of ethical analysis and describe how to apply them to specific cases.

Three cases will be presented and each analyzed and analyze each in the methods described. By the end of the presentation, each attendee should have the tools necessary to conduct an appropriate ethical evaluation of any case that requires it.

Ethics, Forensic Odontology, Dental Case Studies

F3 Glitches, Faux Pas, and Gaffs: A Case Evaluation

Kenneth F. Cohrn, DDS, 422 Teague Trail, Lady Lake, FL 32159; and Jan Westberry, DMD*, 2234 State Road 44, New Smyrna Beach, FL 32168*

After attending this presentation, attendees will have a better understanding of how to avoid errors in case presentation, testimony, and report writing.

This presentation will impact the forensic science community by fostering increased credibility both within the forensic community and the legal system.

The paths of traditional science, forensic science, and the law are on a convergence path for change. The comparative sciences of fingerprints, handwriting, fibers, tool marks, tidemarks, and bite marks are being looked at as being "plausible, under researched, and oversold". The science of definitive individual uniqueness is being challenged in the courts and within the individual forensic subspecialties as well. Questions remain - Is traditional science methodology the appropriate standard for measurement of forensic science? Is the gold standard of DNA type of analysis appropriate for all forensic analysis? Are forensic scientists overselling their science?

The recent National Academy of Sciences Report commented on the shortcomings of various forensic science disciplines. The report has valid issues and recommendations. However, special interest groups will use the report to discredit various of forensic science disciplines as "junk science." Forensic odontology, in particular bite mark analysis, has been repudiated recently with DNA exonerations of incarcerated individuals as a result of faulty bite mark testimony. Charges of tampering with evidence, unscientific procedures, false reports, even outright lying taint the integrity of the cases. Is the problem with the science, the scientist, or both? As forensic scientists, there is a need to be acutely aware of the pitfalls and ramifications of our actions and opinions.

Forensic dental cases will be presented that demonstrate problems that can occur with report writing, court presentation, and examination procedures. Reviewing cases that presented challenges allows us to anticipate and avoid problems. Using appropriate systematic, consistent protocols is essential and attainable for a problem free case. Examination of mistakes, misinterpretations, and oversights prepares us for future cases. Among the cases presented will be misidentification, photographic errors, mistakes in the Medical Examiner office, errors in judgment, falsification of evidence, and more. Mistakes can be accidental and then there are those made by arrogance and enhanced self-importance.

The objective of this presentation is to learn how to avoid problems in identification and bite mark cases by reviewing errors in existing cases.

Forensic Odontology, Forensic Errors, Bite Mark Errors

F4 Dental Age Estimation in a Puerto Rican Population Using Demirjian's Method for Age Assessment

Xiomara Rivera, DMD, Urb. University Gardens, 251 Fordham, San Juan, PR 00927*

After attending this presentation, attendees will have seen results and heard the explanation of research for dental age estimation on a Puerto Rican population aged 12 to 20 years.

This presentation will impact the forensic science community by adding data concerning age estimation in a racially varied population where this topic has not been researched before.

Age estimation is an important part in forensic science. It aids in the identification process if unknown remains are found by narrowing search parameters for possible victims, aids in providing age estimate information relating to illegal immigrants that come into the country without the proper identification documents, and helping the legal system determine if a person in question is considered a minor or not. It is also helpful in identifying the victims of mass fatality incidents that can occur anywhere in the world.

The island of Puerto Rico is located in the Caribbean and is a commonwealth of the United States of America. Puerto Ricans are a mixture of three different races: Spanish settlers, African slaves, and Taino Indians (the original inhabitants of the island), resulting in a vast variety of physical and anthropological characteristics. This mixture has yielded what Puerto Ricans usually identify as three different races: white, black, and "mulato" (the offspring of a white and black or Taino couple).

To date, few studies concerning age estimation in Hispanics have been completed in the United States.[1,2,3] "Hispanic" is a term that defines "a person of Mexican, Puerto Rican, Cuban, Central, South American or other Spanish culture or origin, regardless of race" (Directive 15: Race and Ethnic Standards for Federal Statistics and Administrative Reporting; May, 1977). As noted, the terms "Hispanic" or "Latino" do not refer to a race, and therefore, more population-specific studies are needed.

Regarding race, comparison studies have been done using Demirjian's age estimation method on different populations, and has been generally accepted among the scientific community. Some investigators have shown that this method is applicable to their population due to its high accuracy. Others have reported confirmed age overestimates or that the method has not been applicable.

For this study, panoramic radiographs from subjects aged 12 to 20 years old, all patients of the Pediatric Dentistry and Orthodontics Departments from the School of Dental Medicine in Puerto Rico were examined. This population consists mainly of subjects living in cities close to and in the island's capital, San Juan. The radiographic sample consists of approximately equal number of radiographs separated into male and female groups, and further divided into same age groups. Dental age from each subject was calculated by scoring teeth on the left mandibular quadrant according to Demirjian's stages. If any subject was missing a target tooth (except the third molars), the corresponding tooth on the right side was scored.

The age estimated from scoring the radiographs will be compared with the chronologic age of the subjects at the time the panoramic film was taken. This study investigates whether Demirjian's method provides accurate results that can be used for age estimation in the Puerto Rican population or if population-specific standards may be needed.

References:

1 Solari A, Abramovitch K, "The accuracy and precision of third molar development as an indicator of chronological age in Hispanics". *J Forensic Sci* vol. 47, no.3. (2002):531-535.

2 Kasper, K, et al, "Reliability of third molar development for age estimation in a Texas Hispanic population: a comparison study". *J Forensic Sci* vol. 54, no.3. (2009):651-656.

3 Demirjian A, and Goldstein H, "New systems for dental maturity based on seven and four teeth". *Annals of Human Biology* vol. 3, no. 5 (1976):411-421.

Age Estimation, Forensic Odontology, Puerto Rican Population

F5 Sub-Adult Age Estimation From Three-Dimensional Imaging of the Cervical Spine

Ann Monasky, DMD, University of Texas - Health Sciences Center, 7703 Floyd Curl Drive, Mail Code 7919, San Antonio, TX 78229*

After attending this presentation, attendees will have heard and seen results of investigations into the use of Cone Beam Volumetric Tomography (CBVT) of the cervical spine for age estimation in sub-adults.

This presentation will impact the forensic sciences community by offering a potentially more accurate method of age estimation for this age group. The purpose of this study is to investigate the use of CBVT for assessment of cervical vertebrae development as a viable method for age estimation.

The use of cone beam volumetric tomography has increased significantly since it was first introduced in the United States in 2001. Many orthodontic practices use this modality for comprehensive scans of the head and neck that include the cervical spine. Cephalometric images familiar to orthodontists can be created from the original scans. Orthodontists and others have used multiple methods to estimate developmental age including two dimensional cephalometric radiography of the cervical spine, analysis of hand-wrist development, and analysis of 3rd molar development.

A recent unpublished study at the University of Texas Health Science Center, San Antonio demonstrated that age estimation using analysis of third molar development with CBVT is more accurate than two-dimensional panoramic radiography.

A retrospective study of cases originally sent for routine assessment and reports of pathology was done. The cases selected were based on the type of CBVT machine used, an i-CAT manufactured by Image Sciences International. This was done in order to limit any possible variations in the scans created due to differences in acquisition techniques and reconstruction algorithms between the different cone beam machines. Cases selected were also limited to those taken using the large field of view (FOV), either a 16 cm (diameter) x 13 cm (height) or 16cm x 22cm. The main criterion, regarding size of FOV, was that the structures analyzed were easily readable within the scan. This was dictated by the variability in physical size of the patients who were scanned. Analysis of the vertebral structures was done using a single, third party software, InVivo Dental from Anatomage that was capable of both measurements and three dimensional renderings. The principle investigator was blinded as to the ages of the patients until after age estimation was completed. As in the two-dimensional radiographic technique, the cervical vertebrae assessed were C2, C3, and C4. The maturation and structural changes of these vertebrae were assessed and the age estimation made using standards originally established for the assessment of two dimensional cephalometric radiographs. This includes examination of the degree of concavity of the lower border of the vertebrae, the vertebral body height and width and the overall shape of the vertebral body (Roman, Palma, Oteo and Nevado, 2002). The estimated ages were then compared to the known chronological ages of the subjects. Statistical analysis of the results will be reported.

The use of three-dimensional imaging using CBVT of the cervical spine is an accurate and reliable method for estimating the developmental and chronological ages of sub-adults.

Age Estimation, Three Dimensional Imaging, CBVT

F6 Using Dental Cementum Increments to Determine Season at Death

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After attending this presentation, attendees will understand how dental cementum increments can refine estimates of postmortem interval.

This presentation will impact the forensic science community by exploring how the development of new scientific methods is crucial to the further advancement of forensic science. In this presentation, a method of determining season at death in human skeletal remains is described. Once a validation study of this new method is completed, odontologists and anthropologists will be able to provide more information to aid in the identification of unknown remains.

Forensic anthropologists are often called upon to estimate time since death when analyzing decomposing and skeletonized human remains. Estimates are based on the overall condition of the remains, the presence of insect activity, and the decomposition microenvironment. Postmortem interval estimates are usually expressed as broad ranges of months or years, especially when forensic anthropologists are not present at the time of recovery. Dental cementum increment analysis has the potential to help us be much more specific in our determinations. Dental cementum anchors teeth into their sockets via the periodontal ligament. The main components of cementum are collagen bundles that become mineralized by hydroxyapatite crystals. Cementum is first laid down immediately before the tooth erupts and additional layers are added throughout life. During cementum formation, hypermineralized layers of extracellular matrix alternate with less mineralized layers, creating alternating dark and light bands, analogous to tree rings.

Research with comparative samples of known-age and known date-of-death individuals has demonstrated a consistent relationship between annual seasons and the formation of distinct increment types. The winter or arrested cementum increment appears under polarized light as an opaque band while the summer or growth increment appears as a translucent band. Together these bands represent one year of an individual's life. The total number of pairs of opaque and translucent increments provides a means of determining the individual's age at death within two and one half year ranges of error. To derive age at death, the number of pairs of bands is added to the age at which the tooth is known to erupt.

Zoo archaeologists have long used dental cementum increment analysis to estimate season at death in other mammals, yet the method has been little tested in humans. In this recently completed pilot study, the method of dental cementum increment analysis is extended to humans for the first time. Extracted teeth were donated by dental patients, and date of extraction was used as a proxy for date of death. The participating dentist also recorded the patient's date of birth. Teeth were assigned random sample numbers and were then cleaned and embedded. Thin sections were cut using a low speed saw, the wafers were mounted on petrographic slides, and ground to a thickness of approximately 100 microns. After being polished, the sections were viewed under transmitted polarized light, and the outer cementum increment was identified.

The pilot study revealed that the translucent and opaque bands did correlate with dates of extraction. Translucent bands were significantly correlated ($p<0.001$) with dates of extraction between April and October. Opaque bands were significantly correlated ($p<0.001$) with dates of extraction between October and April. Teeth were effectively sorted by season 99% of the time. Further, both translucent and opaque bands increased in thickness incrementally from the beginning to the end of the respective season ($p<0.001$). This indicates the possibility that with a large enough sample, the seasons might be refined even further from two six-month periods to four three month periods. The results of the pilot

study will be discussed here, and the application of the technique to several forensic cases will be described.

Postmortem Interval, Dental Cementum, Odontology

F7 Age Estimations on Third Molar Development: A Comparison of Nine Samples From Populations With Different Nationality

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After attending this presentation, attendees will become aware of how dental age estimation methods used to discriminate the age of majority of unaccompanied asylum seekers preferably are based on a reference sample including subjects from equal origin as the examined individual.

This presentation will impact the forensic science community by providing reference samples for age estimations on third molar development containing subjects with equal skin color and nationality. Moreover, the analysis of the separate country outcomes will offer forensic investigators legally unquestionable tools when performing age estimations on asylum seekers from equal geographic origin.

Worldwide unaccompanied asylum seekers enter countries claiming to be minor and accordingly request corresponding legal facilities. The authorities of the country they arrive have to discriminate on ethical, legal, and scientific base whether the questioned person passed the chronological age of majority to be able to judge them correctly. Only age estimation methods based on samples obtained from geographically equally localized populations as the investigated individual can offer total legal and scientific proof. The most frequently used dental age estimation method for estimating the age of majority is based on the radiologically obtained third molar developmental stage. The aim of this study is to collect referral third molar developmental scoring data bases of samples containing subjects of equal nationality and skin color. Secondly the obtained data will be analyzed and compared to detect possible specific geographic related information.

From nine different countries (e.g., Belgium, China, Japan, North-India, Poland, Saoudi-Arabia, South–Korea, Thailand, and Turkey) samples were collected. The same selection criteria as published in detail related to the Belgium and Thai dataset were used. The obtained results were statistically described, analyzed, and the country specific outcomes mutually compared.

A main forensic research topic is to know if, for instance, a Belgium reference population can be used to assess age of non-Belgium subjects and what the clinical consequences are. Therefore, a Belgium control data set was developed to verify the performance of the use of Belgium (data) as reference compared with the use of the country specific reference (data). This Belgium control data set was established following the same protocol as for the development of the country specific test data bases.

This worldwide collection of orthopantomograms can continuously extend and provide the forensic odontological community with a legally reliable reference data base when discriminating the age of majority of unaccompanied asylum seekers with known nationality.

Dental Age Estimation, Unaccompanied Asylum Seekers, Geographical Comparison

F8 Radiological Length Ratio of Human Third and its Preceding Second Molar as Age Predictor

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After attending this presentation, attendees will be able to perform dental age estimations on third molar development applying a new developed methodology.

This presentation will impact the forensic science community by demonstrating a semi-automatic dental age estimation method with high reliability.

Dental age estimation methods based on tooth development collect information about tooth eruption, the transition between deciduous and permanent dentition, and tooth germ calcification. The developmental stage of the radiologically detected tooth germ is registered by scoring, measurements or comparison with common tables or reference atlases. The aim of this study was to develop a dental age estimation method based on the calculation of the ratio between the developing third molar length and the length of the preceding second molar.

From the datasets available at the dental clinics of the Katholieke Universiteit Leuven, 170 orthopantomograms of each gender were selected. The subjects were of Caucasian origin, their chronological age at the moment of radiological exposure was between 7 and 24 years and uniformly spread within the collected sample. The x-rays were imported in Adobe Photoshop® for standardized length measurements of the lower right third molar and its preceding second molar. For evaluation of inter- and intra observer reliability the variables of 17 randomly chosen female and male subjects were measured again after one month by the main and a second observer. Descriptive and inductive statistics were performed to detect the relation between ratios of the measured variables and the suspects chronological age. The developed dental age estimation methodology prescribes different protocols whether the second molar was completely developed or not. Furthermore a probability of the age of complete development and the related prediction interval for the second molar is given. The high precision of the variable measurements and corresponding high repeatability and reproducibility was proven by the very good inter and intra observer reliability scores. Specific gender related characteristics concerning this age estimation method were reported. The new methodology and its obtained results are discussed in full extent. Based on variables measureable with high precision, perfect reliable tools for age estimation of unaccompanied asylum seekers are made accessible.

Dental Age Estimation, Tooth Length Ratio, Orthopantomogram

F9 Radiographic Disappearance of the Root Pulp in Wisdom Teeth: A New Method to Determine Whether Young Asylum Seekers are Below 18 Years of Age

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After attending this presentation, attendees will acquire knowledge of the radiographic disappearance of the root pulp canal and the reason for the occurence. The potential application of this finding in age estimation of young asylum seekers will be revealed.

The presentation will impact the forensic science community by enabling forensic odontologist to prove with certainty that asylum seekers who pretend to be below 18 years are in fact above that age and also in most cases above 21 years of age.

From a group of 1,198 OPGs from 629 females and 569 males from 15 to 40 years of age, the visibility of the root pulp of third molars with completed root formation was scored according to stages 0, 1, 2, and 3. The SPSS program was used for statistical analysis and median, minimum and maximum, upper, and lower quartiles were computed for each of the wisdom teeth and for each gender.

The findings showed that for stage 0, minimum age was about 17 years for all teeth and gender. Median age was from 21 to 24 years. For stage 1, min age was above 21 years except for maxillary wisdom teeth in males. Median age was from 23 to 28 years. For stage 2 min age was above 22 years except for 18 for females where it was 21.9 years. Median age was above 30 years except for maxillary wisdom teeth for men where it was 29 years. For stage 3 min age was for females 24 to 25 years and for males 25 years, except for maxillary teeth where it was 21 years. Median age was 32 to 34 for males and 34 to 36 for females.

This phenomenon has not been described before and no research of the age distribution has been available.

This investigation shows disappearance of the pulp canal as it is seen in radiographs. This does not mean that the pulp is completely obliterated. It is proposed that it has become so narrow that compared to the rest of the hard tissue in the tooth and the surrounding bone it means so little that it is not longer visible on radiographs.

These findings indicate that for stage 0 with complete formed roots but visible canal to the apex an age below 18 years cannot be excluded. However, when the canal starts to disappear in one of the roots the person must be above 18 years and most surely above 21 years. For stage 2 and 3, the age can safely be stated to be above 21 years of age. The latter age limit is important in Germany as criminal law prescribe more lenient punishment if the person is below 21 years.

This method may be a powerful tool for the forensic odontologist in age estimation of young asylum seekers who pretend to be below 18 years of age as we now may make a more safe exclusion than before. Ethnical differences in the mineralization of the pulp canal have not been investigated, but it is reason to believe that such differences eventually may be of minor importance.

Age Estimation, Wisdom Teeth, Pulp Canal

F10 Color of Dentine as an Age Indicator for Hispanic Populations in Southwest Texas

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After attending this presentation, attendees will become familiar with a new technique utilizing portable color measurement scanner technology to quantify color of dental tissues; the use of the color measurement scanner to determine if dentine shade measurably changes with age in individuals of Hispanic ancestry, and future applications of this technique utilizing other dental and skeletal tissues (i.e., enamel and cementum) for age estimation in forensic anthropological and odontological settings.

This presentation will impact the forensic science community by evaluating a non-subjective method for measuring tooth tissue color, in an effort to identify trends in shading that may provide an estimation of age-at-death in individuals of Hispanic ancestry. The focus on Hispanics is significant due to the fact that they are the largest minority population in the United States. Additionally, age estimation techniques for Hispanic populations in Southwest Texas is of particular importance to forensic anthropology practitioners in the United States, especially those tasked with providing positive identifications of deceased individuals from border crossing locales.

Although this is not the first study where dentine has been used as an age estimation indicator, it may be the first time that this specific technological appliance has been applied towards assessing and quantifying its shade. Previous research examining dental tissue color includes studies by Martin-da la Heras and colleagues (2003), who analyzed the color of dentine using spectroradiometry and concluded that their technique is a potentially useful and objective method to estimate age in adults. Similarly, tooth root color has been digitally recorded by Laskarin and colleagues (2006), with their resulting data showing that there is a correlation between the obtained RGB (red, green, blue) color values and age. For this project, dentine shade was evaluated in a known, documented sample of molars from 72 modern Hispanic adult individuals from San Antonio, Texas in an effort to determine if dentine coloration differences existed, and whether these differences could be used as an age estimation indicator. Using Hunter Lab's Mini Scan XE Plus© color measurement scanner, a yellowness index was formulated from the shades obtained by the scanner and an average of the yellowness index was calculated for each of the age decades represented by individuals in the study. The results yielded no evident positive correlation between the shade of dentine and the age of the individual. The findings of this pilot study do not support the hypothesis that dentine shade quantifiably changes with age, but there are potentially confounding factors that may require further investigation. First and foremost, the majority of molars in the sample were third molars. Due to the fact that these molars display the greatest variability in size, shape, and eruption rates even within single individuals, their reliability may not be as accurate as other tooth types. The second factor may be that this is not an ideal randomized dental sample, due to the limitations imposed by the requirements of the color scanner. Lastly, a larger sample size would have provided for a wider picture and clearer trends to be observed. A detailed description of the technique will be presented, a review of the color measurement instrumentation, and future directions and suggestions will be provided for utilizing this technique to additionally evaluate the color of enamel and cementum as possible age estimation markers.

Dentine, Age Estimation, Hispanic Populations

F11 Clinical Age Estimation in the Case of a Child With Seckel Syndrome

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The goal of this presentation is to present a case that was a challenge for Colombian forensic scientists because the chronological age of the child was undetermined as a result of low weight and height development, low psychomotor development, mental retardation, and unknown medical and family history. Additionally, the child's physical characteristics were consistent with Seckel Syndrome.

This presentation will impact the forensic science community by discussing how age was estimated on an abandoned child with physical characteristics consistent with Seckel Syndrome.

The child was referred to the Forensic Clinic of the Basic Children Unit of the National Institute of Legal Medicine by the Colombian Child Protection Institute (ICBF) for purposes of "Age estimation and determination of physical condition," pursuant to law 938 of 2004. The Institute of Legal Medicine provides technical and scientific support to the legal system in areas that include age estimation of abandoned children, which is a common problem in Colombia.

As part of the medical history, the social workers who accompanied the child during the forensic process explained that the mother had abandoned the child at the baby sitter's house. Consequently, her origin, her parents' names, her name, her family and medical history, and her chronological age were unknown. The forensic assessment conducted by a medical examiner and a forensic odontologist showed clinical characteristics consistent with Seckel Syndrome or "Bird Head" syndrome. The most relevant features of this syndrome are microcephalia, large, elongated, protuberant eyes with strabismus, marked telecanthus, and short palpebral fissures. The face was asymmetric and elongated, with small mandible and notably retracted forehead and chin, as compared to the rest of the face. Other characteristics included long, curved, and very prominent beak-like nose, short and curved fifth finger on both hands, eleven ribs, hip luxation and dysplasia, significant mental and psychomotor retardation, and indications of the stature and weight of a 2-year-old child. All of the above are described in the literature as typical signs of Seckel Syndrome.

A notable retardation of weight and height development was observed, which corresponded to a 2-year-old child. Bone age was consistent with a 3-year-old child (the pediatric radiologist used the Greulich & Pyle method). Dental age, according to the method of Moorrees et al (1963), was 8.75 years. The method of Demirjian et al (1991) indicated 9.3 years of age. Significant discrepancies were found between staturo-ponderal age, bone age, and dental age.

Many authors have described tooth root formation and dental calcification evolution (periapical X rays) as more reliable methods to obtain an approximation of the clinical age up to 21 years of age, in average. This is due to the fact that eruption and dental calcification are less affected by social, environmental, nutritional, genetic, and endocrine factors.

A thorough medical and dental analysis was conducted. Weight, height, bone, and teeth development were examined. The physical condition of the child resulting from the Seckel Syndrome and the influence of this pathology on stature, weight and bone maturation were taken into account. All of the above, combined with the opinion of pediatric radiology experts, contributed to establish an approximate clinical age of 8.5 years. This was the result of an interesting interdisciplinary approach.

Seckel Syndrome, Clinical Age, Abandoned Child

F12 Intentional Biological Terrorism: Will Dental Students Assist Medical and Mortuary Personnel in the Event of a Mass Disaster?

Pamela Jurgens-Toepke, DDS, 801 South Paulina, Room 221, Chicago, IL 60612*

After attending this presentation, attendees will know if dental students would be willing to assist medical and mortuary personnel in the event of intentional biological terrorism.

This presentation will impact the forensic science community by encouraging governmental agencies to work with dental schools and other health science schools to provide sufficient mass disaster training for students and faculty.

International Public Health planners have concerns that thousands to millions of people will become affected in the event of a mass disaster caused by the intentional release of a biological agent into the community. Should a situation arise, where thousands of people are infected by a biological agent such as small pox, anthrax, or the plague, the public health planning community recognizes that local hospitals will be overwhelmed and staged immunization sites will be needed to provide pharmaceutical distribution and pharmaceutical delivery care to patients. If other responders beyond hospital personnel are available to care for the infected, the morbidity and mortality rate of all involved can be significantly reduced due to timely distribution and delivery of anti-infective pharmaceuticals. The Illinois Department of Public Health (IDPH) and the public health planning and disaster response community in Illinois, recognizes that the University of Illinois at Chicago (UIC) College of Dentistry (COD) provides National Disaster Life Support (NDLS) training through the Disaster Emergency Medicine Readiness Training Center for all dental students and faculty. The UIC COD is located several miles west of downtown Chicago. First year students are certified in Core Disaster Life Support (CDLS). Senior students are certified in Basic Disaster Life Support (BDLS). Illinois recognizes certified Dental Emergency Responders as qualified assistants during a mass disaster. The COD can provide additional clinical care for provider support, to the IDPH during an intentional biological terrorism event. Thus, reducing the risk for community, state, national, and global pandemics.

An IRB approved survey was given to UIC dental students during an introduction to forensic odontology lecture. At the beginning of the lecture pictures were shown of patients suffering from anthrax, plague, and small pox. The students were given a survey asking them if they would be willing to assist medical and/or mortuary personnel in the event of biological terrorism event. The following were used as qualifiers: gender, year in school, religion, marital status and children. It was hypothesized that married students, with and without children, would be less likely to assist medical and mortuary personnel during a mass disaster involving biological warfare. Also, with advanced training, more dental students would be willing to assist.

One hundred fifty-two students answered the survey. Second, third, fourth year, and international dental students (first and second year) responded to the survey. There was no difference between male and female dental students response. Approximately 85% of all students said they would be willing to help during a mass disaster of this magnitude. All classes were equally willing to help. The international second year students indicated more of a willingness to assist than the international first year students. Students who marked that religion played a role in their decision to help were more likely to say they would assist. No religious group was more willing to help than another. Single and married students were equally willing to assist. Single students said that marital status and children played a role in the decision to help. Married students did not feel that their marital status or children affected the decision to assist. Willingness to help correlated with interest in advanced training ($r = 0.42$, $p < .001$), and avoidance correlated negatively with interest in advanced training ($r = -0.19$, $p < .02$).

Overall, neither gender, year in school, religion, marital status, or children played a significant role regarding dental students' willingness to assist medical or mortuary personnel with a mass disaster of this magnitude. If advanced training was available, 90% of the dental students surveyed indicated a willingness to assist medical and mortuary personnel. Dental students and society could benefit if advanced training was provided to dental students interested in assisting medical and mortuary personnel after an intentional biological terrorist attack. Training should be considered for students in all health care fields.

Biological Terrorism, Dental Students, Mass Disaster

F13 An Investigation of the Uniqueness of the Human Dentition

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After attending this presentation, attendees will be familiar with the value of establishing a database of human dentitions to aid in bite mark analysis and population comparisons. The goal of this pilot study is to use an innovative digital analysis technique to measure key characteristics of the anterior dentitions of selected pre- and post-orthodontic treatment cases. This is designed to validate an approach that may be used to add to an existing relational database of 400 individuals.

This presentation will impact the forensic science community by providing scientific evidence on the question of the uniqueness of the human anterior dentition. This will aid the forensic sciences by providing an objective method to investigate whether two or more individuals have the same anterior dental profile.

One of the key problem areas identified by the 2009 National Academy of Sciences Report *Strengthening Forensic Science in the United States: A Path Forward* is that the uniqueness of the human dentition in relation to bite mark cases has not been scientifically established. To date there have been no comprehensive studies reported that have been conducted on large populations or suitably qualified samples of populations to establish the uniqueness of the human dentition. Additionally, there is no central repository of patterns of human dentitions that can allow the comparison of a suspected biter's dentition with a reference population or sample that can indicate what percentage of the population or subgroup of the population could also have produced a bite or patterned injury. There are two postulates that underlie all bite mark analyses. The first is that the anterior teeth characteristics of a biter are unique. The second is that this uniqueness is accurately recorded in the material bitten. Several statistical and geometric studies have been reported that have each supported the concept of uniqueness of the anterior dentition that are most commonly registered in bite marks. Recent reviews have offered scholarly critiques of the historical studies and have largely concluded that much more work needs to be done to not only establish the uniqueness of the human dentition, but also to address the question of the uniqueness of bite marks. The National Academy of Sciences publication has also pointed out that the circumstances within which the techniques used in forensic odontology can provide probative value warrant research to establish valid evidence to support or nullify assumptions that forensic odontologists have used in bite mark analysis. It has also been noted that following orthodontic treatment the anterior dental pattern becomes more homologous, creating greater difficulty in bite mark perpetrator identification.

The Triservice Orthodontic Residency Program (TORP) at Lackland AFB, TX, has digitized patient records for many years using a non-proprietary file format (STL). In this study a convenience sample of the 50 pre- and post-treatment records are used for analysis using an automated measurement and recording system. All patient identifiers are masked to protect the identity of each patient. The demographic information recorded for each case is age and sex at the time the record was taken. The factors for inclusion in this study are that the records must be of patients 18 years old or older, all 12 anterior teeth must be present (upper and lower incisors and cuspids), and the sex must be male.

The images of the dental models are opened in a three dimensional viewing program. The models are oriented using a Z plane that parallels the occlusal plane, positioned for optimal viewing, and a two dimensional screen capture is recorded for analysis. The following measurements will be made on each case:

1. The mesio-distal width of each of the maxillary and mandibular incisor teeth
2. The width of each arch from the center point of one canine to the opposite canine
3. The degree of rotation of each of the maxillary and mandibular incisor teeth

The data represented by these measurements is recorded in a relational database. This will give an accurate method of recording the mesial-distal dimension and degree of rotation of each of the maxillary and mandibular incisors, as well as the arch width. This database of descriptive data of each dentition will allow analysis of each case individually and comparative analysis within this sample. The results of this study will contribute to building a database of characteristics of the human anterior dentition and will document changes due to orthodontic treatment. The data from this sample will also help validate methodologies and data already collected.

Unique Dentition, Human Bite Mark, Orthodontic Changes

F14 Use of Common Orthodontic Measurements to Investigate the Uniqueness of the Human Dentition and Biting Complex

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After attending this presentation, attendees will see results of applying existing objective tools utilized within the specialty of orthodontics to forensic odontology to investigate the uniqueness of an individual's dentition and biting complex.

This presentation will impact the forensic science community by furthering the body of evidence needed to investigate the uniqueness of the human dentition and biting complex.

The American Board of Orthodontics (ABO) has adopted a measurement, called the Discrepancy Index, to evaluate the severity of malocclusions in cases that are submitted by candidates for board certification. The discrepancy index consists of objective categories that are scored individually. In this manner malocclusions can be categorized by severity. The following dental categories are included in this model and used for this study: overjet, overbite, anterior open bite, lateral open bite, maxillary crowding, mandibular crowding, molar relationship, lingual posterior crossbite, and buccal posterior crossbite. The following cephalometric measurements are included and utilized in this study: ANB, SN-MP, and lower incisor to mandibular plane. Finally, the following distinctive traits are scored: supernumerary teeth, ankylosis of permanent teeth, anomalous morphology, impaction, midline discrepancy, missing teeth, missing teeth-congenital, spacing, midline diastema, tooth transposition, and skeletal asymmetry.

In addition to the ABO's Discrepancy Index tool, for many years the specialty has utilized Bolton's tooth size discrepancy values to evaluate difficulty of cases. Bolton's tooth size discrepancy takes into account the summary of the mesial-distal width of the maxillary dentition from first molar to first molar and compares this to the mandibular summary. An ideal ratio has been established. An anterior ratio comparing canine to canine and a posterior ratio was utilized in this study. The last measurements used in this study were intercanine width

and intermolar width for both arches. These twenty nine variables were analyzed individually to determine a distribution within the population as well as for their dependence/independence on other variables.

This study consisted of over one hundred pretreatment records from a private orthodontic practice in which digital radiography and Orthocad digital models were utilized. All dental measurements were made using the Orthocad software and specifically the Discrepancy Index module developed for the American Board of Orthodontics.

To determine the probability of uniqueness of the dentitions of the subjects in this study, a series of analyses were performed. First a sample distribution probability density function (pdf) from the sample data for each of the twenty nine variables was determined. Secondly, for each individual, an overall uniqueness index was created and the probability of this individual having this index was determined.

The results of this study indicate that the individuals in this study demonstrates a unique combination of variables. The "Bite Index" for each individual in the study was unique.

Forensic Odontology, Uniqueness, Bite/Bite Marks

F15 The Effect of Dental Model Placement on Image Distortion During Scanning for Overlay Production in Digital Bite Mark Analysis

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After attending this presentation, attendees will have learned an appropriate method for cast placement on flatbed scanners to minimize distortion.

This presentation will impact the forensic sciences community by demonstrating the critical nature of proper cast placement for consistent and accurate scanning of casts for bite mark analysis.

Computer generated overlays are an accepted method of comparing exemplars to bite marks by the American Board of Forensic Odontology. Scanning dental casts using a flatbed scanner is a first step in creating the computer generated overlays to be used as exemplars in a methodology outlined in the book Digital Analysis of Bite Mark Evidence by Johansen and Bower. Accurate analysis depends on the accurate capture of scanned digital images of the biting surfaces of the dental casts.

Many flatbed scanners utilitze a charge-coupled device (CCD) sensor. Typical CCD's in flatbed scanners incorporate 6,000 to 8,000 sensors. Newer CCD chips may contain 10,000 or more sensors. The number of sensors determines the highest dot-per-inch resolution that a particular scanner is capable of producing. A traditional flatbed scanner with 6,000 element chip and an 11-inch-wide bed can offer a maximum resolution of 6,000 dpi. When divided by 11, the width in inches of the scanner bed, the overall calculated resolution is approximately 545 dpi. The CCD chip must scan the entire width of the bed with each pass. If the flatbed element chip is 8,000 sensors then the maximum dpi is 725 dpi. Resolution if further limited by lens distortion at the edges of the scan. Only a central strip of the long axis of the scanning bed experiences the full resolution. So although the CCD must scan the entire bed and will reproduce images located anywhere on the glass plate, only that portion running along the central strip will experience full resolution. Full resolution allows accurate reproduction of the image without distortion.

When dental casts are placed on the bed of the flatbed scanner in any position other than the central strip, distortion occurs. Examples of this distortion will be demonstrated. If these images are used for bite mark analysis, this distortion will translate to the computer generated overlays created and an incorrect analysis could result. Consequently, when scanning casts with traditional flatbed scanners, the casts must be placed in the center of the bed. This requirement is in addition to other recommendations outlined by Johansen and Bowers.

Traditionally, scanned images of dental models allow for the analysis of the teeth in a mesial-distal and buccal-lingual dimension (X and Y axes). This methodology does not account for the vertical dimension (Z axis), the relative intrusive or extrusive position of the teeth. Developing technology using digital models instead of stone models, or three dimensional scans of dental models or impressions, may help to eliminate the issue of the failure of the flatbed scanner technique to properly consider X axis information. Three dimensional data capture and analysis is needed to allow for a more accurate representation of the morphology and position of the teeth in all dimensions.

Forensic Odontology, Bite Mark Analysis, Scanned Images

F16 The Use of Geometric Morphometric Methods in Forensic Odontology: Overview and Analysis of the Human Dentition

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The goal of this presentation is to present an established technique for shape analysis, and to illustrate how this method can be useful in describing the human dentition.

This presentation will impact the forensic science community by providing an analytical tool that can help to describe and compare similarities/differences within the human dentition.

One of the central questions in bite mark analysis regards the question of uniqueness of the human dentition. Few attempts have been made to address this question. Prior studies have typically used traditional metric dimensional parameters to depict the variation in human dentition. However, this method may not be appropriate with regard to bite mark analysis, as it does not address the manner, and degree to which these features transfer to the bitten surface.

Most studies on dental uniqueness have ignored the possible effects of the skin and reported the results based on the query: *Are the discrepancies of the incisal surfaces of the 12 anterior maxillary and mandibular teeth sufficient to describe uniqueness within a group of individuals or given population?* There is a loss of resolution with transference of the dentition to skin. With regards to bite mark analysis, many of the subtle metric measurement differences that allow for distinction of dentitions, may not transfer to the tissue. Therefore, the more pertinent question may rest with the ability to relate how a given shape or (mal) alignment pattern compares to a given population, within these limitations of measurement resolution. One such method to describe shape variation between specimens is Geometric Morphometric analysis.

The fundamental basis of one class of Geometric Morphometric analysis involves placement of landmark points on either 2D or 3D datasets from which the landmarks can be analyzed statistically as a unit.

The information extracted by means of this technique includes shape variance analysis and statistical treatment of populations from which can be extracted match rates. Amongst the tools available from statistical analysis is principle component analysis (PCA) with which the principle variation of shape can be plotted and visualized.

In order to evaluate this method for bite mark analysis, two different populations were obtained. One was a two dimensional (2D) dataset and the other was three dimensional (3D). In 2D, landmarks were placed that depicted the mesial to distal extensions of each anterior tooth, the intercanine extension, and rotation of the teeth in question. For 3D, curves were placed on the incisal edges of the 6 anterior teeth (upper and lower), each curve containing 10 datapoints (60 total for each arch).

For the 2D dataset, landmark placement was accomplished using tspDIG freeware. The 3D landmark placement was accomplished using Landmark freeware. The landmark data was extracted and statistical analysis was completed using IMP suite of freeware written by the author (HDS) and modified for this project.

Established methodology in geometric morphometric analysis will be described and illustrated with examples from biological shape analysis. As applied to bite mark analysis, the tools necessary to describe the dentition are presented. An initial approach to searching for matches will also be shown. This presentation serves as an introduction and overview of the capabilities of this technique.

Forensic Odontology, Bite Mark Research, Geometric Morphometric Analysis

F17 Similarities of the Human Dentition in an Open Population Using Two-Dimensional Geometric Morphometric Analysis

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The goal of this presentation is to analyze a large dataset of human dentitions using 2-D geometric morphometric analysis.

This presentation will impact the forensic science community by demonstrating the similarity of the human dentition with respect to bite mark analysis.

In February 2009, The National Academy of Sciences released the report *Strengthening Forensic Sciences in the United States: A Path Forward*. This report provided critical comments on the collection, analysis, and application of forensic data in all the forensic disciplines. With respect to the field of forensic odontology, the NAS outlined several inherent problems with bite mark analysis, one of which includes the notion of uniqueness of the human dentition, an integral component of the field.

The premise for bite mark analysis is based on the belief that in an open population every person's tooth arrangement, arch shape and size is unique. The subsequent premise is that based on metric analysis of the bite mark, a dentition can be matched to the injury. Very few scientific studies have attempted to address the issue of individuality of the dentition. Those that did either used a flawed statistical approach or had very small datasets. In this limited literature, authors have tended to arrive at conclusions that support their hypotheses rather than examine their own data, which contrary to their claims, actually supports dental similarity rather than uniqueness.

In this study a more appropriate question is asked by addressing similarities between dentitions of individuals in an open population.

In a joint effort between the SUNYAB School of Dental Medicine's Laboratory of Forensic Odontology Research and the Suffolk County Medical Examiners Forensic Odontology Department, an examination of the similarities between tooth arrangement and intercanine arch size was conducted. The study was based on data from a 2D geometric morphometric analysis utilizing landmark placement of coordinates on digitized images of dental exemplars. Dental models were collected from the SUNY dental clinic and from the practices of participating odontologists from Suffolk County. Models were scanned on a flatbed scanner and digital images were acquired at 300dpi resolution. Landmarks were placed using the tpsDIG set of freeware, and data analysis was performed using the IMP statistical freeware package. Landmarks in this study were placed on the mesial/distal endpoints of the six anterior teeth for both upper and lower dentitions. In addition, landmarks were placed on the central point of each canine, delineating intercanine width. A pilot study was conducted to determine if there was any measurable sexual dimorphism. It was concluded that the correlation was only slightly better that chance, and that therefore, males and females could be combined in the dataset.

Internal controls were added to the dataset that consisted of additional images of the same patient's dentition. These controls illustrated the ability of the statistical analysis to successfully determine a match.

Repeated measurement error was calculated and expressed as a Procrustes distance value, essentially representing the resolution of measurement. This value was then used as a baseline for match rate calculation. A Poisson distribution was noted in Procrustes distance when the datasets were analyzed. This indicated that as measurement resolution was reduced, match rate of dentition dramatically increased. The practical implication of this is that as the dentition is impressed in the skin and distortion occurs thus reducing resolution of measurement, large percentages of dental configurations in an open population may appear to have caused the same bite mark.

Superposition of the extracted landmarks showed that the human dentition occupies a well-defined shape-space. One of the prominent conclusions arising from this study was that as the database size increased, the shape-space became more densely populated, rather than spreading out. This again illustrates the similarity of the human dentition

After this presentation attendees will see the possibility of more than one dentition having a similar dental profile. The results of the study will impact the forensic community by providing a statistical quantification of the similarities of the human dentition and therefore aid in the resolution of some of the "problems" mentioned in the NAS Report findings.

Bite Marks, Dentition, 2-D Analysis

F18 Description of the Human Dentition Using Three-Dimensional Landmarks: An Investigation of Similarity and Match Rates

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The goal of this presentation is to describe the principle shape variables of the human anterior dentition in three-dimensions (3D).

This presentation will impact the forensic science community by illustrating the similarities and match rate for the human dentition from three-dimensional laser scanned models.

The basis of bite mark analysis incorporates two core premises: (1) The human dentition is unique; and (2) The uniqueness transfers to the skin. Recent research, with regards to skin distortion, has suggested that the first premise should be re-stated.

When taking the affect of the skin into play, the more pertinent question to ask may be, *what is the probability of finding a dentition in the general population similar enough that the two cannot be distinguished once impressed in the skin?*

In order to adequately and correctly address this issue, the description of uniqueness must reflect loss of resolution that occurs once the dentition is impressed in the skin. This loss of resolution, with transference of teeth to skin, results in an increased probability of more than one possible dental match. This is due to the inherent qualities of the tissue resulting in a range of distortional effects. The visco-elastic, anisotropic, non-linear nature of skin contributes to the distortion seen in a bite mark. Therefore, the more logical question centers on the limits of discrimination between similar dentitions; in other words, how similar the human dentition is, given constraints of the impression medium. Consideration of similarity of dentitions, coupled with loss of resolution due to skin distortion, may lead to establishment of boundaries of confidence levels expressed in bite mark analysis.

One well established means used to describe and delineate between biological forms is geometric morphometric analysis. Geometric morphometric methods allow for a quantitative analysis of shape by capturing the geometry of morphological structures of interest and preserving this information through statistical analysis. One of the important contributions of this technique is the clear definition of size and shape.

Advances in digital imaging have facilitated the use of landmark placement as coordinates. These coordinates can then be analyzed to describe size and shape of the object in question. The software allows placement of landmark points that are used to delineate dental features including intercanine widths, mesial-distal lengths, rotations, and in 3D, curves, and surfaces.

Landmark placement essentially delineates “dentition space”, or possible configurations of human bite pattern. Given this framework, it can be determined: (1) How big is the bite-space; (2) How much of it is actually occupied by human individuals. As humans are a single species, it is rational to assume that dental dimensions would fit in a finite boundary as determined by the species; (3) Configurations of the human dentition; and (4) Probability of match-rate. Thus a pilot study was conducted on 3D digital dental models to investigate these hypotheses.

All necessary Human Subject Institutional Review Board (HSIRB) protocols were completed for this project and exemption has been granted. Permission has been obtained from a dental company, which manufactures orthodontic appliances and occlusal guards, to copy and utilize 3D laser scanned digital dental model images (resolution of 10 *um*) of patient dentitions. All patient identifying information was stripped from the file. The 3D datasets were collected for use in CAD/CAM fabrication of occlusal guards (night guards, etc.), thus the data represents a wide population of age, gender, race and socio-economic status. The scans were NOT part of orthodontic therapy. The mal-alignment patterns ranged from relatively straight to severely mal-aligned. 500 upper and 500 lower models were obtained.

The datasets were analyzed in 3D, using geometric morphometric software. With the landmark placement software, the dentition can be rotated freely in 3D space and enlarged as needed for accurate placement of landmarks. Inter and intra operator error was determined after an appropriate wash out period.

Curves were placed which delineated the incisal edges of the six anterior teeth in both uppers and lowers. Each curve contains 10 landmark data points on each incisal edge. A total of 60 data points were obtained for each arch.

Following landmark data point extraction, statistical analysis was completed to describe the configuration of the human dentition and to determine match rates in the population studied.

The data presented will allow the forensic community to understand the similarity of a dentition to the general population.

Forensic Odontology, Bite Mark Research, Dentition Similarity

F19 Inquiry Into the Scientific Basis for Bite Mark Profiling and Arbitrary Distortion Correction

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The goal of this presentation is to illustrate the potential problems that can arise with bite mark profiling and arbitrary distortion correction of bite mark images.

This presentation will impact the forensic science community by providing data that demonstrates bite mark profiling, and arbitrary distortion correction of bite mark images, may not be advisable.

It is well known that distortion can occur in a bite mark. What may not be recognized is the limitation that this distortion can place on two potential tenets of bite mark analysis. Prediction of dental characteristics from a bite mark (bite mark profiling), and arbitrary distortion compensation are two practices that have been proposed in bite mark analysis. The assumption that a bite mark photograph can be arbitrarily altered to account for the tissue distortion is one theory. In this situation bite mark photograph is enlarged/decreased in attempt to correlate it to an unadulterated dental overlay of a suspect. A second supposition is that a profile can be generated from a bite mark in an attempt to anticipate the dental configuration of a biter. Recent research on the effect of inherent skin tension properties in bite mark analysis, however, suggests that these practices may be questionable.

One of the properties of skin responsible for distortion is anisotropy, meaning that skin possesses different properties in different directions. Thus in a bite mark, the transferred dental pattern can be distorted unequally in one direction, or another, due to the inherent pre-tension that exists in skin. Anisotropy itself can dictate the overall resultant configuration of a bite mark.

Skin pre-tension does not have a uniform distribution in a human body. Tension not only varies from person to person but also varies at a single site on the same individual. Tension is always greater parallel to tension lines and more relaxed perpendicular to them, resulting in anisotropy in skin. Therefore, the degree of distortion will not be uniform throughout a bite mark. There may be intra-arch as well as inter-arch distortion. The magnitude of these distortional changes can also vary considerably both within and between each arch.

To assess these issues, evaluation of 122 bites created on 11 human cadavers was completed. Of the 122 bites, 66 were selected for this study. Bite marks created to investigate issues such as postural distortion and laceration were excluded from this study, as the distortion in these bites would have been more extreme. Human Subject Institutional Review Board (HSIRB) exemption was granted for all phases of this project.

The bites were inflicted with models mounted to a handheld vice grip. The maximum anterior bite force capable of the vice grip was tested with a bite force transducer and found to be within the range of maximum anterior human biting capacity. This range was established by a volunteer’s *in-vivo* test biting on the bite force transducer giving an average of 190N. This range was also consistent with studies of mean maximum anterior bite force.

Photography was performed with a Canon Rebel XTi 10.1 Mp digital camera. An ABFO #2 scale was in place for each photograph. Each photograph was sized 1:1 and metric and angular measurements

were made to calculate the distortion that resulted. The changes for each bite were tabulated. Hollow volume overlay comparison was also performed. The experimental intra-observer measurement error was +/- 0.2mm for the inter-canine and mesial to distal distances, and +/- 2 degrees for the rotational angle difference.

For bite mark profiling, the photographs were analyzed, and any bite pattern that had a deviation great enough from the dentition of the biter that could be misleading for an investigator was included in this study.

Though some bite patterns reflected the biter's dental arrangement, in many instances the bite pattern, if profiled, would misdirect an investigator to a person that had features not present in the perpetrator's dentition. Of the 66 bites, 25 (38%) showed a change that could be misleading if profiled.

For arbitrary distortion compensation, three sets of three bite marks (each set produced on the same body part) were created with the same dentition and metric and angular measurements were made to calculate the distortion that resulted. The deviations for angle between teeth, mesial to distal length and inter-canine diameter for the six anterior maxillary and mandibular teeth tooth for each bite were tabulated. Hollow volume overlay comparison was also performed.

Arbitrarily and uniformly altering the bite mark photographs produced an inconsistent increase/decrease of dental features to the biter's dental overlay. This study indicated that arbitrary distortion of a bite mark photograph to "match" a dental overlay in an attempt to compensate for tissue distortion is not an appropriate technique. The anisotropic nature of human skin cannot at this time be precisely anticipated to arrive at a percentage enlargement or reduction of an image in any given direction. Results showed distortional ranges were non-uniform both between bites, as well as within each bite. Thus enlarging/decreasing the photograph uniformly would not correct the distortion that resulted.

There may be compelling evidence associated with a bite mark, including the presence of DNA, crime scene context, corroboration of victim accounts, timing of injury/death, exclusion, perpetrator identification, and other factors, which will continue to make bite mark evidence important in court. However, caution should be exercised in bite mark profiling as well as the enlargement/decrease of photographic bite mark evidence to correct for any skin distortion.

Forensic Odontology, Bite Mark Profiling, Bite Mark Distortion

F20 Mammelons and Diastemas in an Adult Population: Frequency and Implications for Bite Mark Evidence

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After attending this presentation, attendees will become familiar with the prevalence of mammalons and diastemas in an adult population.

This presentation will impact the forensic science community by drawing attention to the prevalence of dental characteristics that impact bite mark evidence. It will also encourage dental professionals to track their patient populations for these characteristics.

The seed for this presentation was planted in 1999 at the Armed Forces Institute of Pathology course in forensic dentistry. Dr. William Morlang presented the Penn bite mark case, calling it the "Gold Standard" of bite mark evidence. In the intervening years, there has not been a case of comparable quality.

The bite mark showed the presence of mamalons on the incisal edges of the biter. The clarity and distinct quality of the mark was quite remarkable. Since there have been no cases that approached that level of merit, it became apparent that the particular dental characteristics were deserving of additional investigation.

Mammalons are present on adult incisor teeth due to the developmental lobes that fuse during maturation. They usually are worn flat by the forces of mastication, before adulthood. Sometimes they persist. The observation of that circumstance is the basis of this presentation.

For approximately six months, the adult patients in a private, general practice were evaluated for the presence or absence of mammalons, during the course of their routine recall examination.

The age minimum was established at 18 years. Gender, ethnicity, and current age were noted when mammalons were visualized. It was decided to look for the presence of diastemas as well.

This characteristic is most often associated with the upper front teeth. On occasion it is seen in the lower teeth too. This type of spacing can produce an important feature in a bite mark.

At the end of the six month period, the observations were totaled and compared with the number of patients seen. The resulting fraction will be discussed as a small step toward quantifying the presence of mammalons and diastemas in a general adult population.

The community where the dental practice is located is generally considered upper middle class, with a high proportion of Caucasian residents. These demographics will be discussed, as they could have had an impact on the findings.

This pilot study is meant to draw attention to the simplicity of gathering data that may serve the forensic community. It is hoped that dental professionals, from varying communities, will initiate similar studies. The results can aid in the eventual formulation of a statistical database that may be able to quantify the probability of a biter having mammalons or a diastema. Of course, this will be useful only in cases where these characteristics are evident.

Bite Marks, Mammalons, Diastemas

F21 Using Fractal Dimension to Classify Human Dentitions

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After attending this presentation, attendees will understand the concept of fractal dimension and to comprehend how a box counting algorithm can approximate the fractal dimension of an image. At the completion of the lecture participants will appreciate that a human anterior dentition can be described mathematically and classified as to its uniqueness.

This presentation will impact the forensic science community by making an easy to implement method, to describe and classify the teeth used in a bite mark analysis, available.

Bite mark analysis has been criticized for its lack of scientific basis and mathematical foundation. This study makes available to the forensic community an easy to implement method to describe and classify the teeth used in a bite mark analysis.

This study was undertaken to determine if the fractal dimension of an image of a human anterior dentition could be used to describe and classify the dentition. Images of ten dentitions were available for study. The upper and lower arches were separated from the initial images to produce 20 working images. The working images were manipulated in GIMP 2.6.4 (GNU Image Manipulation Program) to yield an occlusal view of the outline of the facial surfaces of the six anterior teeth. The images of the outlines of the facial surfaces were analyzed by two different box counting programs to calculate the fractal dimension of each image. The box counting programs were ImageJ 1.42q, a freeware program from the National Institutes of Health and a proprietary program written in Microsoft C#.

Fractals are natural phenomena in which a structure is composed of parts that are similar in shape to the whole. The shape of the parts remains the same as the scale is changed when the viewpoint is zoomed in. This is called self-similarity. The facial outline of human anterior

human dentition of either arch is convex in shape and composed of convex shaped teeth, which are composed of convex shaped developmental ridges, which are formed from convex shaped enamel rods. The fractal dimension is a statistical quantity that gives an indication of how completely a fractal appears to fill space. In a box counting procedure smaller and smaller grids are placed over the curve. The number of times the curve crosses a grid box is summed for each different scale. The fractal dimension is approximated form the changes in box counts at the different scales.

A regression formula was developed that allowed classification of the images as either common or unique.

The dentitions depicted in the initial images were divided by forensic dentists into two groups; either normal alignment or malalignment of the teeth.

This study has shown that there is a positive correlation between use of a box counting algorithm to classify dentitions and the ability of trained forensic dentists to discriminate alignment features of a dentition.

This study is an initial feasibility study into the use of fractal dimension as a tool for the forensic odontologist. It is hoped that future studies will yield a scientifically valid method to evaluate the evidentiary value of an individual dentition.

Bite Mark Analysis, Odontology, Fractal

F22 Detection of Flowable Composites Using UV LED Light

Gerald Guzy, DDS, 259 Kinderkamack Road, Westwood, NJ 07675*

After attending this presentation, attendees will gain knowledge of the value of UV LED lights in detecting the presence of flowable composites during forensic dental examination.

This presentation will impact the forensic science community by demonstrating that small battery operated UV LED lights can make the presence of flowable composites more easily detected by the examining forensic dentist.

One of the primary goals in the restoration of carious lesions is the preservation of tooth structure. The philosophy of minimally invasive dentistry is to conserve as much tooth structure as possible by using small cavity preparations. This is possible because adhesive dental materials do not require mechanical retention.

The use of air abrasion, laser technology, and magnification has furthered the philosophy of minimally invasive dentistry. The development and introduction of flowable composite resin in the mid 1990's gave dentists a new class of aesthetic restorative materials that complimented minimally invasive dentistry techniques. The primary advantages of flowable composites have been described as their ease of placement and the precision with which they can be applied.

Flowable composites have been used for a variety of dental restorative procedures including small CII, II, III, IV, V restorations, porcelain crown margin repairs, enamel defect repairs, preventative resin restorations, repair of bis-acryl composite provisional crowns, and repair of polycarbonate crowns.

Pit and fissure sealant materials have been evaluated by the author using battery operated UV LED lights. Recently, a battery operated UV LED light was used to detect the presence of resin based composites during the forensic dental examination of a severely decomposed body. These studies have shown that small battery operated UV LED lights can be important tools in the detection of conventional resin based composites and pit and fissure sealants during forensic dental examinations of unknown human remains.

The purpose of this preliminary study was to evaluate the use of small battery operated UV LED lights at 365 nm and 395 nm for the detection of flowable composite resins.

Twenty-two extracted noncarious, nonrestored human permanent molars were used in this study. The occlusal surfaces were cleaned with a slurry of oil-free pumice and distilled water, and the teeth were stored in distilled water until used. Twenty different flowable composites from twelve different manufacturers were applied to the occlusal surfaces of twenty different teeth. Two teeth had no flowable composite applied, and served as controls. The flowable composites were polymerized with a Morita Jetlite 5000 LED curing light. The light intensity was measured using the radiometer built into the charging base of the curing light. The light output was measured each time a flowable composite was polymerized and was consistently greater than 800 mW/cm2. Polymerization times were based on the manufacturers' recommendations.

The teeth were examined using standard overhead fluorescent lighting, then re-examined in a darkened room using a Nichia 365 nm 5 LED UV light and an Inova X5MT 395 nm 5 LED UV light. These lights were chosen because they are small, inexpensive, easily obtained, and battery operated.

In general, flowable composites appear brighter than the surrounding tooth structure when illuminated with UV LED light due to their fluorescent properties. UV LED lights at 365 nm and 395 nm both enhance the appearance of flowable composites by contrasting the flowable composite with the surrounding tooth structure. The presence of flowable composite is easier to detect using the 395 nm light as compared to the 365 nm light. The flowable composite fluoresce significantly brighter and whiter with the 395 nm light as compared to the light blue fluorescence with the 365 nm light.

The results of this study suggest that the use of small battery operated UV LED lights can be valuable in the detection of flowable composites during forensic dental examinations. However, their use does not preclude a thorough visual and radiographic examination.

UV LED Lights, Flowable Composite, Forensic Odontology

F23 Analysis of Dental Evidence From the Crime Scene

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After attending this presentation, attendees will be familiarized with the use of Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS), Fourier Transform Infrared Spectroscopy (FTIR), and Polarizing Light Microscopy in identifying trace dental evidence.

This presentation will impact the forensic science community by documenting the use of these technologies, Scanning Electron Microscopy, FTIR, and Polarizing Light Microscopy in analyzing a solid fragment, and possibly connecting it to the crime committed.

The presentation will emphasize the usefulness of SEM/EDS, FTIR, and Polarizing Light Microscopy, and their respective databases in the dental and general forensic communities.

During the commission of a crime, many types of trace evidence may be left behind. The challenge for the forensic team, besides collecting this evidence, is to analyze the specimen, and either confirm or deny its connection to the perpetrator or victim. Through SEM/EDS, a suspected tooth fragment can be assessed, and its chemical elemental composition determined. Though this will not positively identify the origin of the fragment, an elemental spectral comparison to a known sample can show whether it is consistent with tooth structure. Polarizing Light Microscopy and FTIR are two more methods which can be used. These analyses can determine the molecular and chemical structure of the fragment, for example, the carbon chain orientation. Once again, the results from Polarizing Light Microscopy and FTIR need to be compared to a known subject. A database of these "knowns" can be accumulated by the investigating institution, or as in the case of

SEM/EDS, access to the FBI's (SLICE) database can be obtained. The author will document the use of these technologies, Scanning Electron Microscopy, FTIR, and Polarizing Light Microscopy in analyzing a solid fragment, and possibly connecting it to the crime committed.

SEM/EDS Analysis, Trace Dental Evidence, FTIR

F24 Bite Mark Profiling Based Upon Color, UV, and ALI Photographic Interpretation

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After attending this presentation, attendees will have a better understanding of the limitations in predicting a biter's profile based upon color, UV, and ALI bite mark photographs

This presentation will impact the forensic science community by analyzing bite marks through various photographic means, providing new knowledge in the already extensive list of factors affecting bite mark analysis.

It is known that bite marks are influenced by many factors such as the nature of skin, Langer's lines, underlying tissue, location of the injury, presence/absence of clothing, victim and/or perpetrator movement as well as conditions under which a body is found and/or preserved[1].

In an upcoming publication[2], the authors' analyzed postmortem bite marks while the current research deals with antemortem bite marks.

Twenty-five scaled (ABFO No.2) color bite mark photographs of varying evidentiary value (Minimal; Poor; Excellent) and of known perpetrator origin (gold standard) were given to two individuals with bite mark experience. The examiners were asked to classify the evidentiary value and to identify if any of the bite marks were created by the same person or if a number of persons were involved and how many. They were not given dental models of the bite mark perpetrator(s). The bite marks were inflicted on many areas of a piglet's body including the abdomen, thigh, hip, leg, back, shoulder, chest, and neck. The examiners were told where the bite marks had been inflicted but were not given an overview photograph other than the scaled photograph.

Following this exercise, the examiners were given UV photographs of the same bite marks and were asked to perform the same exercise without comparing previous color photographs or results.

Lastly, examiners were given ALI photographs of the same bite marks with the same previous conditions.

In summary, this presentation will inform attendees of limitations in predicting a biter's profile based upon color, UV and ALI bite mark photographs. As stated in an earlier study[3], every occasion in which a dentition comes in contact with skin can be considered a unique event. This author urges caution in definitive dental profiling based upon bite mark photographs.

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Bite Mark, Documentation, Photographic Interpretation

F25 Macroscopic and Microscopic Study of the Effects of Freezing and Thawing on Bite Marks

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After attending this presentation, attendees will have a better understanding of the effects of freezing and thawing on bitten mammalian skin.

This presentation will impact the forensic science community by exploring this uncharted territory of bite mark studies, providing new knowledge in the already extensive list of factors affecting bite mark analysis.

It is known that bite mark study and analysis is complicated by many factors such as skin color, Langer's lines, location of the injury, the victim's medical history, underlying tissue, presence/absence of clothing at the bite site, victim and/or perpetrator movement as well as conditions under which a body is found and/or preserved.

On the other hand, many other variables affect the speed of freezing and thawing of a body including skin exposure, temperature, wind chill, humidity, clothing, bacterial/insect/animal activity.

The first part of the presentation will explore the macroscopic effects of freezing and thawing by photographic documentation including general overview, close-up with and without the ABFO no 2 scale, color, UV, and ALI. A comparison done between pre and post freezing photographic documentation is closely examined and discussed. Photographic comparison was performed following the various stages of the experiment to record for loss of bite mark structural detail and to observe the effects of freezing and thawing macroscopically.

Fifteen ante- and postmortem bite marks were produced on a piglet by means of a Vice-Grip mounted dentition. The subject was then placed in a mortuary refrigerator for three days, removed and allowed to reach room temperature, examined, and photographically documented (color, UV, and ALI). The specimen was refrigerated anew for two days, and finally frozen covered by a plastic bag (not vacuum packed) and preserved for (274) days at (-6 C) degrees. The piglet was removed from the freezer, placed in a mortuary refrigerator for three days and subsequently allowed to thaw to room temperature. Complete photographic documentation was performed including general overview, close-up with and without the ABFO no 2 scale, color, IR, UV, and ALI. Bite mark excision was also performed (Dorion Type V), transillumination with further photographic documentation.

The second part of the presentation will look at the microscopic effects of freezing and thawing on bitten mammalian skin and to provide knowledge about the differences or similarities that are to be expected between histological samples. The results will also be studied in the hope of providing ways of maximizing information obtained from frozen and thawed bite marks while minimizing its potential negative effects.

In summary, this presentation will inform the attendees of the influence of freezing and thawing on bitten mammalian skin. This information is expected to aid forensic dentists to take all the necessary precautions to avoid loss of valuable information in bite mark documentation and analysis in the case of artificially or naturally frozen bite mark victims.

Mark, Freezing, Thawing

F26 Bite Marks on a Live Victim: Data Collection, Healing Process, and Loss of Details

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After attending this presentation, attendees will have a better understanding of the influence of many factors involved in bite mark recording, the healing process, and the loss of detail when the injury is inflicted on a live victim.

The presentation will impact the forensic science community by enabling the forensic scientist to observe how, with known medical history in the absence of victim/perpetrator movement and clothing, and the natural healing process, effects bite mark data collection and analysis.

It is known that bite mark data collection and analysis is subject to variables that complicate the task. Such factors as skin color, Langer's lines, location of the injury, underlying tissue, presence of clothing, victim and/or perpetrator movement in addition to the healing process and the medical history of the live bite mark recipient.

The first part of the presentation will expose some of the factors that are usually unknown to the forensic dentist. The objective: to minimize the unknowns such as the amount of pressure applied to produce the pattern injury, the position of the biter and the victim, how specific is the biter's dentition, what are the possible appearance of the pattern injury created by one perpetrator at different locations, with an unanimated victim of known medical history, to prove that even with less unknown factors, bite mark data collection and analysis is a very subjective, delicate and difficult task.

A volunteer was bitten on four locations on the left side without any movement except for the movement of a Vice-Grip mounted dentition. Complete photographic documentation including general overview, close-up with and without the ABFO no 2 scale, color, IR, UV, ALI was performed for each injury on the day of infliction and for three consecutive days post-infliction, to evaluate the healing process of multiple bite marks on a live victim with optimal data collection conditions (immediately post infliction) and a close follow-up.

In the second part of the presentation the ABFO recommended photographic documentation is analyzed (color, IR, UV, ALI) in reference to the healing process. Also comparisons done between various stages of healing and various dentitions is closely examined to try to determine when the amount of information loss is such that perpetrator identification by dental means is not possible.

In summary, this presentation will inform the attendees about the added difficulties of bite mark data collection and analysis when dealing with a live victim. It will also provide the scientific community with the effects of healing on photographic documentation and help in the understanding of important influences of the usual unknowns (force applied, exact timing of the injury) when confronted with pattern injury analysis.

This information is expected to aid forensic dentists to take all the necessary precautions to avoid loss of valuable information and to remain cautious before rendering an opinion in bite mark cases on a live victim.

Bite Mark, Healing, Live Victim

F27 Bite Marks: Physical Properties of Ring Adhesion to Skin - Phase Two

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After attending this presentation, attendees will acquire new information regarding factors influencing ring adhesion to skin.

This presentation will impact the forensic science community by providing scientific evidence for the different methods for ring adhesion in addition to potentially affecting the American Board of Forensic Odontologists (ABFO) bite mark guidelines.

A recent article[1] suggests that 87.5% of Diplomates of the American Board of Forensic Odontology excise the bite site on cadavers. It is also well documented that unsupported excised tissue may shrink by as much as 50% or more[2]. In 1981, a method was developed for ring fixation prior to tissue excision[3]. Several other methods have since been proposed to minimise tissue distortion. The scientific literature, however, reveals little supporting evidence for the preferential use of one adhesive/suturing technique over another in bite mark excision.

In August of 2007, a one week hands-on training course on bite marks was held at the "*Laboratoire de sciences judiciaires et de médecine légale »* in Montreal; this yearly session is part of an online forensic dentistry course which incorporates theory and practice leading to a certificate in forensic odontology from the Faculty of Dentistry at Mc Gill University since 2004. During this module, the "Dorion type 5 technique" was used for pig skin excision. It incorporates TakÒ hydroplastic, mosquito fiberglass netting (screen) and cyanoacrylate gel. A new method was adopted in preparing the pig skin which involved the use of VeetÒ, a commonly used chemical depilatory. The results were disastrous; almost all of the rings separated from the skin during excision and the idea of experimenting on the physical properties of ring adhesion to skin was born.

Ring detachment can be attributed to many factors including temperature variations, ventilation, atmospheric humidity, body wetness and temperature, as well as the cyanoacrylate's physical properties not to mention other chemicals; but little research has been accomplished to scientifically demonstrate these hypotheses as clinical experience prevailed.

The present task is a continuation of Phase 1 presented at last year's AAFS meeting in Denver. It compares ring adhesion methodologies using instrumentation and software from another forensic arena, ballistics, the TriggerScan™ version 2.0.

In addition, Phase 2 deals with: 1. studying the amount of the tensile stress needed to rupture the bond between TAKÒ hydroplastic, the Loctite Supergel and the pig skin that was previously shaved and cleaned with dishwashing detergent and ethanol, with special consideration to temperature factor; 2. Comparing histologically the differences in pig skin when untreated/treated, cleaned with various agents including Veet; 3.Comparing the solubility of different cyanoacrylate glues in formalin 10%, and 4.Testing the Dorion Type 5 technique and its modifications on the TriggerScan with different cyanoacrylate glues. The results give a clearer scientific exposé of the physical properties of the various materials utilized and their interaction.

In conclusion, by compiling and analyzing the precise measurements, risks of tissue distortion and loss of adhesion during bite mark excision could be significantly reduced by utilizing recommended techniques and materials which could ultimately facilitate perpetrator identity.

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Bite Marks, Ring Adhesion to Skin, Trigger Scan

F28 Bite Mark Analysis From a Police Shooting

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The goal of this presentation is to show and classify bite mark patterns and the interpretation of the marks to produce a profile of the biter. The affects of time, humidity, and temperature on the pattern injuries will be shown with examples.

This presentation will impact the forensic science community by showing through actual cases the affects of alternate light, ambient light, time and temperature enhancement of a bite mark injury as well as other examples of pattern injuries. Profiling of the biter from the bite mark is enhanced by gravity, time, temperature and light.

In Miami-Dade County from January through July of 2009 there were thirteen police shootings with the resultant death of six suspects and the wounding of seven others. There was one officer fatally shot by a suspect. In one of the fatal incidents where a suspect was shot and killed by a police officer the officer was bitten in the process of attempting to arrest the suspect. The suspect was combative and the officer was forced to use deadly force when the suspect attempted to take the officer's weapon.

The bite wound on the officer presented DNA evidence, a profile of the biter, position of the biter, in relation to the officer and produced a permanent injury. The analysis of the bite established the position of the officer and suspect as well as the dental arrangement of the suspect's teeth. These investigative opinions proved to be helpful to the Internal Affairs Committee and validated the officer's account of the incident.

The use of alternate light sources has advantages over conventional ambient light to enhance a pattern injury. There are changes that occur to a pattern injury specifically a bite mark during the healing process and these changes were documented graphically in this case. The theory of obtaining bite mark records as soon as possible on the victim, living or dead, may not always produce the best evidence for evaluation. Refrigeration of a decedent in the morgue cooler for extended time such as 24-48 hours will allow for a pattern injury to become recognizable where it may not have been prior to the refrigeration. The reasons are multiple. If the deceased has been in water the injury or injuries may not be noticeable until the body has dried out. The effects of gravity tend to move blood from normal tissue but not from an injury such as ligature marks, other type pattern injuries or bite marks. The drying effect of low humidity tends to dry the skin surface which enhances the traumatic lesion whether bite mark or other type pattern injury. The effects of this phenomenon, drying and gravity are demonstrated with ligature marks undetected on initial examination but became more apparent after drying and storage in the morgue refrigerator in a case of suicide by hanging.

As a result of this presentation the audience will have had an opportunity to see in actual cases the affects of alternate light, ambient light, time and temperature enhancement of a bite mark injury as well as other examples of pattern injuries. Profiling of the biter from the bite mark is enhanced by gravity, time, temperature and light.

Bite Mark Analysis, Bite Mark Classification, Bite Profile

F29 Misdiagnosis of a Bite Mark by an Unqualified Physician

Thomas V. Brady, DMD, 1823 Boston Post Road, PO Box 622, Westbrook, CT 06498*

After attending this presentation, attendees will have learned to rely on their knowledge of dentistry, and training in forensics to determine the accuracy and reliability of diagnosing a pattern injury as a bite mark.

This presentation will impact the forensic science community by stressing the necessity of meeting the Supreme Court *Daubert* decision of 1993 and the ASFO guidelines to fulfill the requirements of a legal bite mark identification.

Two men engaged in a fight on a street in Boston. The precipitating cause was one man's affair with the second man's wife. There were no witnesses at the start of the fight. As the fight ensued, one participant pulled his windbreaker over his head in a defensive move. A crowd gathered and the police arrived.

One participant suffered a through and through tear injury of his left ear. He was transported to the hospital for treatment. Based on what the patient said, the plastic surgeon at the hospital diagnosed the ear injury as a result of a bite by the assailant. The victim underwent a three hour surgery to restore the ear. One hundred and fifty sutures were used. The alleged assailant was arrested and charged with five felony counts which could result in 20 years incarceration. The defendant was a successful businessman. Finances were not an issue but jailtime was abborhent to him. The defendant hired a prominent defense attorney. However, the defense attorney had no forensic experience. He chose to not question the surgeon's diagnosis despite the defendant's insistence that he did not bite the victim. One year later, the criminal case came to trial. As the trial progressed, the pattern injury became the defining issue. The attorney's secretary had watched a television show involving Dr. Henry Lee and forensic odontology. She suggested to the attorney that he contact a forensic odontologist. The attorney was hesitant, but did so at his client's insistence. The attorney's overture to the dentist started with "you are only a dentist. The prosecution expert is a doctor. He is a famous plastic surgeon. Do you think you can help me in this case?" The dentist agreed to look at the evidence despite the attorney's ringing endorsement. The attorney sent the evidence consisting of several pictures were taken by the Boston Police. None of the pictures had a ruler in them. The police did not take the victims jacket for evidence. Hence, there were no pictures of the bloody jacket, no DNA samples taken and no amylase test for saliva. The dentist went to Boston and took pictures of the defendants teeth, study models and occlusal records After a thorough review of the pictures and the study models, using established forensic investigation procedures and the Lucis computer program, the dentist determined that the pattern injury was not caused by human teeth. He so informed the attorney and was asked to testify as a defense witness. In court the plastic surgeon reiterated his diagnosis of a bite mark injury. Based on questions supplied by the dentist during cross examination, the physician admitted he was not a member of AAFS. He also admitted to his lack of knowledge of the *Daubert* principals and dentistry. Based on his own answers, the plastic surgeon recanted his testimony. He assumed the injury was a bite mark, but used no scientific method to reach his conclusion. The defense presented a forensic odontologist who explained the principals of the *Daubert* decision. He showed pictures he took of the defendants mouth. He demonstrated the arch form of the defendants teeth versus the linear pattern of the ear injury. During his testimony, the odontologist testified about the Lucis program, how it can sharpen pictures and distinquish 255 shades of gray. He demonstrated how the program brought up the detail of the pattern injury to the point that it could be determined that the injury was indeed caused by teeth, but not human teeth. The cause of the injury was the teeth from the zipper on the victim's jacket. Due to the testimony of the forensic odontologist and the prosecutors

omissions science triumphed of supposition, the jury took only two hours to find the defendant not guilty on all five charges.

***Daubert*, Lucis, Bite Mark**

F30 The Sharra Ferger Homicide: A Cautionary, Cautionary Tale

Lowell J. Levine, DDS, New York State Police, 1220 Washington Avenue, Building #30, Albany, NY 12226*

After attending this presentation, attendees will understant that keeping the totality of a case in view is crucial to a just resolution.

This presentation will impact the forensic science community by presenting two incidents, in this case, that could easily have led to a miscarriage of justice. All the evidence in a case is crucial to the correct outcome.

On October 3, 1997, nine-year-old Sharra Ferger disappeared from her home in eastern Pasco County, Florida. Her body was found in a nearby field. She had been stabbed 46 times, sexually assaulted, and a bite mark found on her left shoulder. A dentist who worked with the local medical examiner compared numerous dental models to photographs of the bite mark and rendered an opinion that a neighbor had caused the bite mark. A well qualified forensic odontologist was consulted. He agreed with the dentist's opinion and the neighbor was charged with the murder.

A forensic odontologist retained by the defense was able to digitally clarify the autopsy photographs and show the original opinions were in error. The State's Attorney dropped the charges. The defense expert was requested to review the entire case and act as the expert for the State. A "Round Table" review of the case by the agency which employed the forensic odontologist originally retained as a defense expert revealed a hair recovered from the victim's body was never analyzed. That hair yielded DNA information which matched another individual. Dental models obtained from that individual were compared and both the forensic odontologist examining the case and a peer reviewer agreed that the individual whose DNA matched did not cause the bite mark. The investigators determined that the individual whose DNA matched was a close friend of the victim's uncle. Dental model's were obtained from the victim's uncle and the forensic odontologist comparing the models and a peer reviewer rendered opinions that unusual characteristics found made it highly probable that the uncle caused the bite mark. All this work took three years. The DNA match individual was convicted at trial. The uncle pleaded guilty to the murder and admitted causing the bite mark.

The behavioral profile indicated the murderer was a single individual. Had the hair not been examined until many years later and the uncle convicted at a trial based upon evidence which included the bite mark comparison it is possible some individuals would claim that DNA from the hair could exonerate the uncle. An examination of the hair many years post conviction would have shown the DNA did not match the person whose bite mark was part of the evidence which caused the conviction. Bite mark evidence might have been, "Thrown under the bus," in this case…completely in error. Totality of cases MUST be looked at before forensic evidence is blamed for unjust convictions.

Bite Marks, Totality of Evidence, Hair and DNA

F31 Report on a Closed Population Bite Mark Case Involving Two Unrelated Individuals With Similar Dentitions

David K. Ord, DDS, 1001 Shadow Lane, Mail Stop 7415, Las Vegas, NV 89106*

After attending this presentation, attendees will understand and appreciate how similar dentitions may be found in a closed population from unrelated individuals. It will show the need for the study of bite marks on a microscopic level for comparison purposes.

This presentation will impact the forensic science community by serving as a reference for those dental practitioners and other experts who may be requested to provide a bite mark testimony before the court that bite marks on the gross scale, in a closed population, may not be as individualized as previously thought. Additionally, this shows that skin as impression material is not accurate enough with macroscopic examination to determine the differences in two similar but unrelated individuals that allow for an accurate bite mark comparison. Further studies using microscopes such as the scanning electron microscope are recommended to study the individual tooth characteristics of the human bite mark.

It has been the basis of bite mark comparison that no two unrelated individuals in a closed population would have dentitions that produce bite marks close enough in similarity as to prevent an outcome other than inconclusive to the case. This case disproves that assumption because two of the three persons of interest in the case had similarly positioned teeth and because of that both individuals fit a well defined bite mark. An odontologist would expect this similarity if the two persons of interest had been orthodontically treated. However, both individuals had not had orthodontically treated dentitions, yet their arch characteristics are close enough that when compared macroscopically to the bite they were virtually indistinguishable. This will be demonstrated by use of the Mideo Systems' CASEWORKS*eis* ^{TM} program. This is a software system designed for the forensic sciences. The Mideo Systems' ^{TM} program is a state of the art system capable of managing all aspects of the forensic case from comparison to court exhibits. It has been used for managing both identification and bite mark cases. The system, as used in this presentation, is capable of capturing digital images and bringing them to a 1:1 relationship for comparison. This allows comparison of various images while using filters and other tools available in the software.

The purpose of this case review is to demonstrate that despite using current state of the art comparison equipment a conclusion in a bite mark case involving similar dentitions may not be reached without the needed microscopic information. Standard digital photography alone cannot be enhanced enough to show these small irregularities in the dentition. With this information, forensic odontologists, will realize that even in a closed population there may not be unique enough dental characteristics to form a scientific conclusion as to whom can be reasonably ruled out or included. It is also hoped that with this information the forensic odontologist and other researchers will be spurred into studying the microscopic aspects of bite marks and provide ample scientific data as set forth in the February 2009 report on forensics by the National Academy of Sciences.

Forensic Science, Bite Marks, Closed Populations

F32 Solving Bite Mark Problems During Testimony

Paul G. Stimson, DDS, 902 Lakespur Drive, Sugar Land, TX 77479-5909*

After attending this presentation, attendees will see how to overcome obstacles such as inadmissable evidence, inability to project PowerPoint presentation, and improper case write-up will be explored and solved, prior to testimony and actually on the stand.

This presentation will impact the forensic science community by demonstrating how to overcome such obstacles and avoiding inadmissible evidence.

During this presentation, a demonstration on how to overcome the following three different situations will be shown: (1) you discover your write up has an error just prior to testimony; (2) the judge rules the case materials you have generated for the jury is "inadmissible" and how to solve this matter just prior to testimony; and, 3) the lighting is such in the courtroom that your PowerPoint presentation is "washed out" and will not be viewable to the jury.

Three actual cases will be used to show the above problems and how to overcame these problems. One was done shortly prior to testimony. In the second and third cases, evidence was prepared in the jury's presence. How to create useable evidence in the courtroom suitable for use in the case will be illustrated. This will be a simple show and tell for the jury and demonstrate evidence made in their presence that can be examined by the jury will be shown.

These techniques solve the problem of poor lighting and having the judge rule against the evidence you brought to admit for testimony and education of the jury. A bite mark emergency kit carried to trials involving bite marks.

Experience shows that even after the attorney has deemed the illustrative materials are of good quality and he/she will be able to get them admitted for use, preparation must still be made in the event the evidence has been ruled out.

In the case of the poor lighting, the courtroom was surveyed prior to trial, which was an overcast and cloudy day. The court scene was rather dark and the projection was excellent. On the day of presentation, the courtroom was flooded with bright sunlight and the projection was almost useless, as it could hardly be seen. To overcome this problem bite mark exemplars were created in the jury's presence for demonstration, education, and use.

Evidence Rejection, Production, Kit

F33 Gate-Keeping, Bite Mark Evidence, and Research: Out of Adversity Comes Opportunity

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After attending this presentation, attendees will be aware of the potential problems with gate-keeping in forensic science, be cognizant of the pitfalls of peer review, and learn a new algorithm as an approach to bite mark cases that lends itself to the development of testable hypotheses to buttress or refute various steps in the bite mark analytical process.

This presentation will impact the forensic science community by explaining the reason that present peer review and judicial gate-keeping are pillars of the post-*Daubert* era. Current standards of terminology in bite mark cases are based on consensus opinion rather than hard science. Peer review in journals is fallible and neither guarantees truth nor quality. Judges, charged with gate-keeping for the most part have little science background. In this milieu the National Institute of Forensic Science has recommended terminology be standardized for bite mark cases. An alternate algorithm for processes in bite mark analysis is presented that lends itself to the design of evidence-based approaches to bite mark recognition and analysis, and provides alternate, appropriate, accurate, under-stated terminology, that better reflects the level of current science in this field.

Daubert v. Merrel-Dow, a non-unanimous Supreme court decision made judges, few of whom have science backgrounds, the gate-keepers of whether an expert or his testimony is suitably scientific for presentation to the trier of fact. In turn, in jury trials the common man must assess scientific or pseudo-scientific testimony, often with no scientific background. This gate-keeping function of judges is partially predicated on assessment of methodology that has been subject to peer review and published in, presumably, reputable journals that have their own, peer-review processes fraught with potential error. Recent external pressure has justifiably focused a microscope on bite mark analysis as one area of endeavor that requires clear standardization of technique, testing of error rates, and reporting of findings that reflect the science of bite mark analysis as it presently stands. A change in the way that forensic dentists approach bite mark cases can readily address these new, improved requirements and also provide opportunities and direction in the way that future research projects can be developed. Current terminology, though standardized, does not reflect scientific knowledge in the field. Presently, terminology attesting to whether a given patterned injury is a bite mark or not is not a dichotomous one. This allows an injury to be diagnosed as suggestive of a bite mark. Despite these reservations there is nothing to prevent a forensic dentist from carrying on with a "suggested" bite mark and attributing it to the dentition of a suspect. Additionally, despite demonstrations by several authors, there are many bite marks that are diagnosed as such, yet because of their low evidentiary value, do no merit further comment. A revised approach also provides the forensic dentist options to make a diagnosis of a bite mark but not proceed with a complete work-up because the evidence does not warrant one. Further, in testimony and communication with judges and juries the forensic dentist should use language that accurately reflects what is known in the field and more importantly what is not known. Finally in light of a recommendation about clear and non-confusing testimony a less-adversarial, less accusatory, more accurate, and understated means of attributing a given dentition to a suspect dentition is proposed.

The proposed a system is as follows:

1. Is the injury a bite mark? Yes or No
   a) The patterned injury present is a bite mark.
   b) The patterned injury present is not a bite mark.
   c) The material available for review is insufficient for a decision to be made.
2. What is the evidentiary value of the bite mark?
   a) The evidentiary value of data available warrants further investigation.
   b) The evidentiary value of data available does not warrant further investigation.
3. Results of comparisons to suspected dentitions:
   a) The suspected dentition can be excluded as having made the bite mark.
   b) The suspected dentition cannot be excluded as having made the bite mark.

Bite Mark, Gate-Keeping, Terminology

F34 Innocent People Convicted by Bite Mark Evidence: Is There Still a Problem?

Christopher J. Plourd, JD, Law Office of Christopher Plourd, 1168 Union Street, Suite 303, San Diego, CA 92101-3818*

The goal of this presentation is to demonstrate how innocent people are serving sentences for crimes based upon erroneous bite mark identification evidence.

This presentation will impact the forensic science community by proposing a solution to the problem of wrongful convictions based on bite mark evidence.

False convictions using bite mark evidence continue to be a serious concern for the criminal justice system. The educational objectives of this presentation are to identify common errors made in bite mark cases where factual innocence has been demonstrated, and to propose solutions for improving the reliability of bite mark analysis. The attendee will understand the need for extreme caution in reaching any conclusion of identity solely upon a bite mark comparison.

DNA identity testing continues to exonerate innocent people in cases that involved bite mark comparison evidence. The problem of innocent people being convicted and unjustly imprisoned for crimes they did not commit should be of serious concern to the forensic odontology community. Two recent bite mark cases will be discussed.

In a case from Wisconsin, Robert Lee Stinson, served 23 years of a life sentence for the 1984 murder of Ione Cychosz. Ms. Cychosz had been a neighbor of Mr. Stinson, and her body was bitten a number of times in the course of a brutal assault that killed her. Mr. Stinson consistently maintained his innocence. In 1986, Stinson's direct appeal of his first degree murder conviction was denied (*State of Wisconsin v. Robert Lee Stinson* (1986) 134 Wis.2d 224; 397 N.W. 2d 136). In February of 2008, after DNA testing, the State of Wisconsin agreed that Robert Lee Stinson should be granted a new trial. On July 27, 2009, the State of Wisconsin dismissed the murder charge against Robert Lee Stinson.

In a Mississippi case, Kennedy Brewer was accused of the 1991 murder of Christine Jackson, the 3-year-old daughter of his girlfriend. Mr. Kennedy Brewer was initially convicted of raping and strangling Jackson to death in 1995. He was sentenced to death and spent 12 years on Mississippi's death row. In February of 1987, Kennedy Brewer's case was dismissed by the State of Mississippi after another person identified by DNA evidence confessed to killing the 3-year-old girl. The prosecution had relied exclusively upon bite mark evidence to convict him.

Both Stinson and Brewer were convicted because the prosecution relied upon bite mark evidence. In both the Robert Lee Stinson and Kennedy Brewer cases the dental bite mark experts were board certified by the American Board of Forensic Odontology (ABFO). The Stinson and Brewer cases are examples in a growing number of cases where bite mark evidence has been shown to be erroneous. Bite mark identification evidence is now on the brink of being proven to be a junk science. Defense attorneys are filing challenges against bite mark evidence. The challenges contend that there is effectively no valid documented scientific data to support the hypothesis that bite marks are demonstrably unique. Although there is evidence that a person's teeth can be unique, it is argued that there is no documented scientific data to support the hypothesis that a bite mark is a true and accurate reflection of this uniqueness. To the contrary, what little scientific evidence that does exist supports the conclusion that crime-related bite marks are grossly distorted, inaccurate, and therefore unreliable as a method of identification. These criticisms were echoed in a study recently published by the National Research Council entitled *Strengthening Forensic Science in the United States: A Path Forward*, (The National Academies Press, 2009, National Academy of Sciences, hereafter NAS Report). In the specific section on forensic odontology, the NAS Report found that bite mark comparison was the most controversial area of forensic odontology and that there is continuing dispute over the value and scientific validity of comparing and identifying bite marks (*Id.* at p. 5-35). In its criticism of bite mark comparisons, the NAS Report stated:

There is no science on the reproducibility of the different methods of analysis that lead to conclusions about the probability of a match... Even when using the [American Board of Forensic Odontology] guidelines, different experts provide widely differing results and a high percentage of false positive matches of bite marks using controlled comparison studies.

If bite mark evidence is to remain as viable evidence of identification in our judicial system, serious and specific measures must be taken to correct all circumstances where miscarriages of justice have occurred. One principal lesson learned from bite mark exoneration cases is that errors occur when an overstatement of the validity and certainty of a bite mark identification is testified to by the odontologist. Exoneration cases also demonstrate the need to develop a minimum threshold objective criteria for the suitability of a suspected bite mark before a comparison is attempted.

The investigation of bite mark cases by forensic dentists has necessarily evolved as the result of deficiencies uncovered only after convictions which relied on bite mark evidence were overturned by DNA. Developments in this area include improved technology as well as an increasing awareness by forensic dentists that previous assumptions were unsupportable. As a direct result of past mistakes there should be a better understanding by forensic dentists of the inherent variability and resulting distortion of marks left in human skin by teeth. Also, forensic dentists should accept that there is rarely, if ever, a scientific basis to make a statement that a person is an A positive match.

One path forward: A scientific technical working group of the most highly qualified and experienced forensic odontologists should be formed. This technical working group would objectively review all bite mark cases where a person is serving a prison sentence to determine if the error factors found in exonerated cases also exist in those cases. If so, steps would be taken to guarantee that an innocent person is not being wrongfully confined based upon bite mark evidence.

Bite Mark, DNA, False Conviction

F35 DNA Collection From Used Toothbrushes as a Means to Decedent Identification

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After attending this presentation, attendees will understand a refinement of existing methods to recover and extract DNA from used toothbrushes in order to provide a recommended protocol for laboratories to use when provided toothbrushes as known DNA reference samples.

This presentation will impact the forensic science community by describing a simple and effective method to collect the DNA from the used toothbrush while preserving the remainder of the brush for future testing.

This presentation will show that there is no significant difference in the quantity and quality of DNA recovered from a toothbrush that has been used for only one month vs. three months. Additionally, it will be shown that any PCR inhibitors present in the DNA samples will not significantly affect the usefulness of the DNA sample.

A method using aviation snips can be used to remove the distal end of the toothbrush head to leave sufficient area for further analysis intact

and attached to the toothbrush handle. Testing randomly used toothbrushes collected outside of the controlled study will yield similar amounts and quality of DNA as the test controlled brushes.

Fifty-two adult subjects who are not biologically related to each other were recruited as volunteers. The number of subjects will add significance to the results of this study since previous related studies generally used smaller groups of subjects. A used toothbrush was provided by each subject along with a small bloodstain control. Samples were numbered in such a fashion that they could not be attributed to any individual person in this study.

The subjects were divided into three groups and given new toothbrushes: 20 subjects used their toothbrushes in the normal way for four weeks; 20 subjects used their toothbrushes in the normal way for 12 weeks; and 12 subjects surrendered their current toothbrush for DNA testing. Two new, unused toothbrushes were used as negative controls.

DNA Recovery: It was assumed that sufficient DNA would be present on the head of a toothbrush to provide opportunity to complete many DNA analyses. Thus, a technique to recover DNA from a representative sample of the head of the subjects' toothbrushes was sought.

The distal end of the toothbrush head was removed to leave sufficient area for further analysis intact and attached to the toothbrush handle. The sample for use in this study was removed from the head using aviation snips, which are inexpensive and commonly available in hardware stores. The aviation snips were used for each sample and the snips were cleaned and decontaminated between each sample according to established laboratory guidelines and protocols.

DNA Extraction: All experimental samples (52) and controls (2) were extracted using the organic, phenol-chloroform extraction method to ensure consistency and avoid introducing variables.

All toothbrush DNA samples were quantified, amplified, and analyzed at ten STR loci to obtain a full DNA profile. The DNA profile obtained from each toothbrush was compared against the known reference bloodstain DNA profile from the user of the toothbrush.

External Validation: The toothbrush supplied by each of 12 subjects after normal use for random periods of time were analyzed in the same way to determine if these "normal" toothbrushes contain DNA of similar quality and quantity as the experimental samples, and whether it is possible to determine which toothbrush was used by a subject based on the DNA profile.

The results of this study confirm earlier conclusions that a used toothbrush is a good, reliable source of antemortem DNA from a putative decedent. The use of aviation snips to remove a small portion of the toothbrush head provides an easy, inexpensive method of obtaining a DNA sample while preserving the remainder of the sample brush for possible future sampling. This method is recommended as a standardized technique for use in forensic DNA laboratories.

Used Toothbrush, DNA, Aviation Snips

F36 Cheiloscopy: A Reliable Tool in Human Identification - Part Two

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After attenting this presentation attendees will be shown a "modern'' glimpse at cheiloscopy.

This presentation will impact the forensic science community by providing a new perspective to cheiloscopy. The use of modern technology will elevate the understanding, identification, and application of lip print comparison.

Many techniques exist to establish a person's identity. DNA, finger prints, and the dentition are the most reliable scientific methods for human identification. Cheiloscopy (from Greek cheilos, lips and skopein, to see) is the name given to the study of lip prints and is also known as quieloscopy. Like finger prints and palatal rugae, lip prints are unique to one person (Suzuki and Tsuchihashi 1970:52-57; Cameron and Sims 1974:3). Lip grooves rarely change throughout life; they are permanent and unchangeable with few exceptions: physical or chemical burns and pathology may permanently alter the lip subtract.

Even though some rare exceptions, the study of lip prints has been neglected in the past. Historically cheiloscopy earliest study dates to 1902 with the biological description of lip patterns by Fischer. Later in the century, cheiloscopy was used in criminology. By the 1950s, the possibility of using lip prints in human identification was developed. Santos, in 1960, was one of the first to suggest that lip patterns could be classified. In 1972, Renaud's study of 4,000 lip prints confirmed the singularity of the human lip pattern. In 1974, Suzuki and Tsuchiashi developed a new classification for lip prints. They concluded not only lip print singularity but also the response of the lip tissue to different forms of trauma. After healing the lip pattern normally returns to its initial state. The goal of this presentation is to revive interest in this potentially useful tool in human identification.

A first paper on the current subject was presented at the AAFS annual meeting in Washington D.C. in February 2008 by Dr. Sylvain Laforte. It included a historical review of cheiloscopy with an overview of the different classifications (Santos, Suzuki and Tsuchiashi, Renaud, Afchar-Bayat and Domingues). Techniques of lip print lifting and transfer were also demonstrated as well as the use of Photoshop CS2 for lip print photographic enhancement.

The current paper deals with methodology and the use of different materials of impression taking and comparison. In fingerprint analysis, the use of cyanoacrylate, Rhodamine, Bright Yellow, Black Powder, and Red Wop powder are very useful in detection and/or lifting techniques; cups, mugs, glasses, cigarettes, cigars, oral instruments, pencils, pens, humans, etc., are also all potential recipients of lip prints. They may be left by suspects at crime scenes.

This paper will expose a variety of techniques and alternate methodologies resulting in a proposal for a new lip print classification - The Desranleau-Laforte method.

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Luminous Lip Prints as Criminal Evidence. Castelli Et Al. Forensic Science International Vol155, Issue 2-3, Dec 2005 P. 185-187

Establishing Identity Using Cheiloscopy And Palatoscopy. Abel Salazar Biomedical Institute of Oporto University, Portugal

Cheiloscopy, Lip Prints, Odontology

F37 Forensic Analysis and Historical Review of an Excavated Partial Denture From a United States Civil War Camp Site

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After attending this presentation, attendees will have a better understanding of the history of the fabrication of removable prosthetics in the United States.

This presentation will impact the forensic science community by increasing awareness of alternative techniques for the identification of dental prosthesis that may be associated with an individual to aid in their identification.

Historical and archaeological evidence have shown us that ancient civilizations had some knowledge of dental maladies and their treatments. While there have been written records with detailed instructions for wounds of the mouth, there is nothing mentioned for the restoration of lost teeth resulting from these injuries or maladies. Around 700 B.C. we begin to see the art in dentistry and the replacement of lost teeth with the use of ivory and bone, secured by gold bridgework. This level of dental art for the replacement of teeth was lost on further civilizations until the 1700s.

In 1774, the French pharmacist Duchateau designed hard baked, rot proof porcelain dentures, and patented them in 1789 as "Mineral Paste Teeth". These teeth were held in place by platinum pins, invented in 1808 by Italian dentist Giuseppangelo Fonzi. Porcelain teeth came into use in the United States in 1817. Artist Charles Peale began baking porcelain teeth in Philadelphia and the commercial manufacturing of porcelain teeth began in 1825 by Samuel Stockton in Philadelphia. Stockton's nephew improved the design and founded the S.S. White Company in 1844.

Throughout history, denture bases were fabricated from many different materials, each with their own advantages and disadvantages. Carved ivory was used early on as well as metals such as gold, both hammered and cast. Cast aluminum was not available until approximately 1870 but there were problems with it involving warping and imperfect density during casting.

While metal detecting in a field known to have been the site of several camps for armies from the North and possibly the South during the Civil War in the Shenandoah Valley of Virginia, an item was found at a depth of approximately 8 inches. When cleaned, it was found to be a metallic partial denture, yellow in color and having what appeared to be two denture teeth attached to it. After an initial examination, permission was granted to have the denture taken to SUNY at Buffalo for a thorough microscopic examination.

The denture was photographed, weighed, and examined with a stereomicroscope and images were captured of different areas of the denture. It was noted that each of the teeth were held in place to the base by two pins. It was also noted that the metal framework was actually three different pieces that appeared to have been soldered together.

The denture was analyzed by Scanning Electron Microscopy and Energy Dispersive X-ray Analysis (SEM/EDS). Areas analyzed were the base metal, soldered areas, denture teeth material, and the pins. The results were noted by a weight percent analysis of each of the regions giving the elemental breakdown. The results showed the base area to be 81.3% gold, 17.3% silver, and 1.4% copper. The soldered areas were 55% gold, 40% silver, and 5% copper. The solder had higher silver content, with a lower melting point than that of the predominately gold portions of the denture, allowing for soldered connections between the base area, clasp and the area connecting the denture teeth. The pins securing the teeth to the gold framework were 95% platinum, and 5% copper.

The tooth material had a composition corresponding to a ceramic feldspathic silicate, with oxides of silicon, aluminum, and potassium. From the composition of the teeth in this object and presumed provenience, it is possible that teeth from the S.S. White Company were used in this partial.

After the completion of various analyses and reviewing the historical data available regarding the fabrication of removable partial dentures in the United States, the investigator determined that the data tends to confirm that the prosthesis that was excavated from a known Civil War campsite is consistent with the materials in use during that time period in U.S. history.

Forensic Odontology, Forensic Archaeology, Identification

F38 Utilization of the OdontoSearch Comparison Program to Support Identification in a Modern Identification Case

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After attending this presentation, attendees not already familiar with the OdontoSearch program will be introduced to it, and all attendees will understand its usefulness in establishing personal identification in modern identification cases in which dental information is available only in the form of the written treatment record or dental charting (i.e., sans radiographs).

This presentation will impact the forensic science community by demonstrating how dental identifications might, indeed, be made in cases where antemortem radiographs are not available (lost, misplaced, or non-existent) if the antemortem charting is adequate and the uniqueness of the dental restorative pattern is objectively found to be significant.

OdontoSearch is a software program, developed at the U.S. Army Central Identification Lab, Hawaii (CILHI). The program was developed by Dr. Bradley J. Adams et. al. and presented in the *Journal of Forensic Sciences*, May 2003, Vol. 48, No. 3. The program is not an identification program (e.g., Win ID, CAPMI, UDIM). It is a comparison program that allows the odontologist, when an association between postmortem remains and a specific individual has been made, to compare said dental restorative pattern to large reference datasets. The program then allows for the significance of the dental pattern match to be quantified. The results can be used to form an objective and quantifiable association between a missing individual and an unidentified set of remains. By attaching an empirically derived probability value (the expected frequency that a specific pattern would be found in the population), matches based on dental patterns can be quantified in a manner that is easily intelligible and defensible in a court of law.[1]

The case presented is as follows. A murder was alleged to have taken place in Brooklyn, New York in 2004 and was brought to the attention of the authorities in 2005. The supposed victim, an emotionally disturbed young man was allegedly abused, murdered, and dismembered by a family member. His remains were alleged to have been placed in several black trash bags and disposed of in multiple public trash receptacles along a main thoroughfare in the borough. The police were directed to a spot where several of the bags were purported to have been left. The police did, in fact, find three plastic bags, which

contained human remains. Among the remains were an intact skull and mandible, with an intact dentition.

Dental records from the dental facility where the young man had received treatment were secured. The dental chart was legible and up to date. The treatment records were also quite legible and thorough. Unfortunately, however, no antemortem dental radiographs available.

Comparison of the antemortem dental record and two independently performed postmortem chartings revealed virtually identical dentitions. As no radiographs were used the opinion of positive identification based strictly on written records might raise some eyebrows. Prior to the introduction of OdontoSearch the strength of an antemortem/postmortem match based on non–radiographic evidence was "supported" by the subjective judgment of the odontologist. Such judgments were unsupported by statistical analysis. Statements such as "one in a million" and "nobody else on earth" are both unfortunate and totally without any basis in fact.

The restorative pattern of the remains were compared, both in generic and detailed form, to the datasets within OdontoSearch (both, combined and modern civilian). The results of the detailed search reinforced the opinion of a positive identification by demonstrating the uniqueness of the restorative pattern found.

In this particular case, had it been necessary, non-dental confirmation of identification would have certainly been possible (i.e., DNA). However, had that not been a viable option, without the objective analysis afforded by the OdontoSearch program the dental identification would be without any real numerical support which might have rendered it, at the very least suspect and at the very worst, without defense and not believable in a court of law, had it come to that.

Reference:

1 Adams, Bradley J. Establishing Personal Identification Based on Specific Patterns of Missing, Filled, and Unrestored Teeth. J Forensic Sci 2003; 48(3)

Dental Identification, Empirical Analysis, Non-Radiographic Based Identification

F39 Digital Dental Image Transmission for Forensic Identification

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The goal of this presnetation is to present the problems associated with transmission of digital dental x-rays in forensic dentistry.

This presentation will impact the forensic science community by creating a better understanding of the pitfalls associated with electronic transmission of digital dental x-rays when used for forensic identification.

In the aftermath of a mass fatality incident involving multi-geographical decedents, retrieval of antemortem evidence often takes extra time while waiting for their delivery. For the forensic odontologist, trying to obtain one antemortem record from any jurisdiction can present problems. The use of current technology allows the transmission of antemortem and postmortem records, including digitized dental images, to a location of choice.

Proprietary software was developed by many companies for medical and dental imaging devices for use in hospitals and private settings. Transmission of medical and dental images for consultation and diagnostics outside the initial facility could not be done or was extremely complicated. The need for compatibility of imaging systems became apparent.

The American College of Radiography and the National Electrical Manufacturers Association created a joint committee to set up protocols and standards that eventually became known as Digital Imaging and Communications in Medicine (DICOM). The DICOM standards allow different manufacturers to integrate peripherals into a picture archiving and communications system also known as PACS. In hospitals and larger institutions, PACS in conjunction with DICOM, allows for automated exporting of all pertinent information associated with digital images.

The creation of DICOM and PACS has allowed for better transferability for medical and dental imaging. In smaller facilities such as dental offices, the inclusion of a PACS is usually cost prohibitive. Therefore, these changes to proprietary software thru DICOM still does not necessarily allow for easier transferability.

The presentation will show how dental imaging software varies greatly among the different manufacturers. Resulting images produced by DICOM do not always produce the necessary information associated with the original images. Attendees name may not export with the digital dental x-rays and the original dates may be lost during export. The participants will learn that DICOM and PACS are only a set of protocols and standards. There are pitfalls associated with DICOM. The forensic dentist will be shown differences between the DICOM sets. The forensic dentist will leave with a better understanding of what information is contained in the electronically transferred digital images and what information is not.

Forensic Dentistry, Digital Dental X-Ray, DICOM

F40 Hidden in Plain Sight and All in the Family

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After attending this presentation, attendees will have learned about some unusual death circumstances requiring the services of the forensic odontologist. Some useful tips for securing antemortem dental records will also be provided.

This presentation will impact the forensic science community providing knowledge for future investigations.

Occasionally, investigators have only half of the information needed to complete an investigation. For example, an individual claims to have committed a murder and hidden the body of his victim. Police may charge the individual for his actions, but until the victim's body is recovered and scientifically identified, it may not be proved that a crime has actually occurred. It could be months or years until all the pieces of a case are brought together for proper resolution.

Another example could be a missing person where there is no evidence of foul play. It is difficult to investigate a person who may choose not to be found or may be well concealed by circumstances of death.

The two cases described in this presentation demonstrate the role of the odontologist in the identification of persons who have died in unusual circumstances.

The first case involves a missing young man who either fell or was pushed to his death and remained undetected for some time even though a thorough search of his neighborhood revealed nothing. The ultimate discovery of his remains was not by investigators, but rather someone looking for something else. He was found in a most unusual location, almost a year after his disappearance. This individual was listed with NCIC and featured on *America's Most Wanted.*

The second case involves an alleged crime of murder linked to a family dispute. An abandoned live baby was the first clue to the disappearance of a young woman, yet no remains were discovered until months later even after exhaustive searches of the area where investigators suspected the remains to be. Even though a family member claimed responsibility for the missing person's disappearance, no evidence of murder was found. A very bizarre family situation had

emerged from the investigation of this untimely death. This case is particularly interesting because of the difficulty in obtaining antemortem dental records in spite of postmortem evidence of extensive dental treatment. The delay in securing adequate antemortem dental radiographs compelled investigators to employ alternate methods of scientific identification. The difficulties with the antemortem dental record search and the unusual source of records associated with this case will be discussed.

Record Keeping, Death Investigation, Digital Radiography

F41 Identification: It Isn't Magic

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After attending this presentation, attendees will have a greater understanding of the need to have the appropriate forensic experts provide their expertise in cases of missing and unidentified persons.

This presentation will impact the forensic community by serving as a reminder to those involved in missing and unidentified person cases that review, interpretation, corroboration, and the recording of accurate scientific evidence are the keys to victim identification. The goal is to highlight these functions. Experience has shown how easy it is to overlook or misinterpret scientific evidence.

Due to the complex nature of these cases, inaccuracies in the interpretation or recording of evidence pertinent to such cases can delay or hinder identification. Another key to accuracy is to allow another forensic scientist to corroborate findings, when possible. This second pair of eyes is an asset in the review process and reduces the possibility of misinterpreting or otherwise missing key evidence that may actually lead to identification. Diligence, scrutiny, and thoughtful review of the scientific evidence by those who are appropriately trained and experienced in their disciplines will be the best path to success. This is crucial to ensure scientific accuracy for comparison and ultimate scientific identification.

Law enforcement agencies are responsible for the data entry of cases in their jurisdiction. Once entered into a database, this information will be compared to available data to determine if any existing cases may be a possible match. The accuracy of the available data is therefore crucial to provide an effective matching process.

Case studies will be presented involving dental and anthropologic information as an example of the diligence required when documenting and recording pertinent information used in the identification process. Providing information just to fill a database will not magically produce identification.

Identification, Missing Persons, Unidentified Persons

F42 Practical Update in UV LED Fluorescent Light Restoration Detection: Science and Casework

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The goal of this presentation is to inform and update the forensic odontologist of the potential benefits and pitfalls of using an ultra violet light emitting diode (UV LED) light for composite resin and dental restoration detection.

This presentation will impact the forensic community by describing the practical circumstances in which UV LED light dental inspection can be effective.

Composite resin restorations whose shades are well matched to that of teeth and are contoured to be anatomically correct may be difficult to recognize by visual inspection or tactile inspection. Even radiographically, these restorations may not be apparent. This problem is evident in postmortem charting for the forensic odontologists. Teeth naturally fluoresce when exposed to sunlight. This affect has encouraged many manufacturers to add compounds to mimic this property in the composite resin. The result is a wide variety of materials that exhibit varying fluorescent properties that range from no fluorescence to that similar to tooth structure, or much brighter than tooth structure.

A technique using LED UV light was introduced as an aid in composite resin detection at the 2006 AAFS Annual Scientific Meeting. The use of this method can greatly enhance the visual detection of restorations that may otherwise go unnoticed. Many forensic odontologists now include UV flashlights as standard equipment in their forensic armamentarium. However, there have been subsequent questions involving casework in which materials present did not respond to UV illumination. There are several instances in which UV LED light may not produce expected results.

Since dental materials, including porcelains, possess varying degrees of fluorescence properties it is important to understand what the potential limitations of using a UV LED light may be. There are also circumstances that contribute to these limitations, such as instances that involve incineration. Resin material will lose fluorescent properties at a fairly low temperature. This temperature range was determined to be around 300C. Thus, with the wide range of visual results likely with the use of a UV LED light, a spectroscopic study was performed to determine the range of these possibilities.

Twenty-four brands of modern composite resin were evaluated. Discs of resin, 1.7mm in thickness and 1cm in diameter, were prepared between two glass plates and polymerized according to manufacturers directions. Fluorescence spectroscopy was performed on each disc using a UV-Visible light spectrofluorometer (SLM 8100 Spectrofluorometer). The fluorescence intensity maxima and emission maxima of the composite resins was determined. Control samples of dentin and enamel were also measured. The spectral distributions and intensities of flashlights with different LED configurations and wavelengths were also analyzed. The optimal wavelength for LED light inspection was determined to be 395nm. The relative fluorescent properties of the composite resin were documented. The resins were subsequently placed in extracted teeth and the tooth/material exposed to 395nm UV LED light and the results photographed and documented with the aid of a stereomicroscope.

Results indicated that several manufacturers incorporate a fluorescing agent that mimics tooth structure exactly. In this situation there will be no visible contrast between the resin and the enamel. This may lead to a false negative result if the UV LED light technique is used. It is important when using a procedure to be aware of limitations that may exist. The pros and cons of UV LED light will be discussed, and case studies will be presented.

Forensic Odontology, Fluorescence, UV LED

F43 Use of Ultra-Violet Light in Victim Identification: A Case Report

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The goal of this presentation is to discuss how the forensic odontologist must be able to utilize all devices and methods available in

the quest for victim identification. This presentation will deal with the use of an ultra-violet light source to detect fluorescence in certain composite resins or sealants.

This presentation will impact the forensic science community by encouraging the forensic odontologist to be aware of the various investigative modalities available.

The forensic odontologist may not be able to identify every victim he or she encounters due to a multitude of reasons. It is indeed unfortunate when a lack of complete antemortem records will often preclude the certification of a dental identification. Sometimes, however, a relatively small amount of dental information can contribute to a positive identification when considered along with information gleaned from other disciplines. The following case is an example of such an identification; what is particularly unique is that the dental information was ascertained by the use of an ultra-violet light source.

The case involved four victims of a suspicious house fire; later confirmed by the fire marshall as arson. The victims were believed to be members of the same family and included a mother, a teenage son, and two pre-teen daughters. The husband/father in this family was at work when the incident occurred. A complete postmortem dental examination on the adult female was performed and a dental chart with a full mouth series of radiographs was generated. These records were compared to the antemortem dental records supplied by the family dentist. Based on this examination and comparison of both post and antemortem records a positive dental identification of the adult female was established.

The medical examiner had ordered an evaluation of mitochondrial DNA on the victims and it was determined that all the individuals shared the same mDNA. Based on this laboratory finding coupled with the positive dental examination of the mother, the medical examiner concluded that the three children were indeed members of the same household.

A postmortem dental examination of the teenage male victim was performed and a dental chart was produced. Because this victim did not have any antemortem dental records available, a dental identification was impossible. Due to the consistencies of the forensic evidence surrounding this individual, such as age estimation, location at the scene, gender, jewelry, and mDNA a positive identification was deemed credible.

The two young girls presented a different situation. Because of the closeness in their ages there was no significant dental evidence to accurately separate them by the usual age determination techniques. Both victims' mandibles were locked in a slightly open position with approximately 15mm measured at the central incisors. For various reasons resection of the jaws was not an option. No restorations were visible on either victim. Both had been seen by a dentist but there were no radiographs taken and restorative charting had not been done. The records did indicate however that an occlusal sealant was placed on tooth #14 on Girl Victim #1 and an occlusal sealant had been placed on tooth #3 on Girl Victim #2. Examination with a #23 explorer was difficult and inconclusive. Utilizing the properties of Ultra Violet light examination espoused by Guzy et al, the fluorescence observed was consistent with the dental record. With this information Girl Victims #1 & #2 could be tentatively identified.

While these consistencies afforded a "probable" dental identification it was considered prudent that a "positive" dental identification could not be certified based on this one parameter alone. This information when coupled with the mDNA match resulted in giving Girl Victims #1 and #2 their proper names.

UV Light, Fluorescent Resins, Probable Identification

F44 Dental Age Estimation of Unaccompanied Minors as a Part of Human Rights Protection in Europe

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After attending this presentation, attendees will have an understanding of some of the procedures used in European countries for age estimation of unaccompanied minors.

This presentation will impact the forensic science community by showing the importance of age assessment for protection of human rights.

The increase in migratory flows in Europe, and the subsequent complexities resulting from them taken in the broader context of globalization, has revealed a number of problems, such as the protection of human rights, identification of those with the right to apply for refugee status, and the age estimation of unaccompanied minors. Unaccompanied asylum seekers deemed to be under 18-years-old face a very different path through the immigration system from that followed by adults. Generally, adults are subject to immediate deportation or detention in jail. Minors are processed through the juvenile system, where detection is not mandatory; they will often have access to educational programs and may be granted a residency permit. The assessment of chronological age is notoriously difficult. Age assessment is particularly difficult for those who are aged between 15 and 20 years, yet it is precisely this age group where the assessment of age and the outcome of the process is most critical.

In this context dental age estimation methods have proved versatile and are used effectively in various European countries facing the problem of illegal immigration. The purpose of this presentation is to show different examples of dental age estimation through case studies, where odontologists played a major role in age assessment. A review of six unaccompanied asylum seeker/refugees cases from Iceland, Italy and Serbia are presented.

Case 1: Presents a case in Iceland which was requested by Icelandic Directorate of Immigrants. A male from Albania insisting to be 16-years-old, was found to be over 20.

Case 2: Presents a case in Iceland which was requested by Icelandic Directorate of Immigrants where a female from China claiming to be 17. Estimates confirmed the probability that the she was the age claimed, given the standard deviation. Kullman (1992), Mincer (1993) and Haavikko (1970) dental age estimation methods were employed.

Cases 3 & 4: Presents two cases in Italy which were requested by Immigration Police authorities and Judges. A male from Nigeria and a male from Iraq, both claiming to be minors. Relying on skeletal maturation as seen on an x-ray of the wrist, iliac crests, and dental panoramic (Harris, 1984; Kullman, 1992 and Moorrees, 1963), together with background information and external examination of each individual, only case two proved to be under 18.

Cases 5 & 6: Presents two cases from Serbia requested by Serbian NGO "Praxis." The cases examined regard two refugees from Kosovo who escaped after NATO bombing in

1999. In both cases, tables by Kahl & Schwartz (1988) Mincer (1993), Olze (2003), Orhan (2007), Gunst (2003), and from Smith (1991) were employed by an odontologist to verify the real year of birth in order to issue proper identification documents. The experts' report was based on the recommendations of Forensic Age Estimation Study Group of the German Association for Forensic Medicine including anthropometric measures and radiological analysis of the wrist. The age claimed was confirmed by the procedures.

The presentation does not attempt to give a definitive account of the different scientific methods for the assessment of age, but age estimation of unaccompanied minors is a fundamental principle of human rights and dignity. A possible increase in the accuracy of age estimation process can only be achieved by using multiple age estimation parameters. In order to achieve and maximize the effectiveness of the age assessment process, implementation of international standards through a technical table with the political will is needed. Nevertheless, more observational data in the countries where refugees come from and a synergy between medical examiners and odontologists is needed, in order to assess the correction parameters to be used in dental age estimation formulas.

Dental Age Estimation, Asylum Seekers, Refugees

F45 What's So Special About a Specialist?

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After attending this presentation, attendees will have an understanding of the reason why pursuing recognition of forensic odontology as a "legitimate" specialty by the American Dental Association might not be in the best interest of the field.

The presentation will impact the forensic science community by providing a more complete answer, than a simple "no" to the question occasionally asked of forensic odontologists in court: "Is forensic odontology recognized as a specialty by the American Dental Association?"

Forensic odontology is not recognized as a "legitimate" dental specialty area by the American Dental Association (ADA). Most state dental boards allow dentists to present themselves to the public as specialists in *only* the areas approved by the ADA. Therefore, in most states, dentists are permitted to claim to be specialists in only the fields of endodontics, orthodontics, periodontics, pedodontics, prosthodontics, oral & maxillofacial pathology, oral & maxillofacial radiology, oral & maxillofacial surgery, and dental public health. A dentist wishing to present him/herself as a specialist must, of course, meet the requirements promulgated by the particular dental board in the state where the dentist practices—generally, one of the requirements is certification by the appropriate board of examiners in the specialty area. The ADA has designated the organizations which are these "legitimate" certifying bodies, and also what sort of training is necessary to meet the requirements in order to challenge the respective board exam.

The American Board of Forensic Odontology (ABFO) was established in 1976 under sponsorship of the American Academy of Forensic Sciences (AAFS). In order to practice forensic odontology at a high level of competency—particularly in the area of bite mark analysis—substantial training and experience is required beyond that received in the usual undergraduate dental curriculum. The requirements established by the ABFO for an odontologist to be eligible to challenge the board exam are extensive, and the examination is rigorous. In the span of 33 years since its founding, less than one hundred and fifty individuals have achieved board certification by ABFO.

Nevertheless, the ADA does not recognize specialty certification by ABFO, and does not recognize forensic odontology as a true dental specialty. The primary reasons *appear* to be: (1) forensic dentistry is not considered a "healing art;" and, (2) the educational prerequisites set forth by the ABFO do not include the typical requirement of two-year's full-time study in an ADA-approved academic institution.

Many forensic odontologists, according to anecdotal reports, have been challenged in court by opposing counsel with the question "Is forensic odontology recognized by the ADA as a legitimate specialty?" It is possible the truthful answer "no" might be used by counsel in an attempt to plant a seed in the jury's mind that forensic dentistry is, therefore, somehow untrustworthy. It is contended, though, upon reflection, it is not recognition of forensic odontology by those in the *dental* field that is important, but recognition by those in *forensics* that is significant in court. Forensic odontology may well *not* be a healing art, but it *is* a legitimate and accepted forensic field.

A caution is further presented that *if* forensic odontology *were* recognized by the ADA as a specialty field, there could be a counterproductive result. Dental specialists are usually required by their organizations to restrict their practice to only the specialty area. Since most forensic odontologists are "part-timers" with their principal employment in academics, the military, or in general practice, many would still not be able to limit their practice to only forensics and claim specialty status.

The case of *Potts v. Zettel*, 220 Fed.Appx. 559, 2007 WL 412232 (Ninth Cir. 2007), involved a California dentist (Potts) who advertised to the public that he was a specialist in dental implantology, and that he was board-certified by the appropriate board in that field. But since this is not a recognized specialty area by the ADA, and, consequently, not recognized by the California dental board, California sought an injunction to prohibit Potts from further such advertising. Potts, in turn, sought declaratory and injunctive relief on freedom of speech grounds, and was awarded summary judgment by the federal district court. On appeal, the Ninth Circuit reversed and remanded on other grounds. The impact this case might have on those who wish to present themselves as specialists in forensic odontology is reviewed.

Specialization, Forensic odontology, Potts vs. Zettel

F46 A Preliminary Investigation of Bite Marks on Human Skin: Clothed Versus Unclothed

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After attending this presentation, attendees will understand some principles of bite mark investigation, in relation to force and bruising on a given anatomical location.

This presentation will impact the forensic science community by increasing understanding of the nature of bruising on clothed skin versus unclothed skin.

In bite mark analyses, a forensic odontologist must consider the probability that a bite mark found on the skin surface can be matched to a given pair of teeth. Acceptance of bite mark evidence in court can be traced back to the early nineteen century, although recent knowledge in the field has increased since the late 1970s. This development was substantiated by the number of reported criminal cases which began to accelerate after the conviction of Ted Bundy in 1978. Much attention has been concentrated and focused around the preservation and accuracy in bite mark analyses. The American Board of Forensic Odontology (ABFO) developed a set of guidelines to improve the methodologies used in bite mark cases with one of the most important developments being the ABFO No. 2 reference scale.

This study collected bite mark data and analyzed the differences in bruises between bites on bare skin versus bites through clothing from eight white European adults, in Nova Scotia, of both male and females

from various ages. One set of dentition was used to create the bite marks; the dentition were dentures mounted on a vice grip-type device. Photographs were recorded every 15 minutes for the first two hours and then hourly up to six hours in indoor day light illumination. The following day, examinations of bruising were carried out in a dark room using alternative ultraviolet crime light sources at 415 nm and 450 nm wavelength (Hughes *et al*: 2006). The anterior side of the left forearm was chosen as the substrate for the bites; the unclothed bite mark was created approximately 7 cm from the wrist and the clothed bite mark was created approximately 5 cm from the elbow. The force was kept constant for each bite mark created on the volunteers. Variances were observed between the bite mark inflicted upon clothed skin as compared to the classical bite mark structure. The strongest variable, regarding visibility of the bite marks, was the age of the volunteer. Other variations were also seen between volunteers within the same age range. Body Mass Index (BMI) was not included in this study so the results do not reflect the individual distribution of fat and musculature tissue in this anatomical location.

The results of this study provide preliminary data for the analysis of bite marks inflicted on unclothed and clothed skin. The results indicate that the bites on clothed skin heal faster than the bite marks on unclothed skin. Further studies would need to be conducted in order to assess the distortion and bruising of skin in relationship to age, sex, BMI, and bite mark distortion on clothed and unclothed skin surface with a given force.

A preliminary study of bite marks on clothed versus unclothed skin as examples of case work related to sexual assault and abuse will be presented.

Bite Mark, Force, Bruising

F47 Identification of the Edentulous Individual: An Investigation Into the Accuracy of Radiographic Identifications

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After attending this presentation, attendees will understand that the identification of edentulous individuals is often found to be problematic, due in part, to a poor uptake in the labeling of complete dentures.

This presentation will impact the forensic science community by highlighting the fact that the dental identification process is often found to be challenging due to the lack of antemortem materials and/or unique features more commonly visible in dentate radiographs.

Since radiology provides the basis for most dental identifications it would appear reasonable to assume that the majority of dental records may provide useful information to facilitate comparative identification. However, the task of identifying found human remains based on dental comparisons of postmortem and antemortem radiographs is labor-intensive, subjective, and has several drawbacks, including inherently poor image quality, difficulty in matching the viewing angles in postmortem radiographs to those taken antemortem, and the fact that the state of the dental remains may entirely preclude the possibility of obtaining certain types of radiographs postmortem.

This less than satisfactory situation is more often than not, exacerbated by the constant resorption process occurring within the maxillary and mandibular alveolar ridges over the lifetime of an edentulous individual. From such observations it could be argued that any radiograph taken of an edentulous ridge may at best represent only a "snapshot in time" of that process, hence unless the examiner is proficient in matching bone trabeculations, such temporal changes in residual ridge morphology have the potential to mislead all but the most experienced of dental investigators.

The purpose of this study therefore, was to quantify the error rate and reliability of dental identifications based on a comparison of synthesised antemortem and postmortem radiographs of edentulous individuals. Ten observers examined ten cases on two occasions and reported dichotomous and conclusion level decisions. The data were analyzed using Kappa and ROC. The mean area under the curve was 0.75 and the mean sensitivity was 0.57 and specificity was 0.83.

The results obtained from the data suggest that dental identifications of edentulous individuals using radiographs alone have a high error rate and hence should be dual reported. Forensic organizations worldwide have recommended that dental prostheses should be labeled with at least the patient's name and preferably with further unique identifiers such as social security number, etc. The data obtained from the aforementioned study add further weight to the argument that all dental prostheses should be labeled and that all dental implants should be serialized.

Forensic Science, Radiography, Denture Marking

F48 X-Rays, Angles, and an ID: A Case Presentation

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After attending this presentation, attendees will gain another technique to aid in obtaining postmortem radiographs for a dental identification.

This presentation will impact the forensic science community by demonstrating how a specific difficulty with antemortem radiographs can be addressed.

Radiographs are one of the best tools that forensic odontologists use to assist in the identification of deceased individuals. Obtaining quality antemortem records, especially radiographs, is crucial for identification. However, in this case, the antemortem radiographs were not ideal, therefore, the postmortem radiographs needed to be similar to allow for an accurate comparison.

In this situation, the suspect poured gasoline on Victim A while the victim was sleeping in the lower level of a house, and then set him on fire. The flames soon spread to the rest of the home and consumed it. Two other family members were able to escape from the upper level, but Victim B did not get out of the building. As sad as any homicide is, this was made more poignant by the fact that the suspect, Victim A, and Victim B were all related. The suspect was the cousin of Victim A and the brother of Victim B.

The identification of Victim A was straight forward. His antemortem radiographs were obtained and compared to the postmortem radiographs taken in the Coroner's office. He had several posterior amalgams that were consistent and it was determined to be a positive identification.

The identification of Victim B was more difficult. There was a current set of full mouth radiographs that were provided by the decedent's general dentist. These antemortem radiographs were compared with the full mouth set of postmortem radiographs taken by a forensic dentist at the corner's office. When compared, the posterior radiographs showed much consistency, but the anterior teeth did not. The antemortem radiographs were very foreshortened. The case was made even more arduous in that the victim had all thirty-two adult teeth, but no restorations.

Test radiographs were made on a human skull that had been dissected for medical study. Different film placements and angulations of the X-ray unit were attempted to reproduce the foreshortening seen in the antemortem radiographs; but to no avail. Finally, the dental office of Victim B was contacted and it was requested that they demonstrate their radiographic technique. The dental office agreed and the dental assistant that took the antemortem radiographs of Victim B showed exactly how

she placed the radiographic film, and at what angulations she took the radiographs. To document this technique, the assistant was asked to photograph a sample of her method, so that it could be replicated at the coroner's office. The postmortem radiographs were then taken again on the descendent, using the new film placement and angulations.

Comparison of the antemortem radiographs of Victim B and the new postmortem radiographs revealed that they were consistent. Therefore the conclusion was a positive identification.

Forensic Odontology, Indentification, Dental Radiographs

F49 A Review of the Literature Concerning Radiation Safety Features of the Nomad™ Portable Hand-Held Dental Radiation Emitting Device

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After attending this presentation, attendees will be able to understand the current literature regarding the radiation-emitting characteristics of the Nomad™, compare and contrast the results of the various independent studies concerning radiation safety for the Nomad™, and evaluate the consistency and validity of the various independent studies to determine for themselves the operational safety for the device.

This presentation will impact the forensic science community by clarifying why the Nomad has proven to be a valuable tool for the forensic odontologist. The Nomad™ presents many possibilities in dentistry and other fields of science and industry. However, State Radiation Safety Authorities have been reluctant to allow the use of the Nomad™. This presentation will allow the profession to evaluate the safety of the device to encourage its broader use in dentsitry and other professions.

The Nomad™ portable hand-held dental radiation emitting device, developed in 2004 and approved as a medical device by the FDA in 2005, and has since its introduction, been used almost exclusively in the resolution of mass fatality incidents (MFIs) requiring forensic dental identification of numerous victims. Thus, radiological assistance provided by this device is generally acknowledged among forensic specialists and units have become standard components of the prepositioned armamentarium supporting the mission of Federal Disaster Mortuary Operational Response Teams (DMORTs) in the United States and their counterparts internationally.

Since the introduction of the Nomad™ unit, a body of research that has analyzed and measured scatter radiation control capabilities and radiation shielding characteristics of this portable hand-held dental radiation emitting device has evolved. With the information provided in this review of that literature, forensic odontologists, general dental practitioners, and those in other disciplines, seeking to employ the Nomad™ device, will have access to a broad knowledge base related to the radiation safety parameters of the Nomad™ unit. Analysis of the radiation safety aspects that have been incorporated into the Nomad™ portable hand-held dental radiation emitting device will be stressed. These features have been shown in previous studies to offer protection to the operator of the Nomad™ device as well as the patient, attending staff personnel and bystanders.

Therefore, it is the purpose of this report to review and collate information from studies which have evaluated radiation safety factors associated with use of the Nomad™ unit. By distilling and summarizing this information, the presentation will impact the forensic community and/or humanity by serving as a single reference which will facilitate dissemination of this knowledge to forensic dentists, general dental practitioners and other experts who may be asked to use the Nomad™ device in dental setting or in other fields of practice (veterinary medicine, physical anthropology, surgery). This will permit those who utilize the Nomad™ instrument to make decisions based on evidence in the literature regarding their need or choice to use additional radiation protective and monitoring devices, such as lead aprons and dosimeters, while operating the machine.

Additionally, although the NOMAD™ unit has been used successfully, since its introduction in the situations described previously; in the United States, use of these portable radiation emitting instruments in private dental offices and/or clinics, or by other professionals, has been hindered by individual state radiation safety laws. If these restrictive policies are to change, state radiation safety officers in the United States and similar officials internationally, can utilize the information in this presentation when determining future policies related to the use of these devices within their jurisdictions

Forensic Science, Portable Radiation Emitting Device, Radiation Safety

F50 Current Radiation Safety Regulatory Policies and the Utilization Status in the United States of the Nomad™ Portable Hand-Held Dental Radiation Emitting Device

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After attending this presentation, attendees will understand and appreciate that despite the successful implementation of the Nomad™ hand-held dental radiation emitting device in the aftermath of recent international and national forensic multiple fatality incident (MFI) events, virtually every state radiation safety regulatory agency in the United States has continued to adhere to its previously established radiation safety regulations, which prohibits the general use of the hand-held radiation emitting device in dental settings and in other fields of practice (veterinary medicine, physical anthropology, surgery).

This presentation will impact the forensic science community by serving as a reference for those dental practitioners and other experts who may be requested to provide supportive testimony before state radiation safety regulatory agencies when advocating the common use of these hand-held radiation emitting devices. Additionally, this state-by-state radiation safety policy review study can facilitate the task of state radiation safety officials, responsible for reevaluating current restrictive principles associated with these units, as they deliberate and reassess jurisdictional policies which can lead to eventual approval status for the Nomad™ portable hand-held dental radiation emitting device for general use in their respective states.

Although recent studies have shown the Nomad™ unit to be extremely safe for the operator, patient, and bystander, state radiation safety regulatory agencies have often been reluctant to approve of the application of the Nomad™ device for general use as indicated above. Thus, these agencies have continued to maintain rigid regulations governing the general use of this devise. Principally, the caution expressed by these regulatory agencies continues to be based on the extremely poor scatter control and poor shielding characteristics of

earlier hand-held radiation emitting devices. As reported, the Nomad™ unit has overcome the limitations of its predecessors.

It is the purpose of this study to review, compare, summarize, and report the current state-by-state radiation safety regulatory policies in the United States regarding the approval status of the Nomad™ device for general use. With this information, forensic odontologists, general dental practitioners, and those in other disciplines, seeking to employ the Nomad™ device, will have knowledge of the regulatory stipulations required in their respective jurisdictions.

Forensic Science, Portable Radiation Emitting Device, Radiation Safety Regulatory Policies

F51 Comprehensive Disaster Preparedness and New York City's Medical Examiner Special Operations Response Team (MESORT): A Forensic Odontologist's Perspective

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The goal of this presentation is to brief attendees on the New York City's Medical Examiner Special Operations Response Team (MESORT). The attendee will be exposed to NYC's multidisciplinary approach to emergency management and its multi-faceted training protocol.

This presentation will impact the forensic science community by discussing how mass fatality incidents come from many sources; terrorist attacks, hurricanes, earthquakes, and pandemic influenza events, and how municipalities need to be prepared. This presentation will expose the attendees to year round training drills New York City undergoes and how forensic odontology plays a key role in the New York City's multidisciplinary approach to disaster management. These risks are universal and therefore its usefulness in the field of forensics and its impact on humanity is incalculable.

As part of its disaster preparedness program, New York City's Office of Chief Medical Examiner (OCME) has developed a multidisciplinary team to respond to and manage mass fatality incidents. Funded with Department of Homeland Security grant funds, the federal mandate for this program is to not only cover a terrorist attacks, but to take and all hazards approach in dealing with other incidents such as hurricanes, earthquakes, or pandemic influenza events. An essential element of this plan is New York City's Medical Examiner Special Operations Response Team (MESORT) program. This presentation will give a brief overview of MESORT and cover some of the key elements of preparation, training, and mock disaster drills to insure an organized and effective deployment in the event of an incident. It will also discuss the role the role forensic odontologist plays as part of this multidisciplinary response team.

Thousands of person-hours have gone into design, coordination, and implementation of specific response plans for MESORT operation. The fundamental component of MESORT operations are preparedness and training. MESORT training consists of multiple annual drills deployed in numerous areas. Drills are divided into three types: Family Assistant Center, Disaster Mortuary Operations, and Field Investigative/Recovery Operations. Additionally, a critical aspect of these drills incorporates Management Information Services (MIS) and the deployment of critical computer hardware and software components.

Family assistance center drills are performed at specially designated locations throughout the city often near major transportation hubs such as airports. This program is coordinated with multiple local and federal agencies including New York City Office of Emergency Management, New York City's Police Department, and the Department of Environmental Protection, the Department Of Transportation, as well as numerous other city agencies. Federal agencies include National Transportation Safety Board (NTSB), Department of Defense (DOD), and the Department of Homeland Security.

Disaster Mortuary Operational preparedness involves exercises conducted at one of five New York City medical examiner facilities. These drills test the preparedness of each facility to handle a sudden increase in volume as well as the ability to distribute the work force if necessary. Again, coordination with other city and federal agencies is a crucial component of this disaster drill.

Finally, a crucial part of MESORT operation is Field Investigative/Recovery Operational training. The ability to deploy a field mortuary to deal with potentially hazardous remains is crucial. The presentation will cover this process including the HazMat components necessary to insure the safety of MESORT personnel. Additional discussion will include the special equipment developed for Field Operations.

Another key component of MESORT operations is the Pandemic Influenza (PI) Surge Plan for In and Out of Hospital Deaths. The planning assumptions are based on the Centers for Disease Control and Prevention's (CDC) estimates of a PI event fatality scenario. This plan coordinated OCME's efforts with local Health Care Facilities (HCFs) to assists in the removal, tracking and temporary storage of decedents. Through the use of strategically placed Body Collection Points (BCPs) of refrigerated storage units the MESORT is responsible to aid HCFs by providing temporary storage, track decedents under their responsibility, and to release decedents to private sector entities (e.g., funeral directors and crematorium owners) without delay or perform city-directed burial of decedents when necessary.

The lifeline of the MESORT operation is its Management Information System (MIS) division. This presentation will cover some of the deployment specifications as well as the difficulties in deploying a complete technology infrastructure in New York City within hours of arriving at a location. A discussion of connectivity requirements as well as field-testing of MIS systems will be covered. In addition, review of communication cooperation agreements with the Department of Defense and Homeland Security utilizing their terrestrial and satellite communications infrastructure to ensure backup communications capability will be presented.

A brief discussion of updates to the Unified Victim Identification System (UVIS) and the UVIS Dental Identification Module (UDIM) as it relates to disaster operations will also be presented. This software is the key component of the MESORT operation and its role as the integration of a multidisciplinary approach to mass fatality management cannot be overemphasized.

The presentation will conclude with a discussion of the MESORT multidisciplinary approach to disaster management. A critical component of this approach was the inclusion of Forensic Odontologist in the process and the seamless integration of dentistry in the identification at process.

MESORT, UVIS, UDIM - UVIS

F52 Dental Identification Based on Photographic Comparison: A Case of Homicide Concealed as an Auto Accident

William C. Rodriguez III, PhD, Armed Forces Medical Examiners Office, 1413 Research Boulevard, Building 102, Rockville, MD 20850*

The goal of this presentation is to provide the attendee with a case example in which the postmortem dental identification of a badly burnt body was based on comparison of an antemortem photograph.

This presentation will impact the forensic community by presenting information on the technique of utilizing unique dental characteristics and anomalies of the anterior dentition which may be useful in establishing positive identification of the deceased when radiographic records may not be available.

Use of distinguishing individual dental morphology such as shape, size, contours, and chipping injuries can be utilized for identification purposes through detailed comparison to dental characteristics depicted in a recent photograph of the deceased in question. The usefulness of this technique depends on the uniqueness of the dental feature/s being compared, and the clarity/resolution of the photograph of comparison. How modern digital photography and computer enhancement will be demonstrated so that the attendee will be able to incorporate this technique in their forensic practice.

The case to be presented involves the murder of a 19-year-old Caucasoid female whose badly burnt remains were recovered from a burning vehicle. In early July 1986, the Quachita Parish, Louisiana Sheriff's Department responded to a vehicular fire along a local interstate road. Examination of the scene by the Sherriff's Deputies and the local coroner concluded that the vehicle involved apparently had run off the road striking a tree, a fire ensued thus resulting in the death of the driver. The remains of the deceased were transported to the Bossier Parish Coroner's Office for examination as a vehicular accident victim.

On the same day the Bossier Parrish Coroner's Office received another body, that of a young adult male whose body had been discovered in a parish adjacent to Quachita Parrish. The deceased male was determined to be a homicide victim who died as the result of a large knife wound to the neck. According to the sheriff's report the remains recovered from the burnt vehicle were likely that of an elderly male in whose name the vehicle was registered. Forensic anthropological examination of the remains found them to primarily consist of a badly burnt torso in which the internal organs were exposed and heavily charred. The skull was noted to be in a burnt and fragmented state. Much of the remaining top half of the skull, which was recovered as burnt cranial fragments from the body bag, were reconstructed on top of the inferior half which remained partially articulated to the cervical spine. Additional anthropological examination revealed the remains not be those of an elderly male but those of a young adult Caucasoid female. The identification of the remains as a young female was unexpected in lieu of the sheriff's investigational reports.

Detailed reconstruction and examination of the upper cranium revealed the presence of a small defect located along the left side of the frontal bone. The defect was identified as an entrance gunshot wound to the head. Radiographic examination of the reconstructed skull, and adhering brain remnants provided evidence of bullet remnants which were collected as evidence. Investigational reports received later in time from the scene of the car fire, noted that the degree of impact exhibited by the car did not appear sufficient to produce the death of the deceased much less result in the vehicle fire. As investigational clues began to develop during the day it was determined that the victim from the car fire was possibly that of a young female who was reported missing along with her married boyfriend. The actual owner of the burnt vehicle was located and he informed the authorities he had loaned the car to the boyfriend of the young female in question. At this point identification of the young male with the slit throat was confirmed by the coroner's office as the friend who had borrowed the car.

Identification of the badly burnt torso became crucial and solving a final piece of the forensic mystery. Initially, dental records could not be located of the young woman in question, and therefore a request was made for a recent photograph. A joint examination by the consulting odontologist and anthropologist found the remaining dentition to be consistent with a dental age of approximately 18 to 21 years of age. No restorations were noted on the dentition; however, the remains of the maxilla revealed a chip on the labial surface along the inferior medial edge of the right lateral incisor which was discolored. Comparison of the configuration of the remaining maxillary dentition found a matching discolored chip on the corresponding tooth in the photograph. Based on the anthropological and odontological findings the deceased was positively identified. Additional confirmation of the identification was made later after a radiographic record was recovered and utilized for comparison by the odontologist.

Establishing the identity of the young woman lead the law enforcement authorities to theorize that the two young individuals who had planned to travel to a local motel for an intimate date had possibly encountered a hitch hiker or other individual at one of the many truck stops along the section of interstate. The individual or individuals they encountered apparently took control of the vehicle, driving to one parish and killing the young male and dumping his body along side of the road. The vehicle was then driven to the adjoining parish where the vehicle was driven off the road where the young woman was shot in the head, and the car set on fire in an attempt to disguise the crime. As of this presentation the two murders have yet to be solved.

Identification, Odontology, Photographic Comparison

F53 Albuquerque, New Mexico Serial Homicides – The Dental Identification of Seven Skeletal Remains Recovered From a Clandestine Burial Site

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After attending this presentation, attendees will have an understanding of the difficulties in making dental identifications with limited or no antemortem dental records and to learn how the identifications of remains from this large serial homicide burial site were made.

This presentation will impact the forensic science community by demonstrating the importance of obtaining antemortem dental radiographs and written records soon after a person goes missing. Since all of these remains had evidence of past dental treatment, it is likely that all eleven remains could have been identified quickly if antemortem records had been obtained when the women went missing.

On February 2, 2009 a left human femur was found by a woman walking her dog in a remote area of Albuquerque, NM. Over the ensuing three months, eleven complete and partial sets of human skeletal remains were recovered from this recently developed land for a home subdivision. It was soon apparent that these were modern remains, perhaps some of twenty four women that had gone missing in Albuquerque between 2001 and 2005.

Antemortem medical and dental records on these twenty four missing women were scant. Other than missing person reports being filed when these women went missing, little was done in follow-up to obtain antemortem medical and dental records. Once the recovery began and it was realized that these might be some of the missing women, a concerted effort was made to obtain antemortem medical and dental records by the New Mexico Office of the Medical Investigator (NMOMI). NMOMI investigators searched for hospital records, dental records, and correctional and institutional facility records. New Mexico dentists were contacted and asked to search their current and archived records for records of these women.

As a result of this effort, seven of these recently recovered remains have been positively identified by dental comparisons with antemortem dental and medical radiographs and written records. Another skeleton recovered in 2004 that had remained unidentified until June 2009 was also identified by dental comparison as one of the twenty-four missing women from Albuquerque.

This presentation will focus on the recovery and identification of these emains. The dental identifications were not only based on the comparison of antemortem dental radiographs and written dental records with the postmortem evidence, but also on the comparisons of head and neck CT scans, facial photographs, medical records, and in one case an oral surgeon recognizing his surgical handiwork of an osteotomy and the internal wire fixation he placed on the fractured ramus of a mandible.

The presentation will also stress the importance of the need to obtain antemortem records of missing persons in a timely manner. All but one of the eleven remains exhibited evidence of past dental treatment. Some had extracted teeth, silver amalgam restorations, sealants, endodontically treated teeth, and crowns. They had been to a dentist, therefore a dental record and likely dental radiographs were probably available at the time these women went missing, yet missing person investigators did not obtain the information at that time. Trying to find records three to nine years after a person has gone missing is difficult. Records are purged, archived at remote locations, dental practices are sold, dentists die, and offices are reluctant to spend the time needed to search for old records. It is incumbent upon law enforcement to seek out missing persons dental records after thirty days. A missing person report with the supplemental dental coding must be entered into the NCIC missing person database as well as the NamUs MP database. Along with the dental coding, it is important that images of the radiographs be uploaded into the NamUs file and the National Dental Image Repository (NDIR) so they can be accessed by forensic odontologists attempting to make comparative dental identifications.

Dental Identification, Missing Persons, Skeletal Remains

F54 Flight 3407 and Application of Technological Advances in Victim Identification

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After attending this presentation, attendees will understand the affect of incineration and fragmentation on victims of a mass fatality incident and how the identification of this degraded postmortem evidence can be enhanced through use of technological advances in instrument analysis. The importance of quality record keeping will be emphasized.

This presentation will impact the forensic science community by illustrating how knowledge of dental materials and instrument analysis can aid in victim identification in extreme circumstances.

The goal of this presentation is to outline the sequence of events in victim identification in a mass transit disaster in which difficult circumstances included severe fragmentation, incineration and disassociation. Every disaster provides us with an opportunity to learn from our experiences and better prepare for inevitable future catastrophic events.

The crash of Flight 3407 at 10:20 p.m. (EST), February 12, 2009 in Clarence, NY presented a number of challenges due to the nature of the crash, ensuing fire, prevailing weather, and subsequent difficulties of victim retrieval. In most cases, severe fragmentation occurred at the time of impact. The fire that followed was fueled not only by the aviation fuel but also by a natural gas leak, burning for 11 hours. From evidence recovered at the scene it was apparent that temperatures reached at least 800˚C in certain areas of the wreckage. Attempts of firefighters to extinguish the blaze in below-freezing conditions resulted in a frozen mass that subsequently had to be thawed, hampering recovery efforts. Recovery operations proceeded for a number of days following the incident. The condition of the victims ranged from mostly intact to that of a single tooth. A team consisting of volunteer and DMORT dentists and hygienists performed the majority of the identifications through traditional radiographic comparative analysis.

As disassociated remains were logged and inspected in the ME's office, some dental specimens that were not readily identifiable by conventional radiographic means were tagged for further instrumental analysis. Portable instrumentation that could identify materials was deployed from the Laboratory for Forensic Odontology (LFOR), SUNY Buffalo, and characteristics were compared to a database previously developed for victim identification. Other unidentified fragmented dental specimens were brought to LFOR for inspection utilizing stereomicroscopy and analysis by SEM/EDS. The combination of digital radiography, stereomicroscopy and SEM/EDS proved to be powerful. Recognition of restorative situations and dental materials was rapid and the analysis took place in minutes. These advances contributed to identification and re-association which otherwise was not possible.

From a dental identification standpoint, it was deemed a successful operation with a majority of the identifications being of dental origin. The enhanced ability to recognize and analyze restorative situations and materials added another level of certainty in victim identification. One particular identification could not have been made without this knowledge. Fragmented specimens existed that may have been deemed unidentifiable through conventional clinical and radiographic comparison methods. Useful information from these previously unidentifiable specimens could be gained through the use of advanced techniques.

A successful operation is based on the condition of the recovered postmortem (PM) evidence along with acquiring meaningful antemortem (AM) information. The two go hand in hand and the mission is driven by collecting quality AM information. This operation also revealed that there is an inverse relationship in the ability to make an identification and the quantity and quality of the PM and AM information. Select cases from this mission showed that as the quality of the PM evidence degraded, from fragmentation and incineration, there was a need for AM information that exceeded normal requirements to establish an identity.

Instrument Analysis, Victim Identification, Dental Records

F55 Flight 3407: Lessons Learned

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Upon completion of this presentation, participants will appreciate the importance of forensic odontology in a mass disaster identification effort, understand the importance of full body radiographs, recognize the importance of altering work flow to optimize efficiency in a mass disaster identification effort, and learn the procedural changes made during the Flight 3407 identification effort which resulted in increased efficiency

This presentation will impact the forensic science community by explaing why in a situation where family members have experienced personal loss, it is critical to have an identification process that runs efficiency and accurately in order for family members to have timely closure.

On February 12, 2009, Continental Connection Flight 3407 left Newark, New Jersey on route to Buffalo, New York. It never reached its destination. The purpose of this abstract is to identify lessons learns from the recovery and identification operation.

In the case of Flight 3407, odontology and finger printing were the two most expedient forms of identification. DNA was also used to make identification; however, the results took several days to several weeks and incineration adversely affected the quality of the tissues for sampling.

The recovery operation was completed in less than one week. The processing of remains was completed in nine (9) days. The identification operation started on February 13, 2009 and continued as an ongoing process for weeks in an attempt to identify the victims. After all efforts were exhausted 49 out of 50 victims were positively identified.

What made this operation run efficiently? In the early stages of the identification process, a traditional process was followed with remains being moved from one station to the next in a pre-determined series. There were three (3) stations. Station #1 was full body radiology, Station #2 was examination, and Station #3 was odontology. In Station #2, there were multiple tables on which different forensic activities were performed. Thus remains were moved from station to station, and within a station, from table to table.

Moving a set of remains sequentially from station to station was not efficient because at any given station the processing of an individual's remains could be delayed and thus the whole identification operation would come to a stop. Some stations would take a lot more time than others and in some cases, a station was not needed at all (i.e., there was no finger print evidence or odontology evidence). Moving from station to station in a predetermined series was therefore a very inefficient process.

Moving from table to table within a station also required moving remains from one table to another. For example, in Station #2 there were 3 tables. Table #1 was personal effects, photography, and finger printing. Table #2 was pathology and Table #3 was anthropology and DNA. The process of transferring each set of remains from one table to the next was very time consuming and labor intensive.

To increase efficiency, teams of pathologists, anthropologists, odontologists, DNA experts and Personal Effects/Photography started to move from table to table. Remains, therefore, were situated in one place while in Station #2. What eventually evolved during this process was a triage system where teams of forensic professionals circulated through the tables in Station #2. If there was, for example, dental evidence present, a member of the odontology team would resect the dental evidence, clean the dental evidence, re-bag the material and label the bag as dental with the case number. The bag was placed with the rest of the remains.

It should be noted that full body radiography was essential in this triage process. Through the full body radiographs, the anthropologists and odontologists could quickly identify dental evidence. This was critical for two reasons. First as dental evidence was recognized, the dental evidence was recovered and not displaced or separated from the victim. Second, when the remains with the dental evidence bag reached the odontology station, the exam, x-rays and charting took in a fraction of the time. By triaging the remains in the exam room, if there was no dental evidence for identification, the flow sheet would be signed by the triage person and the remains would then bypass the odontology station. The remains then moved immediately on to the next station. This also worked very well for finger printing.

Forensic Odontology, Victim Identification, Flight 3407

F56 The Recovery and Identification of the Victims of the 2008 Trinity County Helicopter Crash

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After attending this presentation, attendees will understand some principles of forensic dental identification as they apply to a small mass fatality event involving victims with severely burned remains.

This presentation will impact the forensic science community by serving as an example of the value of forensic dental identification when the remains are so severely charred that the resulting identification can only be accomplished via dental records.

On the evening of August 5, 2008 a Sikorsky-61N helicopter with 13 people on board crashed deep in the mountains of Trinity County California. The helicopter and its occupants had been participating in the containment of the Buckhorn fire. They had just refueled and were headed back to their U.S. Department of Forestry base in Oregon. Upon liftoff the helicopter lost power and altitude. It's blades struck a tree causing it to freefall and crash land on its port side. Miraculously, four people were ejected from the aircraft and survived but the remaining nine passengers died on impact. The helicopter immediately burst into flames and due to the inaccessibility of the crash site, the steep rugged terrain, and the ignition of the magnesium metal in the aircraft engines, the fire could not be extinguished. The fire was was allowed to burn itself out, which took three days.

Once the fire had extinguished itself coroner's investigators from both Trinity and Shasta counties participated in the recovery of the remains. The intensity and heat of the three day fire had resulted in a crash scene of melted, twisted metal along with nine sets of co-mingled, and cremated human remains. It took the investigators three additional days, working on their hands and knees, in one hundred plus degree temperatures, on the side of a mountain, to uncover, collect, catalogue and bag the remains. According to one of the investigators, they would uncover the spinal column remains and trace it up to the skull. Then they carefully collected the skull and dental remains and bagged them separately knowing that the dental remains were going to be key in identification.

Trinity County has a cooperative agreement with its neighbor county, Shasta, for use of its coroner's facilities and staff so all the remains, once collected, were transported to the Shasta County Coroner's office. It was at this time that the process of identification of the nine decedents by means of dental records began. In addition, the Governor's Office of Emergency Services (OES) was contacted for activation of the California Dental Identification Team (CalDIT). The OES arranged for transportation of team members to Northern California. Drs. Anthony R. Cardoza, Duane Spencer, and James Wood were asked to participate in the event. A portable digital radiograph unit was also procured.

On August 13, Wednesday afternoon, the process of identification of the nine decedents was started. Since antemortem dental records were initially slow in arriving it was decided to sort out and process the nine sets of postmortem dental remains first. Once the antemortem records arrived, then the antemortem to postmortem comparisons would proceed.

The maxillas and mandibles were mostly fragmented and all were calcined. The teeth were often missing postmortem and/or fractured with no coronal portion recovered. The procedure was to sort out and photograph the remains to determine which jawbone fragments corresponded. The corresponding fragments would be bonded together with cyanoacrylate. We then focused on piecing together the fragmented dental remains though most were root tips only. Lastly, it was determined which sockets the dental fragments corresponded with and this would be confirmed both visually and radiographically. If in fact the fragments fit then they were bonded with cyanoacrylate, if not, then the fragment was removed and the process was repeated in a different area or different fragment. It was during this step that the use of the digital radiography equipment greatly expedited the process. The ability to radiograph an area and see the picture in three seconds saved time and energy. By Thursday afternoon, the postmortem documentation for all nine decedents was complete.

Beginning on Wednesday August 13 and into the following month antemortem radiographs were delivered to the coroner's office. During that time eight of the nine victims were positively identified by dental records. Some identifications were accomplished by comparison of the porcelain/metal crowns or root canals which survived the fire mostly intact. Other comparisons were based on root morphology or the relationship of the roots to adjacent bony anatomy. Only one decedent

did not have antemortem radiographs available and coincidentally this person was missing teeth eight and nine antemortem. Only one body recovered had closed and healed sockets in the position of eight and nine so because this was a limited population that decedent was signed off as identified.

In conclusion, this tragic event serves as an ideal example of the strength and value of dental identification. It was felt from the onset that because of the calcined remains, no other forensic evidence could be utilized to complete these identifications - so dental evidence ruled the day.

Crash, Calcined, Odontology

F57 Dental Identification of a Burned Homicide Victim

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After attending this presentation, attendees will be able to list steps taken to recover charred human remains in a careful and thorough manner, and determine the effectiveness of dental identification after attempted criminal concealment by burning, pulverizing, and scattering of remains.

This presentation will impact the forensic science community by showing how, in spite of the best efforts by criminals, thorough and careful search for charred human remains can recover enough dental evidence for identification following complete conflagration, pulverizing, and scattering of evidence.

A 73-year-old retired reclusive millionaire living in a modest subdivision in northern Kentucky was kidnapped, bound, forced to sign over power of attorney and drugged. His body was driven 100 miles away to a remote field near Indianapolis and burned in a fire fueled by automobile tires, then raked and scattered and then transported to another site. Among the debris at the first site, an anthropologist collected then dry sifted the remains. Only one intact lower right first molar with an occlusal amalgam was recovered along with multiple charred roots and jaw fragments. These were individually bagged and tentatively labeled according to likely tooth numbers. Antemortem periapical radiographs of the putative victim were compared to the intact tooth. The radiographic silhouette pattern of the amalgam was similar in both films as was the anatomy of fused roots. The forensic odontologist requested another search of the scene and a wet sift of remaining fragments. Additional roots and jaw fragments were recovered including a critical specimen. Lastly, a fine sifting of the crumbled material in a single bag holding a molar fragment revealed another surprise. After the final collection of root and jaw fragments, most teeth could be correctly assembled and labeled and compared to antemortem films. The combination of specific concordant features permitted a positive identification in what was initially considered a seemingly hopeless case in which homicide and person identification was intended to be well concealed.

Dental Identification, Burning, Homicide

F58 Forensic Odontology in the Aftermath of the 2009 Australian Bush Fires

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After attending this presentation, attendees will have a greater understanding of the issues involved in the identification of victims of a large bushfire, with particular reference to forensic odontology techniques.

This presentation will impact the forensic science community by serving as a reference for improving forensic odontology practice and preparedness in dealing with mass casualty events.

On February 7 and 8, 2009, the state of Victoria suffered the hottest temperatures ever recorded, with some parts of the state reaching 48˚C and an average temperature of 46.4˚C (115.52˚F). Combined with hot northerly winds reaching speeds of 130kpH, this resulted in the creation of a firestorm which ravaged approximately 1 million acres and destroying over 2,200 homes. The fire danger index on February 7 was recorded at 180; an extreme reading on the same index is 50. There were 173 fatalities resulting from this disaster, 164 of whom were included in the DVI operation mounted. Over the ensuing days and weeks 298 suspected human remains were admitted to the Victorian Institute of Forensic Medicine (VIFM) for identification.

The Odontology team's contribution to the Victorian Bushfire tragedy involved the commitment of the totality of the forensic dental resources within Australia, as well as assistance from both Indonesia and New Zealand. In total, over 50 forensic dentists deployed to VIFM over the operational period, and at the peak of the identification process we had up to 20 dentists on site at any one time. The majority of the forensic odontologists utilized in this operation had many years of previous mass disaster experience. Many had been involved in both the 2003 Bali bombings and the Boxing Day 2004 Tsunami, and so were well equipped to deal with an operation of this magnitude.

The geographical scope of these massive fires, coupled with the condition of many of the deceased, made both scene examination and identification work very challenging. The odontology team worked in all phases of this DVI process, from multiple scene attendances to assist police with the complicated recovery of commingled and severely damaged remains (Phase 1), to the mortuary where we conducted our detailed examinations of the deceased (Phase 2). Dentists were also heavily involved in antemortem data collection and interpretation (Phase 3). Once all antemortem and postmortem data had been entered onto the computer program DVI Sys®, by Plass Data, the exacting task of matching these records and providing identifications could begin. Reconciliation is the culmination of our work, where we match antemortem and postmortem findings in order to confirm the identity of deceased individuals (Phase 4). Following the confirmation of identity, our findings were then presented to the State Coroner in formal identification boards.

The Victorian bushfire was the first disaster victim identification operation where the odontologists worked almost exclusively with digital information. To ensure accurate and error free handling of this information, and subsequent high quality analysis, a series of new standard operating protocols were developed. These protocols will prove to be an invaluable tool for the management of any future incidents.

At the conclusion of the last identification board on the April 30th, there had been some 140 dental reports generated, 65 of these being a positive dental match, and 48 being probable matches. Dental evidence was presented in all of the 19 identification boards, and odontologists contributed to the evidence confirming identity in approximately 60% of cases. The remainder of our reports dealt with non-human remains, exclusionary reports, and reports on commingling of human remains. Of the 164 individuals included in this DVI operation, 163 were positively identified, with only one person for whom no remains were ever discovered.

In all phases of this process odontologists worked closely with mortuary staff, police, coronial staff, administration staff, IT staff, and other scientific staff at VIFM including molecular biology, pathology, and anthropology. This close cooperation enabled our work to proceed with the greatest efficiency and resulted in timely and accurate identifications. The remarkable conclusion to this operation was that out of 164 people reported missing as a result of the Black Saturday fires,

positive identification of 163 individuals was achieved, with only one person for whom no remains were ever discovered.

Odontology, Disaster, Identification

F59 Dental Identification in a Massacre Case

Olga L. Barragán, National Institute of Legal Medicine and Forensic Sciences, calle 7a #13-62, Bogotá D.C., COLOMBIA*

The goal of this presentation is to describe the dental approach adopted by a team of forensic scientists who conducted the identification of 11 individuals who were kidnapped and murdered by an illegal armed group as a result of the Colombian domestic conflict.

This presentation will impact the forensic science community by exploring how dental identification was completed on the 11 victims of a guerilla massacre.

Twelve congressmen of the state of Valle del Cauca in Colombia were kidnapped on April 11, 2002. After five years of captivity, eleven of them were murdered.

As soon as the news on the victims' death was published, family members requested the bodies. A Commission of the ICRC was appointed to undertake body recovery activities in the area. Additionally, a commission of international forensic scientists was created to oversee the forensic recovery process conducted by the Colombian forensic team.

The ICRC commission found obstacles due to the timeline established by the armed group to return the bodies. Other constraints were the topographic conditions and limited access to the area. The deadline for delivery of the victims' bodies was purposefully delayed by the kidnappers. Additionally, the conditions of the terrain was a significant limitation.

One week after the arrival of the forensic scientists in Cali, the bodies were taken to the National Institute of Legal Medicine and Forensic Sciences. The waiting time was used by forensic scientists to conduct detailed planning in terms of management, logistic coordination, forensic scientists' roles, and detailed analysis of the victims' antemortem information, i.e., photographs, medical records, dental records, intra- and extra-oral x-rays, myofunctional plates, retainer plates (after orthodontic treatment), dental models, etc. Both medical and dental records were supplemented by telephone interviews with treating dentists. Information on every potential victim was published on a bulletin board at the morgue as a tool to orient the identification process. Each piece of evidence was analyzed jointly with the international forensic team. Informative meetings with family members were carried out. The participation and support of well-known international forensic scientists contributed to build trust among relatives, who provided additional information and new evidence for identification purposes.

The forensic identification process started after the 11 bodies were inspected by the Technical Investigation Team (CTI). At the morgue, forensic odontologists contributed significantly with identification tools due to advanced decomposition of the bodies. Initial identification was corroborated using formal odontoscope and fingerprint comparison. Two forensic odontology teams were created for verification purposes. First, a forensic odontologist of the National Institute of Legal Medicine examined and described dental findings, followed by an odontologist of the Technical Investigation Team who verified the records and minimized potential error. Postmortem evidence included each and every dental feature, positive and/or negative findings in bone and soft tissue, intra-oral X rays and/or dental models. This presentation will describe each one of the cases identified using odontology, as well as the evidence supporting dental identification.

The conclusion of this effort was that adequate planning of how, when, who, and where is an essential success factor and that antemortem information weaknesses on potential victims may be overcome by a detailed analysis of existing evidence. In this case, forensic odontology was able to orient the initial identification and represented an added value to the forensic approach. The support of the international commission, harmonious work, and high scientific standards were essential to generate confidence among the victims' family members and the international community at large.

Dental Identification, Massacre, Antemortem Information

G1 Retinal and Optic Nerve Sheath Hemorrhages Are Not Pathognomonic of Abusive Head Injury

Evan Matshes, MD, Southwestern Institute of Forensic Sciences, 5230 Southwestern Medical Avenue, Dallas, TX 75235*

After attending this presentation, attendees will understand the limited value of eye evaluation in child death investigation.

This presentation will impact the forensic science community by bringing clarity to the controversial topic of retinal and optic nerve sheath hemorrhages.

For many years, the dogma of pediatric forensic pathology was "retinal and optic nerve sheath hemorrhages are pathognomonic of abusive head injury", including especially, the Shaken Baby Syndrome (SBS). Growing controversy surrounding the existence of SBS has lead to questioning of that dogma. A retrospective review of all child deaths (≤ 36 months of age) at a metropolitan medical examiner (ME) department was undertaken to establish the spectrum of retinal (RH) and optic nerve sheath hemorrhages (ONSH) encountered in a medical examiner's population. In this office, pediatric eye removal is routine, and all eyes are evaluated by consultant ophthalmologic pathologists. The medical Examiner's database had 137 cases that met age criteria over a five year period; complete case files were available on 123 cases. Of those 123 cases, 18 cases (15%) had RH and/or ONSH; eight cases had both RH and ONSH, seven had only RH, and three had only ONSH. Of these 18 cases, two were certified as natural deaths, eight were certified as accidents, and eight were certified as homicides. Evaluation of the data demonstrated statistically significant relationships between RH/ONSH and: restitution of a perfusing cardiac rhythm following advanced cardiac life support (with short term survival); and cerebral edema (regardless of etiology). Of those children who died without head trauma, but with eye pathology, 6 of 7 received advanced cardiac life support. Qualitative assessment of hemorrhage severity suggests slightly more severe retinal hemorrhages in children whose deaths were ruled homicides; these children were also more likely to have more lengthy post-injury survival periods and brain swelling. In conclusion, RH/ONSH are not limited to children who die of inflicted head injuries; instead, they may be seen in a wide variety of situations, and may be linked to cerebral edema, and sequelae of advanced cardiac life support.

Retinal Hemorrhages, Shaken Baby Syndrome, Pediatric Forensic Pathology

G2 Child Abuse vs. Accidental Falls: Judicial Outcomes in Alleged Child Abuse

James A.J. Ferris, MD, Department of Forensic Pathology, LabPlus, 85 Park Road, Grafton, PO Box 110031, Auckland, NEW ZEALAND*

After attending this presentation, attendees will learn that the incidence of accidental head injuries in infants and children is greater than previously accepted.

This presentation will impact the forensic science community by demonstrating how accidental short distance falls may simulate child abuse.

This presentation will review the trial outcomes in 14 cases from personal case files of alleged child abuse in which the defense claimed that the head injuries were as a result of short distance accidental falls (40-120cm) or relatively minor head impact trauma.

The nature and extent of the pathology will be presented and the incidence of subdural and retinal hemorrhage will be presented. Twelve cases were found to have unilateral subdural hemorrhage and in two cases the subdural hemorrhage was bilateral. Eight cases had bilateral retinal hemorrhages and four cases had ipse-lateral retinal hemorrhages. There were three cases of skull fracture but in one case with bilateral skull fractures no retinal hemorrhages were described. In four cases there was evidence of a prior head injury.

Cerebral edema or raised intracranial pressure was documented in 12 cases. However, in one case, a six-week-old infant born seven weeks premature with several documented hypoxic episodes, who had apparently fallen 60 cm from a bed, had unilateral subdural hematoma, bilateral retinal hemorrhages and no evidence of increased intracranial pressure.

The evidential basis for the respective arguments by the prosecution and defense will be presented and the possible reasons for the verdicts will be analyzed. It may be significant to note that in two cases there was a history of minor shaking as attempt at resuscitation after the infant had exhibited signs of collapse and seizing. The defense council decided to plead his client guilty to shaking as he was afraid to expose the accused to a jury because of the widespread adverse publicity related to Shaken Baby Syndrome.

The problems relating to the presentation in court of the controversies relating to the pathogenesis and interaction of hypoxia and raised intracranial pressure on the development of subdural hemorrhage and retinal hemorrhages will be discussed.

The influence of these current controversies, particularly relating to Shaken Baby Syndrome, had on the outcome of each case will be discussed.

Child Abuse, Head Injury, Accidental Falls

G3 Pediatric Deaths in Harris County

Kathryn H. Haden-Pinneri, MD, and Sharon M. Derrick, PhD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation, attendees will gain a better understanding of the types of pediatric deaths investigated in Harris County, Texas and will be exposed to the extensive pediatric death investigation and autopsy procedures employed in our office.

This presentation will impact the forensic community through the documentation and discussion of almost 900 pediatric deaths.

Pediatric deaths pose a unique and sometimes complex set of challenges for forensic investigators. As is typical in other cases, information is gathered from family members regarding the events leading up to the death. In infant deaths, the parents must be interviewed with as much detail as possible in order to document the correct set of circumstances. This is often very difficult to do when the parents are extremely distraught and when they are the potential suspects. Because babies and small children may have injuries that aren't apparent at the scene or emergency room, all deaths need to be thoroughly investigated beginning as soon as proper officials are notified. This can sometimes cause emotional duress and resistance to talk on the part of the parents. With experience, understanding, and a standard infant death investigation procedure, these obstacles can be overcome.

The Harris County Medical Examiner's Office (HCMEO) is located in Houston, Texas, serving a population of 3.9 million (per 2008 data from the Office of the State Demographer, Texas State Data Center). Additionally, contract services are provided to seven counties in the surrounding area. Approximately 16,000 deaths are reported each year and an average of one-fourth are brought in for either an external examination or a full autopsy. Discussed in this presentation will be the extensive investigative and autopsy procedures, including photographic documentation of the scene, special techniques and consultant assistance.

Over a four year period beginning January 2005, the HCMEO assumed jurisdiction of 870 deaths involving children 10 years of age or younger, 12.3% of which were homicides. Deaths in which an infant is found dead or unresponsive while sleeping with an adult are classified as undetermined (co-sleeping) in our office, allowing for tracking of this risky behavior. Documented wedging or overlays are classified as accidents. The diagnosis of Sudden Infant Death Syndrome (SIDS) is utilized when all investigative and autopsy findings fail to reveal a cause of death in a child under the age of one. The average rate of SIDS deaths over the four year study period is 12% (104). As expected, non-motor vehicle related accidents account for the majority of the deaths, with an average of 21.6% (188).

Statistics will be reviewed in detail for each year of the study and discuss the significance of the trends with regards to co-sleeping, asphyxial deaths, drowning, and child abuse. An unfortunate occurrence in our hot climate is the yearly cluster of heat related deaths due to children being left in motor vehicles and the increasing number of drownings. An alarming statistic discovered from this study is that the number of child deaths due to homicide is higher than those due to motor vehicles. Preventable deaths need to be targeted and all reasonable attempts need to be made to educate parents and caregivers of the dangers of leaving children in hot cars, unsupervised in swimming pools, co-sleeping with small infants, and other inappropriate sleeping conditions that may result in a child's death.

Pediatric Deaths, Homicides, Co-Sleeping

G4 What Is the Frequency of Finding Lethal Injury When a SIDS-Like Death Is Reported?

M.G.F. Gilliland, MD, Brody School of Medicine at East Carolina University, Pathology & Lab Medicine, Brody 7S-10, Greenville, NC 27858-4354*

After attending this presentation, attendees will understand how frequently lethal injuries were found in a group of infants less than one year of age initially reported to have been found dead after sleep. Attendees will also understand how important it is to thoroughly investigate infant deaths.

This presentation will impact the forensic science community by providing a scientific basis for the need to perform an autopsy, even if there is parental objection in infant deaths. Attendees will have scientific support for thorough law enforcement investigation of unexpected deaths in infancy.

Sudden unexpected deaths of infants less than a year of age are concerning to families and law enforcement. The frequency of finding evidence of lethal injury when the history is that of Sudden Infant Death Syndrome – child found unresponsive after sleep – is important in determining the extent of investigative effort required.

Method: Examination of a database of prospectively studied child death investigations from the Southwestern Institute of Forensic Sciences in Dallas, Texas from 1981-1989 identified 84 infants less than one year of age. These infants were part of a larger study of 169 children less than ten years of age. The deaths were from Dallas city and county as well as adjacent Justice of the Peace jurisdictions in north central Texas. Investigations included: scene circumstances, medical records, investigative information from law enforcement and social services, autopsies with ocular examinations, toxicologic studies, and radiographs when indicated.

Results: SIDS-like histories were reported in 36 of the 84 infants, 42.9% of the total group. Infants with SIDS-like histories were found to have injuries playing a role or causing their deaths in eight cases of this group, 22.2%. Seven of these were attributed to non-accidental injuries when no adequate explanation was provided once internal lethal injuries were found at autopsy. Three of these non-accidentally injured infants had no external injuries. Three others had only small facial or scalp injuries which were concerning in the context of a SIDS-like history. The seventh infant of the non-accidental death group was slightly decomposed and had visible injuries in spite of the SIDS-like initial history. The accidental death occurred in an infant who had sustained a simple skull fracture when his stroller rolled down hill and crashed into a wall three days prior to death. He was treated and released and found unresponsive in the morning. He had a healing small head abrasion. Laryngeotracheobronchitis was considered a significant contributing factor in his death.

Seven of the infants' deaths in the SIDS-like history group were ruled undetermined, 19.4%. None of them had external injuries or internal injuries sufficient to cause death and none had sufficient natural disease to account for death.

Sufficient gross and/or microscopic findings to attribute death to natural diseases were found in eight infant deaths. Six died of respiratory tract illnesses and two died of other illnesses for a total of 22.2% of the total group.

The diagnosis of exclusion, SIDS, was reserved for 13 of the infants, 36.1%. None of these infants had any external injuries. At the time of the study the SIDS definition did not include extensive metabolic and radiologic studies. Scene circumstances, medical and social services information, complete autopsy, and toxicologic studies for child deaths between one month and one year of age were used to define SIDS in this study. As has been found in most studies of SIDS deaths, ten of the infants were three months old or less, 76.9%.

	Accidental	Non-accidental	Natural	Undetermined	TOTAL
Head Injury	1	7	0	0	8
Undetermined	0	0	0	7	7
Respiratory	0	0	6	0	6
Other Natural	0	0	2	0	2
SIDS	0	0	1	0	13
	1	7	21	7	36

Conclusion: Although more than half of sudden unexpected deaths of infants less than one year of age were attributed to natural causes 15 of the 36 deaths this study (41.7%) required additional law enforcement activity. Non-accidental injuries were found in 19.4% of deaths and a similar percentage could not be attributed to natural causes (undetermined cause and manner). Sudden unexpected infant deaths must be thoroughly investigated; many will be the result of natural causes, but a significant number will be unnatural deaths. Any external injury is an indication that an autopsy must be performed. The absence of external injuries did not accurately predict natural deaths. Autopsies are still necessary to exclude trauma. This study did not address high-resolution radiographic virtual autopsy techniques to allow examination in the face of parental objection to autopsy.

SIDS, Non-Accidental Injury, Infant Deaths

G5 Cardiac Channelopathies Linked to Sudden Infant Death Syndrome/Sudden Unexplained Death Syndrome

Dawei Wang, PhD, and Donald Siegel, PhD, New York City Office of the Chief Medical Examiner, 421 East 26 Street, New York, NY ; and Yingying Tang, MD, PhD, Mechthild K. Prinz, PhD, and Barbara A. Sampson, MD, PhD, Office of Chief Medical Examiner, Department of Forensic Biology, 421 East 26th Street, New York, NY 10016*

The goal of this presentation is to describe the use of genetic testing to assist medical examiners in determining cause of death in undetermined cases. After attending the presentation, attendees will understand the definition of sudden infant death syndrome (SIDS) and sudden unexplained death syndrome (SUDS), the procedures of SIDS/SUDS investigations, and the SIDS/SUDS genetic testing method. An example of a SUDS case investigation will be presented.

This presentation will impact the forensic science community by emphasizing the need for and use of genetic testing in the determination of unexplained deaths. Discovery of the new mutations presented here will also enrich cardiac ion channel mutation databases and hopefully lead to better understanding of the pathogenesis of these diseases, their diagnosis and treatment.

SIDS is defined as sudden unexplained death under the age of one year. SUDS is defined as sudden unexplained death from one year of age through adulthood. In both syndromes a thorough scene investigation, complete autopsy, and review of the circumstances of death and clinical history are required.

Both environmental risk factors and genetic risk factors are believed to contribute to SIDS and SUDS. Environmental factors involved in SIDS include bedding, bed sharing, and sleeping in the prone position. SUDS can be triggered by vigorous exercise, swimming, emotional stress, and auditory stimuli. Genetic risk factors of SIDS and SUDS include genes that can contribute to arrhythmias. Studies have shown that cardiac arrhythmia may constitute up to fifteen percent or more of SIDS/SUDS cases. Since mutations on six cardiac ion channel genes- KCNQ1, KCNH2, KCNE1, KCNE2, SCN5A, and RyR2 are major causes of cardiac arrhythmias, current genetic testing for SIDS/SUDS is to sequence all exons of these six genes.

Testing of SIDS and SUDS cases in the New York City Office of Chief Medical Examiner has identified genetic variants that are consistent with a cause of death due to cardiac arrhythmias. Fifty-one SIDS cases and thirty-four SUDS cases have been tested. Thirty percent of tested SIDS cases and twenty two percent of tested SUDS cases carry possible disease causing mutations on one of the six cardiac ion channel genes describe above. Among the fifty-one SIDS cases, twelve percent carry mutations on SCN5A, 8% of cases carry mutations on each KCNQ1 and KCNH2, and two percent of cases carry mutations on RyR2. Among thirty-four SUDS cases, eleven percent of cases carry mutations on SCN5A, five percent of cases carry mutations on KCNQ1, and three percent of cases carry mutations on each KCNH2 and RyR2. These results appear to confirm a link between cardiac channelopathies and SIDS/SUDS deaths.

A SUDS case investigation will be presented as an example how genetic testing could help medical examiners determine cause of death when autopsy findings are negative. It is recommended that SIDS/SUDS genetic testing become a routine procedure in undetermined death investigations.

Sudden Unexplained Deaths, Genetics, Arrhythmias

G6 Fatal Acute Intracranial Injury With Subdural Hematoma and Retinal Hemorrhages in an Infant Due to Stairway Fall

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The goals of this presentation are to discuss the significance of retinal hemorrhages in an infant with a traumatic brain injury and an acute subdural hematoma and the discordance of published articles about serious injuries or fatalities in infants and young children associated with stairway or short falls.

This presentation will impact the forensic science community by emphasizing the importance of a meticulous investigation required when an infant or young child dies following a history of a short fall coupled with a critical examination of the current literature on short fall fatalities.

Mistaking a fatal accidental head injury in a young child for abusive head trauma can cause serious and protracted consequences. A case of an infant with an acute subdural hematoma (SDH) and severe hemorrhagic retinopathy due to a fatal accidental head injury from a short fall down carpeted steps will be described. The clinical, autopsy, and investigative findings of this case refute the pervasive belief of many physicians that a short fall down stairs by infants and young children are invariably trivial events and cannot cause serious intracranial injuries and extensive retinal hemorrhages.

According to the mother, her 7¾-months-old son had been active, playful, and crawling on the floor when she heard a loud thud and found him supine on the basement steps' landing. He was transported by ambulance to the medical center's emergency department. The child was *in extremis* and cranial computed tomography revealed a left-sided acute SDH with a midline shift. He was taken immediately to the operating room; however, in the surgical suite he became asystolic. The neurosurgeon evacuated the blood but resuscitative efforts were unsuccessful.

Neuropathological examination verified the radiological findings of an acute intracranial injury with compressive effects from a left-sided acute SDH. He had bilateral multilayered retinal hemorrhages (left > right), optic nerve sheath hemorrhages, macular edema and microscopic retinal detachments.

The upper half of the stairway from the hallway to the landing was a flight of six carpeted steps with a carpet over hardwood landing (total units of rise = 7). The stairway pitch was 37° and the rise of each step was 0.2032 m with a total rise of 1.42 meters. The oak runners and landing were 2.0 cm thick and the synthetic carpet and pad over the steps and landing measured 1.9 cm in thickness.

The accounts of the incident by the mother were repeatedly consistent and unchanging as provided to the emergency dispatcher, paramedics, emergency department physicians and nurses, neurosurgeon, detectives, and medical examiner. A multidisciplinary team of medical professionals and law enforcement personnel reviewed the investigative reports, scene images plus clinical and autopsy findings. All concurred that his injuries were due exclusively to the stairway fall.

Published studies on stairway falls and serious injuries or fatalities from short falls involving young children are discordant. Joffe and Ludwig (1988) maintained that falls down stairs seldom result in serious injury. In contrast, Chiaviello et al. (1994) concluded that while most stairway-related injuries in young children are minor, severe head injury can occur. Hall et al. (1988) reported that falls accounted for 5.9% of childhood deaths due to trauma and 41% of the falls were minor.

Williams (1991) reported that falls witnessed by two or more people or by a non-related person were associated with less severe injuries suggesting alternate mechanisms in the unwitnessed group. Chadwick et al. (1991) described seven children who died in short falls and had other injuries (5/7 with retinal hemorrhages). They concluded that when children incur fatal injuries in falls of < 4 ft, the history is false. Reiber (1993) reviewed coroner's records (1983-1991) and analyzed relevant articles. He concluded that while children on occasion suffer fatal head injuries from short falls, such events are rare. Plunkett (2001) described 18 head injury deaths resulting from playground falls in the National Electronic Injury Surveillance System database over 12 years (1988–1999). He concluded that an infant or child can sustain a fatal head injury with retinal hemorrhages from a fall of less than three meters. Wang et al. (2001) reported on low and high-level falls in a pediatric population and found a mortality rate of 1% for low-level (<15 feet) falls. Chadwick et al. (2008) reviewed the current literature plus a statewide injury database and asserted that the best current estimate of short fall mortality rate for infants and young children was <0.48 deaths per one million young children per year.

The clinical, radiographic, autopsy and investigative findings of this case will be presented followed by a critical examination of published articles on stairway-related injuries and fatalities from short falls involving young children. Lastly, caution is urged in attributing an acute SDH and traumatic brain injury with extensive retinal hemorrhages solely to abusive head trauma in an infant or young child following a stairway or short fall based on the current medical literature.

Short Fall, Subdural Hematoma, Retinal Hemorrhages

G7 Morbidity and Mortalities Related to TV Tip Over

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The goals of this presentation is to increase awareness of incidence of injuries from TV tip over, provide guidelines for distinguishing these injuries from abusive head trauma, and emphasize risk factors and need for prevention.

This presentation will impact the forensic science community by demonstrating how the incidence of injuries related to TV tip over is increasing.

This presentation will emphasize how the incidence of injuries related to TV tip over is increasing. It will present the scene investigation and autopsy findings from three fatal cases and demonstrate how a forensic pathologist can distinguish them from abusive head injury. Recent literature of this phenomenon will also be presented.

The San Diego County Medical Examiner's Office investigated three fatal cases within a nine month interval from December 2007 to September 2008. Rady Children's Hospital in San Diego treated an additional twenty-six children with non fatal injuries from the same mechanism in the two years prior to September 2008. The workup of each case will illustrate how it was distinguished from abusive head trauma (AHT).

In the first case a 3-year-old girl attempted to reach for items on a TV and/or the dresser on which the TV was positioned. The dresser and TV tipped over impacting her face. She had a fractured orbit and subarachnoid hemorrhage as a result of a probable vertebral artery injury when her neck was hyperextended. She had a brief period of consciousness prior to transport to a hospital where she was diagnosed with nonsurvivable head injuries. The second case involved the death of a 21-month-old child in which a TV on a shelf held up by three unsecured wooden dowels in an entertainment cabinet was dislodged by a sibling playing in the room. The TV fell on the decedent and caused multiple fractures of the calvarium and base of the skull. One posterior fracture intersected with the foramen magnum and caused atlanto-occipital hemorrhage and cerebral injuries resulting in rapid death. In the third case an 11-month-old infant was struck by a falling TV when her older siblings tried to climb a dresser serving as a TV stand. She sustained massive skull fractures, destruction of her right frontal lobe and basal ganglia, and impaired perfusion of her left cerebrum. These cases were distinguished from AHT by comparing the data obtained from the scene investigation and interviewing the parties at the scene and matching the patterns of injury with the characteristics of the TV sets and their stands and positions, and noting the absence of any prior injuries at the postmortem examination and on x-rays.

A review of the literature for the past ten years indicated that crushing head injuries and fatalities from falling TV's and standup appliances are increasing while the manufacture of larger TV's with inadequate support appliances is also increasing. However, there is a need to critically examine the reporting methods of these cases since the data may not be complete or accurate. There is also a need for better public education about this problem and for the development of standards so as to prevent these injuries. One may consider requiring manufacturers to give notice to purchasers of the dangers of TV-stand tip-over by placing warning notices on the products, developing more stable TV support appliances, and consider better ways to anchor TV's on their stands.

Television Injuries, Head Injuries, Children

G8 Hanging Deaths in Children: An Investigation of Manner of Death

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After attending this presentation, attendees will understand that investigations into pediatric hanging deaths require a very thorough scene investigation, research into the decedent's psychiatric, medical, and social history, and a complete forensic postmortem examination in order to determine the manner of death. Clearly, the determination of the manner of death in these cases can be controversial and can have a tremendous impact on the child's family. Our research supports the hypothesis that hanging deaths in children aged eight to twelve years of age are less likely to have suicide as the manner of death compared to hanging deaths in those aged thirteen to eighteen years of age.

This presentation will impact the forensic science community by helping medical examiners and forensic investigators elucidate information which will help determine the manner of death in these difficult cases.

Background: Suicide in children unfortunately is not an uncommon phenomenon. Suicide is the fourth most common overall cause of death of children aged ten through nineteen years of age in the United States. However, suicide attempts and completions are rare in pre-pubertal children. The rate of suicide deaths increases with increasing age after the onset of puberty.

The number of suicide deaths in the United States for those aged fifteen through nineteen has doubled in the past 40 years, and has tripled for those in the ten to fourteen year age group. However, not all deaths by hanging in children are suicides. Asphyxial "contests" such as the "choking game" have emerged in the past few years as increasing concern with hanging deaths involving children. Additionally, many of the children whose hanging deaths are deemed accidental have histories of attention deficit disorder and impulsive behavior.

Investigations into pediatric hanging deaths require a very thorough scene investigation, research into the decedent's psychiatric, medical, and social history, and a complete forensic postmortem examination in order to determine the manner of death. Clearly, the determination of the

manner of death in these cases can be controversial and can have a tremendous impact on the child's family. Our hypothesis is that hanging deaths in children aged eight to twelve years of age are less likely to have suicide as the manner of death compared to hanging deaths in those aged thirteen to eighteen years of age.

Design: Using the medical examiner's computer registry, all hanging deaths from the past ten years involving children aged 18 years of age and younger will be identified. This will include all applicable deaths in St. Louis City and surrounding counties. All the aspects surrounding the deaths, will be analyzed including the decedent's medical, social, and psychiatric history. The results will then be compiled and presented in two groups divided by age, 8-12 and 13-18. Data will then be analyzed to show whether our hypothesis is supported.

Results and Conclusion: These findings support the hypothesis that hanging deaths ultimately ruled suicides in children aged 8-12 years of age is an unusual phenomenon and is more likely to be accidental in nature compared to hanging deaths in children aged 13-18. Since research in this area of hanging deaths in children is lacking, our goal in this retrospective review is to help elucidate information which will help medical examiners determine the manner of death in these cases. Further research will help to illuminate the issues surrounding these deaths and will assist forensic pathologists in determining the manner of death in these cases.

Hanging, Child Deaths, Asphyxial Deaths

G9 Does a Draft Really Influence Postmortem Body Cooling?

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After attending this presentation, attendees will become familiar with the process of body cooling after death in various body sites, conditions which could influence this process, and the estimation of the Time Of Death (TOD).

This presentation will impact the forensic science community by showing the possibility of estimation of the TOD by measuring the *postmortem* temperature of the eye together with the analysis of the body cooling process in different environmental conditions, including still air and the presence of draft in the experimental room.

The *postmortem* body temperature decrease is a key factor in determining the time of death in humans and temperature-based methods of the TOD estimation are deemed to be most precise during the first several hours after death. The study focused on verification of the significance of the effects of airflow (draft) present in the room where the corpse is found, on the cooling process of specific body sites, and hence on determination of the TOD. The study was carried out in pigs. The investigations were commenced 75 min after the pigs had been killed and involved computerized recording of the cooling process of the eyeball interior (the vitreous humour), soft tissues of the orbit, muscles, and the recta, measured with thermal pin probes. The first part of the study was performed in still air; the second, with airflow generated by air conditioners and a fan.

The data was processed with Matlab® Software version 7.0. The estimation was done via the least squares method implemented in Matlab's *nnlinfit* function. The precision of the parameters estimated was assessed by calculating the coefficient of variation (% CV) using the *nlparci* function. The influence of air flow on the cooling rate and the initial temperature was tested comparing the individual estimates of the cooling rate in the first and the second part of the study. A t-test was performed to test the hypothesis that individual estimates of cooling rate with and without air flow are independent random samples from the same normal distribution with equal mean and variance. Additionally, the relative difference (RD) was calculated as a difference between the mean individual estimates of both parts of the study divided by the value of the first part of the study to assess the magnitude of the difference between the parameters. It was demonstrated that the moderate airflow (draft) present in the experimental conditions did not significantly affect the course of cooling of the investigated body sites. Despite moderate wind generated in the room, it appeared that the air movement close to the pigs bodies was in fact minimal. Therefore, in order to evaluate the TOD most precisely, one should first have reliable data on the actual velocity of air in the direct vicinity of the body rather than relying on the subjective sensation of the air velocity and using various unnecessary corrective factors.

Time of Death (TOD), Postmortem Body Cooling, Draft

G10 Forensic Medicine in Dubai, United Arab Emirates

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The goal of this presentation is to present the medicolegal features of the United Arab Emirates with different culture and spectrum. Interest to the audience would include the type of cases examined compared to that of their own countries, and this presentation will contain some interesting statistical information.

This presentation will impact the forensic science community by presenting information on a topic where little information is published about this region of the world, as far as forensic science is concerned.

Various characteristics of the medicolegal scene in Dubai are described, along with an overview of all cases examined over a period of six years. During the period of study, a total of 17,683 cases were examined in the Department of Forensic Medicine of Dubai Police General Headquarters. This constituted a yearly average of (2,947). The average annual increment was 11.13%, the percentage of increase between 2002 and 2007 being 68.96%. This rate of increase represents the actual increase of referral by the prosecution and the police, as well as the increase due to population growth of 7% to 8% annually. Clinical cases of injuries were found in 10,165 (57.48%), 5,404 (30.56%) postmortem examinations, 1,525 (8.62%) clinical cases of sexual crimes, 409 (2.3%) age estimations, 58 (0.32%) medical responsibility, 20 (0.11%) criminal abortion, 61 (0.34%) civil actions, and 38 (0.21%) miscellaneous cases. Males represented 4,846 (89.7%) of postmortem examination; females 558 (10.3%). The age ranged from (0-90) years, with a mean age of 40.5 years. The peak incidence was in the age group (20-50) years, where the extremes of age were least represented. Only in 361 cases (6.68% of the grand total) the deceased was a local citizen. Autopsies amounted to 394 cases, which constituted 7.29% of the total deaths examined. The four manners of death in descending order of frequency were natural 3003 (55.57%), accidental 1,727 (32%), suicidal 498 (9.2%), homicidal 164 (3%). The manner was undetermined in 12 (0.22%) of the cases over the six-year period.

As anywhere else, interesting cases have been seen occasionally. These include all manners of death, even a natural manner of death that occurs in circumstances that puzzle the crime scene investigators. Unusual cases previously reported include a case of homicidal strangulation that was staged by the perpetrators to simulate suicidal hanging; masking and bondage in suicidal hanging; accidental death due to inhalation of sulfuric acid fumes; postmortem sole incisions in a morphine overdose; an unusual case of accidental positional asphyxia; and, accidental sand inhalation which was misdiagnosed by the doctor in the hospital. Unpublished cases of note are several: a man was found dead in the passenger seat of his own car, which was locked and his trousers and pants were half way down his thighs, which was found later to be due to massive cardiac infarction: a man alleged by his family to have been found dead in his bed was discovered later to have committed suicide by hanging and the family cut him down and put him in bed to avoid loss of life insurance policy if the fact of suicide death was known;

and in the drug scene arena, during 2008 three accidental fatalities from misuse of Tramadol (Ultram) tablets were reported for the first time. Bloody death scenes are often found when the police suspect homicide, but the forensic evidence confirmed that the death was suicidal. In one case self mutilation was so extensive that it really took some courage from the forensic medical examiner to face the suspicious and skeptical crime scene officers.

Forensic Medicine, Dubai, United Arab Emirates

G11 Injuries to Abdominal Organs in Fatal Road Traffic Crash Victims

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After attending this presentation, attendees will have learned about the types and distribution of abdominal injuries detected in a study of fatal road traffic crash victims at a large department of forensic medicine. The types of injuries, their incidence, distribution, and relationship to the mode of transportation will be presented and the relevance to the forensic community will be discussed.

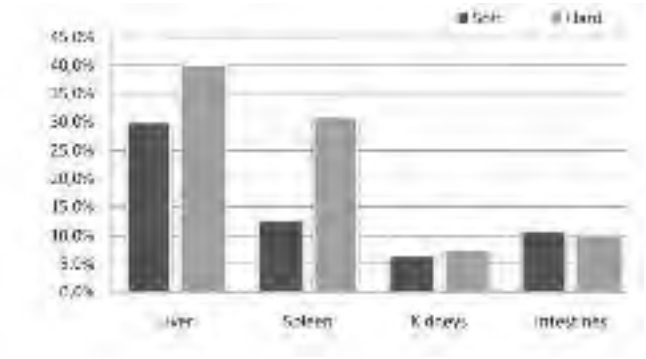
This presentation will impact the forensic science community by augmenting future forensic studies and supplying forensic scientific data for the purpose of improving traffic safety, injury prevention, and clinical management.

Introduction: In clinical settings, abdominal injuries can be challenging and knowledge of common topographic distribution of injuries may be helpful. There is literature suggesting that injuries to the abdominal organs are common following automobile accidents, and that the symptomatology of these injuries may range from significant to more occult clinical presentation. Abdominal injuries have been found to be common among people killed in road traffic crashes. The characteristics of fatal and non-fatal abdominal injuries are both correlated with the use of safety belts and the direction of impact. This study examined the impact of factors such as mode of transportation and type of crash scenario on abdominal injury in a group of people killed in road traffic crashes who subsequently underwent autopsy.

Methods: Autopsies performed during the period 2000-2004, involving road traffic crash victims were included. Data from autopsy and police records were retrieved from an internal database and evaluated with regard to the mode of transportation, the type of crash (i.e., passengercar, motorcycle, moped, and bicycles), and presence of injury to abdominal organs (i.e., liver, spleen, kidneys, and intestines/mesentery). Details concerning age, gender, influence of alcohol, and drugs/medication were retrieved.

Results: A total of 180 road traffic crash fatalities (133 passenger car occupants, 5 motorcycle, 19 moped, and 23 bicycles) were included. Overall, 53% of the subjects had injury to one or more abdominal organ, the liver being the most commonly affected, followed by the spleen, intestines, and kidneys. After grouping into "hard" (passenger car) and "soft" (MC, moped, and bicycle) victims, a significantly higher risk of injury to the spleen was found among car passengers *(RR=2.41 [1.10-5.32], $p<0.05$), whereas no statistically significant differences were found for other types of injury in relation to this grouping (Table 1). Frontal collision was the most common crash vector in passenger car crashes. For all types of abdominal organ injury lateral impact increased the likelihood of injury in passengercar victims. Injuries were more common among passenger car victims compared with other road users. Safety belt use was positively identified in 20 (36%) of a total of 55 recorded cases. Among the safety belt users, there was a higher risk of intestinal/mesentery injury, but a tendency towards a reduced risk of all other types of abdominal injury. Alcohol test was positive in 38% of 146 tested subjects (55/146), and 39% of 46 tested subjects (18/46) were positive for drugs/medication.

Table 1 Incidence of abdominal injuries according to mode of transportation by grouping "Soft group"; MC, moped and bicycles, "Hard group"; passenger car, n=180



Discussion: Injuries to the liver and spleen were found to be the most common abdominal injuries following fatal road traffic crashes. Interestingly, only minor differences were observed in the incidence of abdominal injury in car passengers versus less protected road users (motorcycle, moped and bicycle). The significantly higher risk of injury to the spleen among passengers in motor vehicles is probably due to the generally higher energy transfer to occupants in passengercar crashes. Similarly, the increased risk of injury in lateral impact is in agreement with previous studies. The high number of positive tests for alcohol and drugs/medication in this population is similar to figures reported in the literature. Although abdominal injuries are not necessarily fatal by definition, they often contribute significantly to the cause of death. The presence, location, and severity of these injuries therefore remain of importance to the medicolegal investigation.

Conclusions: This study showed that injuries to the abdominal organs are very common following fatal road traffic crashes. Injuries to the liver and spleen were the most common types of injury affecting about a third of the deceased. The incidence rates and distribution of abdominal injuries were found to correlate to the direction of impact and mode of transportation. Future investigations into the mechanisms and pathology of abdominal injury are needed in order to improve traffic safety issues, injury prevention and clinical management.

Abdominal Injury, Fatal Road Traffic Crash, Postmortem Investigation

G12 Case Example: Cerebral Dural Venous Sinus Thrombosis Following a Motor Vehicle Accident

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After attending this presentation, attendees will understand general principles related to cerebral dural venous sinus thrombosis, especially those impacting the forensic science community, including presenting signs and symptoms, risk factors, clinical diagnostic tests, potential autopsy findings, and pathophysiology. Additionally, a specific case example from the Jackson County Medical Examiner's office illustrating many of the above principles will be presented.

This presentation will impact the forensic science community by reviewing findings related to cerebral dural venous sinus thrombosis that

could easily be overlooked by medicolegal investigators, clinicians, and/or forensic pathologists unfamiliar with this potentially fatal condition.

Once familiar with this condition, medicolegal professionals will be less likely to overlook subtle diagnostic clues in a decedent's medical history and/or postmortem examination.

Among the information presented in this presentation will be anatomical diagrams and images illustrating the cerebral dural venous sinus system and potential areas of thrombosis. The potential for cerebral dural venous sinus thrombosis to cause a fatal cerebral infarct will be discussed. Risk factors including traumatic head injury and hypercoagulability from various medical conditions including dehydration from diabetes mellitus will be discussed. Images from a case example will be used to show petechial hemorrhages in the brain, a common autopsy finding in cerebral dural venous sinus thrombosis. Additional images from the case example will show scattered pulmonary thromboemboli; pulmonary thromboemboism is a rare and serious potential complication of cerebral dural venous sinus thrombosis of which many medicolegal professionals are undoubtedly unaware.

A complete case example from the Jackson County Medical Examiner's Office will be presented, including scene investigation findings, medical history including CT and MRI radiologic findings, and gross autopsy findings as described above.

Sinus, Thrombosis, Thromboembolism

G13 A Death Due to Subinvolution of the Uteroplacental Arteries: A Case Report and Literature Review

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After attending this presentation, attendees will be educated on subinvolution of the uteroplacental arteries, the risk of delayed postpartum hemorrhage with subinvolution, associated morbidity with subinvolution, and pathophysiology of subinvolution.

This presentation will impact the forensic science community by providing education as to the morbidity and mortality of the pospartum patient with subinvolution of the uteroplacental arteries.

Postpartum hemorrhage remains one of the major causes of postpartum morbidity and mortality and is defined as blood loss > 500 mL in vaginal deliveries and > 1000 mL for cesarean births. Hemorrhage within the first twenty four hours after the birth is more common, and referred to as primary or early postpartum hemorrhage. Primary and secondary postpartum hemorrhage share many of the same causes and can include uterine atony, retained placenta, placental accrete or percreta, endometrial infection, inherited coagulation disorders, consumptive coagulopathy, and lacerations of the perineum. Secondary postpartum hemorrhage, however, has received less attention, most likely because it complicates only about one percent of all pregnancies and is more frequently associated with maternal morbidity rather than mortality. However, secondary postpartum bleeding may be fatal, as is the case in this individual, and because the increase uterine bleeding occurs between one to two weeks after delivery and the patient is often home and unaware that the hemorrhage is significant.

The etiology of secondary postpartum bleeding often remains unknown if the patient can be treated conservatively; however, if bleeding is severe, a hysterectomy may be performed or the individual may not survive and require an autopsy to determine the cause of the bleeding. In subinvolution of the placental site, the uterus is grossly enlarged and boggy. Multiple microscopic sections of the placental implantation site should be taken to determine the cause of the hemorrhage and to rule out other causes of secondary postpartum bleeding such as gestational trophoblastic disease, retained placenta, placenta accreta, and endometritis. Subinvolution of the placental site is an important cause of secondary postpartum bleeding and is defined by either a partial or complete lack of the normal involution of the superficial modified spiral arteries at the placental implantation site. Microscopically, the spiral arteries in the superficial myometrium are large and dilated and are partially occluded with thrombi. In addition, cytotrophoblasts are identified within and surrounding the vessels and can be highlighted using low molecular cytokeratin immunohistochemistry staining.

The physiologic and anatomic changes that occur in the uterine vessels during pregnancy and in the postpartum period are complex. In the beginning of pregnancy, the cytotrophoblasts derived from the placenta invade and surround the maternal spiral arteries, transforming them into large vessels that accommodate the increased blood flow needed by the placenta and fetus. The findings are most striking at the site where the placenta has inserted into the uterus. In the normal postpartum period, involution of the arteries occurs. Involution involves the modification of the arteries back to the non-gestational state and eventual removal of the arteries from the uterus. The changes in the arteries include fibrointimal thickening, endarteritis, thrombosis, replacement of the cytotrophoblasts within the vessels by maternal endothelial cells and regeneration of the internal elastic lamina. There is also a disappearance of the cytotrophoblasts from the myometrium interstitium. This process, in addition to the sloughing of the decidua in the superficial endomymetrium and the uterine smooth muscle contraction, is necessary to avoid abnormal postpartum bleeding.

The clinical symptoms are delayed postpartum bleeding usually within two weeks of delivery. There is an abrupt onset of increased uterine bleeding that may require a hysterectomy in some cases.

The exact pathophysiology of subinvolution is not known. Some suspect an immune component leading to abnormal interaction between the maternal and fetal tissues.

Subinvolution of the uterine arteries at the placental implantation site is the result of the modified spiral arteries refusing to convert to a non pregnant state. This can lead to significant postpartum bleeding, and if not suspected, may result in death as in our case. The pathophysiology behind subinvolution is unknown but speculated that an immune etiology with miscommunication between the maternal and fetal tissues. Although it is a common suspect in delayed postpartum bleeding and can cause significant morbidity, the mortality rate due to subinvolution is unknown.

Postpartum Hemorrhage, Subinvolution, Uteroplacental Arteries

G14 Case Studies of Cranial Trepanation in Apulia (Southern Italy) Through Forensic Imaging

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After attending this presetation, attendees will have a greater understanding and interpretation of trepanated skulls.

This presentation will impact the forensic science community by allowing a differential diagnose between traumatic and intentional ante or postmortem trepanation.

Cranial trepanation is a practice known since prehistory in various, often geographically distant populations, from Europe to Peru. It seems to have been mainly spread during the Bronze Age and underwent a partial decline during the Iron Age. Also during the Roman Era this

practice is well attested by detailed description of specific surgical techniques and tools. It consists of several surgical treatments performed with various tools with the aim of opening a hole in the cranial vault for therapeutic purposes on living individuals. It is believed that this surgery was intended to cure cerebral disturbances related to vascular pathologies, migraines caused by intracranial pressure, or edema drainage after a severe skull trauma or as a religious ritual to drive out the evil spirit, to obtain bone powder to be used in curative potions, to obtain a bone disc as an amulet against disease, to fill the skull with incorruptible substances, or as a victory sign on dead enemies.

Differential diagnosis and the interpretation of trepanated skulls can be particularly difficult. It is necessary to distinguish between traumatic or intentional and ante or postmortem trepanation.

In case studies two early trepaned skulls who are being evaluated through radiological imaging are presented. Both skulls were found in Apulia (Italy). The first skull comes from Canosa (6^{th}–7^{th} AD) and the second is from Vieste (3^{rd} BC). Both skulls present perforation, although at different stage of healing. The radiological analysis confirmed that the skull perforation was a consequence of a therapeutic operation following trauma in the Vieste skull, while the perforation was a pathologic process in the Canosa skull.

The radiological analysis was performed with a portable X-ray device (Nomad) combined with a digital sensor and computerized axial tomography with 3D reconstruction. Signs of healing reaction and bone apposition around the perforations were recognized in the Vieste skull, but not in the Canosa skull. The Vieste skull perforation can therefore be referred to as a therapeutic operation following trauma, while the lesions of the Canosa skull suggest a pathological process or a postmortem ritual practice.

The case study indicates the value of a forensic imaging approach in order to improve data analysis for a complete osteological evaluation of skulls.

Forensic Science, Cranial Trepanation, Forensic Imaging

G15 Systemic Lupus Erythematosus and Fatal Cardiac Failure Due to Pancarditis in a Young Man

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The goal of this presentation is to present a case of sudden cardiac failure and death in a 28-year-old Caucasian male, with reactivation of Systemic Lupus Erythematosus (SLE). A complete methodological forensic approach by means of autopsy, histological, and immunohistochemical examinations lead investigators to conclude an acute congestive heart failure due to pancarditis as cause of death.

This presentation will impact the forensic science community by discussing a definitive diagnosis of acute congestive heart failure with dilated cardiomyopathy after pancarditis was made, as a fatal and rare complication of Systemic Lupus Erythematosus.

SLE is an inflammatory, autoimmune disease of unknown etiology, characterized by the production of autoantibodies and the deposition of immune complexes in various organs. Cardiac involvement occurs frequently, although it is often mild enough not to cause clinical concern. Pericarditis is most commonly seen, with a reported prevalence of 60%. Myocardial involvement is present in only a minority of patients and valvular abnormalities can be demonstrated in an increasing number of patients. Although most of the valvular lesions will be present without any symptoms, valve incompetence can result in congestive heart failure. Myocardial involvement usually accompanies other cardiac lesions. Isolated myocarditis, or dilated cardiomyopathy, is a rare and usually late clinical manifestation of SLE. Autopsy series in diagnosed SLE patients showed 62% pericardial involvement, 50% valvular involvement (Libman-Sacks lesions and infective endocarditis) and 40% myocarditis, but all have been underdiagnosed clinically.

A 28-year-old Caucasian man, with systemic lupus erythematosus (SLE) treated with hydroxychloroquine and systemic glucocorticoids, was admitted to the emergency department for an arm-ache after an accidental fall. Admission radiographs revealed a spiroid diaphyseal humeral fracture at the mid-distal third, which was treated by surgical internal fixation with a locked antegrade intramedullary nail, and then it was replaced by an external fixation. An ECG showed sinus bradycardia (58/min), QRS axial left deviation in the frontal plane, incomplete right bundle branch block, marked ST-T segment elevation.

After few days he was discharged to continue anticoagulant and antibiotic therapy at home, but three days later he was admitted again to the same hospital for high fever (39.5–40.5°C). The clinical examination revealed pharyngeal hyperaemia, cervical lymphadenopathy and the classical "butterfly" erythematosus rash on the face and on the neck. Hematologic studies revealed anaemia, neutropenia, lymphopenia and thrombocytopenia; the morphological examination of peripheral blood and the research for viruses with cardiac and lung tropism were negative. On the eighth day the diagnosis of reactivation of SLE was made and higher doses of glucocorticoid, antipyretic, and antibiotic therapy were administered.

On the fourteenth day, an echocardiography was performed showing normal atrioventricular and semilunar valves, the ventricles were dilated and hypocontractile, with a 33% ejection fraction; the Doppler examination revealed the mitral valve regurgitation. He was transferred to the Department of Cardiology but few hours later he suddenly collapsed; blood gas analysis revealed metabolic acidosis. Vasoactive drugs (dopamine and noradrenaline), bicarbonate, and fluids were administered. The next morning he collapsed again but cardiopulmonary resuscitation was unsuccessful and the man was pronounced dead.

A postmortem examination was performed 48 hours after death. The external examination revealed only malar erythematosus cutaneous rash. Internal examination was unremarkable except for heavy lungs and reddish colored foam on trachea and the main bronchi and a cerebral edema.

The heart had a normal shape (15x13x5cm) and a weight of 495g. The left ventricular wall thickness was 1.9cm and the right ventricular wall thickness was 0.8cm. The atrial chambers were normal, the ventricules ones were dilated, and the myocardium was flaccid. Cross sectioning of extramural coronary arteries showed no significant stenosis or thrombotic occlusion. The atrioventricular and semilunar valves were normal except for mitral valve, which showed abnormal leaflet thickening with a decreased mobility.

The histological examination of the heart was performed using haematoxylin-eosin (H&E) and revealed pericardial spots (lymphocytic infiltrates); the myocardium showed focal and rare lymphocytic infiltration in perivascular areas, patchy fibrosis, rare foci of irreversible hypercontraction with myofibrillar break and anomalous cross band formation, and focal interstitial hemorrhages in subendocardial layers (reflow areas). The mitral cusps showed diffuse fibrosis and lymphocytic infiltrates.

The immunohistochemical examination of the heart specimens revealed a positive reaction in cardiac myocytes for antibodies anti-TNF-α and IL-8, and a stronger positive reaction for antibodies anti-IL-15 and IL-10.

Furthermore, the expression of CD-4 and CD-8 showed a strong positive reaction in pericardium, valvular endocardium, and less positive in myocardial specimens.

Examination of the other organs was unremarkable except for cytotoxic cerebral edema, massive pulmonary edema and polyvisceral stasis.

A definitive diagnosis of acute congestive heart failure with dilated cardiomyopathy after pancarditis was made, as a fatal and rare complication of Systemic Lupus Erythematosus.

Lupus, Pancarditis, Dilated Cardiomyopathy

G16 Autopsy Investigation and Bayesian Approach to Coronary Artery Disease (CAD) in Victims of Motor Vehicle Accidents

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After attending this presentation, attendees will understand the importance of coronary artery disease in causing motor vehicle accidents. Each year 1.2 million people die world-wide as a result of motor-vehicle accidents and the prevalence of injuries is estimated at 50 million, representing a tremendous burden to health. The objective of this study was to define the prevalence of coronary disease and its possible role in motor-vehicle accidents.

This presentation will impact the forensic science community by discussing the data regarding the important percentage of evidence of acute myocardial ischemia in traffic accidents.

Consecutive cases of non-hospital sudden death autopsies between 2002 – 2006 were examined. The research focused on those individuals victims of motor vehicle accidents. A total group of 1,260 individuals in the area of West Quebec were identified. Severe coronary artery disease (CAD) was defined as a narrowing of ≥ 75% cross-sectional area or acute plaque events in major epicardical coronary arteries. In order to evaluate the probability of fatal accidents caused by the presence of significant coronary disease, a *Probabilistic Expert System* (PES) was applied.

Motor-vehicle accidents were responsible for a total of 123 deaths (63%); 100 (81.3%) were males and 23 (18.7%) were females. In individuals over 40 there was significant coronary artery disease in 64.1%, with evidence of acute myocardical ischemia in 12%. In decedents older than 60 years, the prevalence of significant coronary disease and ischemia were 84.6% and 18.18% respectively. Two-thirds of the coronary patients were identified as having erratic driving behavior by bystanders before the accident. ETOH was detected in 11.8% and drugs in 4.9% of the drivers. Statistical analysis showed that an individual affected by coronary artery disease has an accident with a probability of 0.09 (9%).

This research data shows that there is a very high prevalence of severe coronary artery disease in individuals who have suffered a motor-vehicle accident. In an important percentage there is evidence of acute myocardial ischemia. In contrast with previous statements, a large group of the coronary drivers who died, had no time to control and stop the car before the accident. This evidence has important implications for driving safety.

Motor Vehicle Accident, Coronary Artery Disease, Autopsy Investigation

G17 An Unusual "In-Custody" Death

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After attending this presentation, attendees will have learned possible symptoms related to pheochromocytomas and learn basic guidelines for investigating in-custody deaths.

This presentation will impact the forensic science community by providing basic information required by the medical examiner or coroner for deaths that occur in the presence of law enforcement officials. The presentation will also provide information of symptoms related to an adrenal gland tumor.

In-custody deaths or deaths that occur in the presence of police officers are usually high-profile cases that have the potential to become politically charged events. Scene investigation is vital to these types of deaths and should include acquisition of any video of the event, eyewitness' statements, investigation of the event by an independent agency, and autopsy of the decedent. Because of the potential for rumors of foul-play or police misconduct to be propagated within a community, an autopsy should be performed on individuals who die while interacting with law enforcement officials even if the deaths seem "straight forward."

This presentation presents the sudden death of a woman with long-standing hypertension during detainment by a peace office for a traffic violation. During her detainment, which caused her considerable stress, she complained of having a "panic attack," chest pains, and shortness of breath. She became increasingly confused and would not respond to the peace officer's questions. She became unresponsive shortly after emergency medical services arrived at the scene. According to the peace officer, at no point was the woman physically restrained. Autopsy findings were remarkable for lack of trauma, cardiomegaly with left ventricular hypertrophy, hypertensive changes in the kidneys, and a tumor in the left adrenal gland that was diagnosed as a pheochromocytoma. Pheochromocytomas can produce a variety of symptoms including hypertension and have been associated with sudden death. Physical and emotional stress may precipitate hypertensive crises in individuals with these tumors. In this case, the woman's unfortunate death happened to be in the presence of a police officer. Although the death was regarded as a probable natural manner of death from the onset, an autopsy was mandated to confirm this initial impression by establishing an exact cause of death and to quell any possible accusations of misconduct by the peace officer.

In-Custody Deaths, Investigation, Pheochromocytoma

G18 Analysis of Female Firearm Homicides in King County, Washington 2000 - 2007

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After attending this presentation, attendees will be able to describe distinctive features of female homicides due to firearm injuries.

This presentation will impact the forensic science community by delineating the demographics, modalities, circumstances, and motivations that characterize female homicides.

Materials and Methods: The records of the King County Medical Examiner's Office (KCMEO) in Seattle, Washington, were searched to locate homicide victims from 2000 through 2007. These records were analyzed with respect to demographics and cause of death to compare male and female homicide victims. Those cases in which the decedent

was female and the cause of death was firearm injury were analyzed in more detail and were used to construct a database comprising essential medical examiner information. Investigative records from the Homicide Investigation Tracking System (HITS) of the Washington Attorney General's Office were incorporated into this same database to include details regarding the victim, circumstances, and perpetrator of her death. Analysis of this database was the basis of the results of this study.

Results: From 2000 through 2007, there were a total of 618 homicides investigated by KCMEO; 490 were male and 128 were female. Asphyxia, blunt force injuries, sharp force injuries, firearm injuries, and mixed modalities were identified as causes of death. Considering deaths due to firearm injuries only, 334 (68.2%) of the male homicides were due to firearm injuries, compared to 52 (40.6%) of the female homicides. This difference is highly statistically significant ($p<0.0001$). In the group of 52 female firearm homicides, ages ranged from 5 to 93 years with an average of 41.7 years; 23 were married, 17 single, 8 divorced, 2 widowed, and 2 of unknown marital status; 21 were employed outside the home, 7 were homemakers, 5 students, 5 retired, and 2 unemployed. Blood alcohol levels in the decedents were positive in 21 cases and ranged from 3 to 24 mg/dL. In 34 cases, the shooting occurred inside a residence, 2 in unspecified buildings other than a residence, 8 on the street, 3 in vehicles, 2 at worksites, and 1 in a tavern. In 27 cases, the homicide was a consequence of domestic violence. Other motivations and/or circumstances included 6 reckless or unintentional shootings, 4 for financial gain, 2 in "heat of anger", 2 "mercy killings", 2 police officer involved shootings, 1 gang-related, 1 "recreational", 1 child abuse, and 1 due to ethnic hatred. Sexual assault did not appear to be a motivation in any case. Seven of the decedents were from incidents involving multiple homicides. Perpetrators were identified as 15 husbands; 17 boyfriends, ex-boyfriends, male room-mates or male acquaintances; 8 family members (child, parent, or other family member); 9 strangers, unknown assailants or unspecified male; and 1 female acquaintance. In 20 cases the perpetrator shot himself immediately after killing the female.

Conclusions: In this study, firearm injuries accounted for less than half of all female homicides and occurred most commonly in a setting of domestic or intimate partner violence. Typically the decedent was a mature woman and had stable employment. Perpetrators were nearly all males with a close or intimate relationship with his victim. Most instances occurred in homes, but it was not unusual for an ex-partner to make a deliberate attack elsewhere, such as at a worksite. Although attacks were often directed at intimate partners or ex-partners, sexual assault was not a factor in any case. Nevertheless, the emotional context of these homicides was evident in that nearly forty percent of the perpetrators shot themselves after killing the female. These findings support the conclusion that domestic violence and firearms are a dangerous combination.

Firearm Injuries, Female Homicides, Domestic Violence

G19 Genetic Aspects of Sudden Death in Youth: A Retrospective Study of Familial Hypercholesterolemia

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After attending this presentation, attendees will understand some principles of genetic heart disease and the advantage of genetic examination in selected forensic autopsies of sudden death. Preliminary results of premature ischemic heart disease will be presented as an example.

This presentation will impact the forensic science community by serving as a key aspect of sudden cardiac death investigation as it can augment traditional means of investigation by including postmortem genetic examination in order to reveal familial hypercholesterolemia (FH) in young people dying from coronary athero-thrombotic disease.

Several cases of sudden death due to basis of genetic heart disease have inspired this newly started retrospective study. The goal of the study is to examine inherited heart disease from selected forensic autopsies.

Purified DNA from blood of approximately 230 selected autopsies; aged 0-40 will be examined. The following genetic heart diseases will be emphasized: Ischemic heart disease due to FH caused by defects in the low density lipoprotein receptor (LDLR) and apo – lipoprotein B (ApoB) gene; Long QT-syndrome and Brugada syndrome due to defects in cardiac ion channel proteins; catecholaminergic polymorph ventricular tachycardia due to defects in the ryanodine receptor; arrhythmogenic right ventricular cardiomyopathy due to defects in the desmosome proteins; hypertrophic, and dilated and restrictive cardiomyopathies due to defects in the contractile proteins.

Preliminary results of the study concerning premature ischemic heart disease will be presented. Examination of approximately forty cases of death in youth due to ischemic heart disease is being examined for defects in the LDLR and ApoB gene.

Mutations in the genes of the above mentioned proteins are known to present as arrhythmia or sudden death. Diagnosed cases of sudden cardiac death in the Danish population are few, despite the estimated higher number of cases in the literature. The perspective of the study is to determine the molecular cause of sudden cardiac death in order to intervene and prevent sudden cardiac death in relatives to cases with proven genetic heart disease.

Sudden Cardiac Death in Youth, Genetic Heart Disease, Familial Hypercholesterolemia

G20 An Unusual Death of a Masochist: Accident or Suicide?

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The goal of this presentation is to describe a very unusual case of the death of a masochist resulting from autoerotic behavior.

This presentation will impact the forensic science community by bringing attention to the unusual practice of compressing the neck and chest during masochistic activities, along with other information related to basic crime scene investigation, reconstruction of events, and autopsy findings in these type cases.

Fatal masochistic asphyxia is a relatively rare phenomenon secondary to the malfunction of apparatus used to provide sexual pleasure. The basic mechanism of sexual asphyxia is the creation of cerebral hypoxia which, according to the literature, is generally brought about by constriction of the neck by use of a ligature. In a small percentage of cases, less typical methods of sexual asphyxia involving chest and abdominal compression are also employed. In all such cases, hypotheses of suicide and homicide must not be ruled out.

A case of a 52-year-old man found dead in the house where he lived alone is reported here. The corpse was found in his study, lying supine on the floor, underneath an open chair bed with a 1.3 x 3.2 meter mattress. The victim's head protruded from under the mattress and was partially covered by two blankets. One of the legs of the chair-bed was discovered pressing perpendicularly into his throat, between which a rubber slipper was positioned, and whose sole was facing the anterior portion of his neck in midline. An iron support bar, which made up part of the bed frame, was pressed against the chest and upper abdomen, causing the bed frame to be elevated off floor. He was wearing typical men's pajamas, underneath which he wore boxer shorts with the fly open. Autopsy revealed the clear imprint of the slipper's sole on the anterior side of the neck. There was no fracture of the hyoid bone or thyroid cartilage, but several deep muscle bruises of the neck were identified. Histological analysis revealed a hemorrhage of the jugular vein and injury to the vagus nerve. An examination of the lungs revealed a large solid mass (7 cm in diameter) occupying the inferior lobe of the right lung; nodules and sclerotal patches involving the omentum were observed, along with the presence of very large adhesions of the peritoneum together with sub-obstructions of the bowel. Toxicological examination revealed no substances of abuse in the blood or urine. The cause of death was attributed to asphyxia by external compression of breathing apparatus

Further investigation of the victims' history revealed that he was under the care of a psychologist, due to the fact that he the had habit of placing heavy objects (especially books and chairs) onto his chest or abdomen with the purpose of engaging in masochistic sexual gratification. This practice interfered with his ability to become intimately involved with women, and so he sought out psychological help to free him from this behavior. The victims' medical history is unknown, including the fact that he had cancer. As far as is known, no suicidal ideation was ever expressed by the victim.

These findings suggest that the manner of death should be classified as accidental. However, the unusual circumstances involved in this case, including the presence of cancer, does not rule out that the death may have indeed been suicidal.

Masochism, Asphyxia, Autoerotic

G21 Numerous Rhabdomyomata and Cortical Tubers in a Possible Case of SIDS

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After attending this presentation, attendees will exercise different difficult possible manners of death in cases of SIDS.

This presentation will impact the forensic sience community by the importance of fact findings through detailed investigations; medical, interviews with family members, etc.

Sudden Infant Death Syndrome (SIDS) is the leading cause of death for infants between the ages of one month to one year. This position has remained unchanged despite risk reduction campaigns and the resulting decline in prevalence in the past two decades. The rate of SIDS in the United States is 0.539 per 1000 livebirths in 2005, accounting for 7.8 % of all infant death. SIDS is defined as the "sudden death of an infant less than one year of age, with onset of the fatal episode apparently occurring during sleep that remains unexplained after a thorough investigation, including performance of a complete autopsy, review of the circumstances of death, and the clinical history. SIDS, a diagnosis of exclusion, can only be made after other explanations for unexpected death have been ruled out. Such explanations include Tuberous sclerosis and infantile asphyxia.

Tuberous sclerosis complex is an autosomal dominant syndrome that is occasionally the findings in these patients with unexpected infant death. Infantile asphyxiation is an important condition that results from unsafe sleeping conditions and must be ruled out before a diagnosis of SIDS can be made. Unsafe sleeping conditions include excess soft beddings, adult beds, chairs, sofas, waterbeds etc.

A case of an unexpected infant death during sleep with multiple factors that confound the cause of death will be discussed. Factors and attempts to delineate their contributions to arrive at a cause and mechanism of death will also be discussed.

Cerebral Tuberous Sclerosis Cardiac Rhabdomymata, Undetermined Manner of Death, Final Fatal Mecanism of Death

G22 Fatal Subarachnoid Hemorrhage During Sexual Activity: A Case Report

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After attending this presentation, attendees will have learned about a case of sudden death immediately after coitus.

This presentation will impact the forensic science community by explaining that sexual activity, in susceptible subjects may be a trigger of medical emergencies with a real risk of sudden death.

Particularly, the anatomical and physiological responses to coitus may determine many acute and severe complications. Among these, cardiovascular, neurological and urological diseases, soft tissue and immunological consequences may arise in patients with predisposing risk factors, even if asymptomatic (*A. Banerjee, 1996*).

Many cases of sudden and unexpected death during autoerotic activity have been reported in literature; the majority of these may be considered accidental deaths, especially by asphyxial mechanism. Only few cases are reported as due to natural causes (*N. Beahrendt et al., 2002*).

Studies on sexual related deaths show that cardiovascular diseases and cerebral hemorrhages are the most important causes of death connected to sexual activity.

Coronary artery disease (CAD), myocardial infarction and reinfarction, dissection of aortic aneurysms along with cardiomypathy – with or without heart failure – are more frequently associated with coital death.

Even if intracerebral bleeding during sexual activity is rare, coitus has also been considered to trigger subarachnoidal bleeding, because of the transient rise in blood-pressure.

As any form of physical exercise, sexual intercourse increases heart rate and blood-pressure. In the majority of cases of natural death combined with sexual activity, the victims are generally male (*W. Janssen et al., 2005*).

Although the gender differences in the incidence of CAD and SAH are statistically not significative, the male dominance of CAD has been showed. On the contrary, the female dominance of SAH has been demonstred (*S. Lee et al., 2006*).

Many authors described a "malignant coital headache," so that it can be considered a common feature of cerebral vascular accident (*M. Sutton Brown et al., 2006*).

A case of sudden and unexpected death of a homeless 45-year-old woman is described. During the questioning of the circumstances of death, the partner reported that they were on the beach, lying under a boat, around 1:00 p.m. The woman suddenly presented severe dyspnea and rigidity of the body just after sexual intercourse. Medical assistance was immediately called but the woman died despite attempts at resuscitation. According to the antemortem data obtained from the police report and relatives, it showed that the deceased was apparently healthy and did not show any prior symptoms of cardiovascular disease. No signs of serious headache were present at all in the clinical history. Because the cause of death remained unknown in order to investigate the partner's report, a complete medicolegal autopsy was performed. The external examination was unremarkable and no signs of injuries or trauma were observed. The internal examination revealed pulmonary edema and lung congestion. There was massive subarachnoid hemorrhage due to a basilar artery aneurysm rupture. No other important pathological findings were observed. In conclusion, subarachnoid hemorrhage secondary to a cerebral aneurysm rupture is still an important cause of death despite steady advances in diagnosis and treatment. Although transient hemodynamic changes associated with sexual activity seem to play some role in the pathogenesis of subarachnoid hemorrhage, the mechanism of physical activity induced subarachnoid hemorrhage is still not completely known.

Sexual Activity, Subarachnoid Hemorrhage, Sudden Death

G23 Occurrence of MRSA in the Peritoneal Cavity Following PEG Tube Insertion

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After attending this presentation, attendees will become familiar with the means of transmission of methicillin-resistant staphylococcus aureus (MRSA) to the peritoneal cavity, proper percutaneous endoscopic gastrostomy (PEG) tube insertion procedures, and potential pitfalls, peritonitis, and a situation that links all previously mentioned aspects.

This presentation will impact the forensic science community by explaining that the occurrence of MRSA as an isolate in bacterial peritonitis does not increase the significant mortality for the patient to a greater extent than from mixed aerobic gram negative organisms or from anaerobic infection. It is nonetheless important for the forensic pathologist to appreciate the potential for nosocomial spread of MRSA to both the respiratory tract as well as into the peritoneal cavity, with the skin often colonized by MRSA when internal isolates of this microorganism are detected. Proper understanding of the mode of transmission will hopefully facilitate the development of guidelines to help prevent peritoneal nosocomial spread of Methicillin-resistant Staphylococcus aureus.

This presentation will examine the transition of MRSA as a skin commensal both to the respiratory tract of an immunologically compromised individual as well as to the peritoneal cavity following the insertion of a percutaneous endoscopic gastrostomy tube. This is the case of a 46-year-old white male who had a history of severe mental retardation/Down Syndrome and upper respiratory problems including dysphagia, being discharged from a regional hospital on January 20, 2009 after having a percutaneous endoscopic gastrostomy tube inserted for feeding. Upon returning to his place of residence, he suffered respiratory arrest, with resuscitative efforts to no avail. The decedent was pronounced dead at 9:15 p.m. on January 20, 2009, only several hours after being discharged from the hospital. Autopsy examination demonstrated a peritonitis that tested positive for Methicillin-resistant Staphylococcus aureus, with an excess of 300 ml of purulent tan fluid within the peritoneal cavity as well as coating visceral surfaces, and with fibrinous adhesions extending between bowel loops. Present as well was a gastrostomy tube inserted within the pyloric region of the stomach that readily slipped out of the insertion point upon removal of the viscera from the abdominal cavity. Other significant findings included chronic pancreatitis, with an extensively sclerotic pancreas, cortical contusions of the inferior orbital gyri of the left cerebral hemisphere, and extensive fenestrations of all aortic valve cusps, with extensive epicardial scarring of the surface of the heart. The cause of death was determined to be acute pneumonitis, with aspiration complicated by Methicillin-resistant Staphylococcus aureus-positive acute peritonitis, with significant contributing factors being inanition and dehydration, history of severe mental retardation/Down Syndrome, dysphagia, and chronic pancreatitis. The manner of death was rendered undetermined. Percutaneous endoscopic gastrostomy tubes are used to provide long term hydration and nutrition to patients who are no longer capable of receiving nutrition through oral means. Infections such as peritonitis may arise upon gastrointestinal perforation, but may also develop after percutaneous placement of gastrostomy feeding tubes in patients afflicted with commensal skin involvement by pathogenic bacteria. Typical bacteria cultured from the peritoneal cavity in circumstances of gastrointestinal perforation (e.g.,-perforated diverticuli, gastric ulcerations, etc.) include mainly a mix of aerobic gram negative bacteria (primary) and anaerobes (secondary). Isolation of a pure culture of MRSA is no longer an uncommon event in cases of bacterial peritonitis, however, likely a consequence of percutaneous nosocomial transfer of these organisms. Prior MRSA infections in an individual increase the likelihood of developing future such events. The insertion of a PEG tube facilitates MRSA spread into the peritoneal cavity, presumably through nosocomial spread from the skin. Bacterial peritonitis is always a life-threatening event; MRSA as the source of bacterial peritonitis underscores both the ubiquity of this microorganism and the dangers associated with introduction of catheters into the peritoneal cavity within this context. The occurrence of MRSA as an isolate in bacterial peritonitis does not increase the significant mortality for the patient to a greater extent than from mixed aerobic gram negative organisms or from anaerobic infection. It is nonetheless important for the forensic pathologist to appreciate the potential for nosocomial spread of MRSA to both the respiratory tract as well as into the peritoneal cavity, with the skin often colonized by MRSA when internal isolates of this microorganism are detected. Proper understanding of the mode of transmission will hopefully facilitate the development of guidelines to

help prevent peritoneal nosocomial spread of Methicillin-resistant Staphylococcus aureus.

PEG Tube, Peritonitis, MRSA

G24 Two Cases of Generalized Myxedema

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After attending this presentation, attendees will be able to summarize the clinical manifestations of hypothyroidism, recognize various autopsy findings associated with the hypothyroid state, appropriately utilize ancillary testing to support their diagnosis, and discuss pathophysiologic aberrancies which may lead to death in this type of case.

This presentation will impact the forensic science community by providing education about this medical condition and photographic representation of several autopsy findings, as well as underscore the diagnostic importance of performing a complete medicolegal autopsy with ancillary studies.

Hypothyroidism is rarely diagnosed in the forensic setting. Two cases of hypothyroidism with generalized myxedema were diagnosed at the SWIFS between 2006-2009 and will be discussed in the presentation.

Generalized myxedema is also known as Gull disease, as it was first linked to the hypothyroid state in 1873 by Sir William Gull. The clinical manifestations of hypothyroidism varies with age of onset. Children present with cretinism. Adults; however, suffer from relatively nonspecific manifestations such as generalized fatigue, apathy, and mental sluggishness, slowing of speech and intellectual function. Constipation, decreased sweating, cold intolerance, and weight gain are common. Skin involved by myxedema takes on a thickened and waxy appearance. The skin may become cool and pale due to decreased blood flow and/or an anemic state. Reduced cardiac output contributes to symptomatology of shortness of breath and decreased exercise capacity. The hair often becomes thinned, coarse, and dry-appearing.

There are two forms of myxedema – generalized and pretibial. Generalized myxedema is often seen in persons with hypothyroidism, whereas pretibial myxedema is associated with a hyperthyroid state. Histologic changes are similar in both forms, as the affected skin shows accumulation of matrix substances (glycosaminoglycans and hyaluronic acid), with the separation of collagen bundles in the reticular dermis. In generalized myxedema, matrix accumulation occurs in deeper subcutaneous tissues and visceral sites, therefore involvement of the heart may directly lead to death in some cases.

In cases of generalized myxedema, a thorough scene investigation and medical history should be obtained. In addition, a full medicolegal autopsy to include toxicologic and ancillary serologic analyzes should be performed. Thyroid stimulating hormone (TSH) is the most sensitive screening method for the diagnosis of hypothyroidism, and TSH levels in the serum of both adults and children are reliable up to twenty four hours after death. It is important to note that in cases of secondary or tertiary hypothyroidism (i.e., pituitary or hypothalamic disease), the TSH level will not be increased. Thyroxine (T4) levels will be decreased in all cases of hypothyroidism. Hypothyroidism is easily treatable and carries a low mortality if one is given timely and sufficient hormone therapy.

Although a diagnosis of generalized myxedema is rare in the forensic setting, it is critical for the forensic pathologist to be able to correctly identify this disease. There are many variations and subtle findings which may easily be missed by the uneducated pathologist. One must be able to recognize the various abnormalities at the time of autopsy, critically examine tissue by light microscopy, and select the appropriate serologic studies in order to correctly determine cause of death.

Forensic Pathology, Myxedema, Hypothyroid

G25 Adipositas Cordis and Iatrogenic Death: Fatal Complication or Medical Error?

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After attending this presentation, attendees will learn some basic information regarding the risk of pacing maneuvers, and the role of fatty infiltration of the right ventricle in causing delayed cardiac laceration.

This presentation will impact the forensic science community by discussing the utility of an integrated analysis of clinical, radiological and histological data for identifying any eventual medical error during pacing maneuvers.

It is well-known that the hearts of most adults in western countries contain varying physiological amounts of fat, found mainly in the subepicardial region of the anterolateral wall of the right ventricle. In the normal heart the boundary between the inner myocardium and the outer subepicardial fat is usually distinct, although a slight fuzzy border may be observed. On the contrary, in the fatty infiltration of the right ventricle irregular islands of adipose tissue may extend from the epicardium to the endocardium with the interposition of only few muscle fibers.

In such cases the risk of cardiac rupture after myocardial infarction as well as the risk of ventricular laceration after cardiac surgery is notably increased.

The case of a 70-year-old woman who died of an acute pericardial tamponade due to a delayed laceration of the right ventricle after pacemaker implantation is reported. The autopsy finding of a severe fatty infiltration of the right ventricle, its causal role in determining the fatal pericardial effusion and the legal responsibilities of the physicians who performed the implantation are critically discussed under a forensic point of view.

Myocardial perforation by pacing electrodes or Implantable Cardioverter-Defibrillator (ICD) leads is a well-known and documented complication, occurring at a rate of about 0.4-2.0%. The largest part of the injuries are clearly related to the impacting maneuvers peculiar to the manipulation of pacing catheters and are recognized intraoperatively or in the early postoperative period. Even if the complication is misdiagnosed or the rupture is delayed, due to the "self-sealing" properties of the myocardium and to the fact that generally the lead closes up the ventricular perforation (avoiding a massive bleeding), life-threatening pericardial or pleural effusions are rare.

In our case, the presence of an extended fatty infiltration of the lateral wall of the right ventricle (35% of the myocardium was displaced by adipose tissue) forced the operator to move the implantation lead back and forth to obtain a valid electric signal. In that manner, because of the enhanced fragility of the right ventricle, the surgeon produced three micro-perforations, one of them localized on the lateral wall above the insertion of the anterior papillary muscle, and two of them localized near the apex. All the perforations were of small dimensions and had "self-sealed" soon after the lead damage because the echocardiography performed thirty minutes after the implantation did not reveal pericardial effusion and the patient was totally asymptomatic during the afternoon and the evening of the operative day.

Clinical and radiological data suggest that the fatal ventricular laceration has formed during the late evening or night. Indeed, the

granulocyte infiltration along the margins of the tear dates the lesion between four and six hours before death.

Considering the size and morphology of the injury as well as the extensive transmural fatty infiltration observed in that point of the ventricle, the most probable explanation is that the micro-perforation, produced by the lead, progressively enlarged due to the presence of multiple adipose cells that reduced the adhesion forces between the myocytes. Therefore, the fatty infiltration not only favored the lead-related injuries, but also played a key-role in causing the rapid and fatal pericardial bleeding.

Regarding the site and method of pacemaker implantation as well as the post-operative clinical monitoring, it is believed that several questionable choices have been made.

Attempting multiple maneuvers (i.e., making several punctures) to find a site to place an active fixation lead at the apex is extremely dangerous, above all if the patient suffers from a fatty infiltration of the right ventricle.

Moreover, even if the echocardiography performed thirty minutes after the intervention did not reveal any pericardial effusion, considering the complicated implant procedure, the patient should have been cautiously monitored in a coronary unit, instead of being transferred to an internistic department. A proper postoperative surveillance would have prevented the fatal outcome with a high degree of probability.

Fatty Infiltration of the Right Ventricle, Delayed Cardiac Rupture, Hemopericardium

G26 Public Death From Orally Ingested Drugs During a One Year Period in Louisiana as Analyzed by a Single Forensic Toxicology Laboratory

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After attending this presentation, attendees will learn about a population-based timed study of death by oral ingestion of drugs.

This presentation will impact the forensic science community by teaching the necessity of scientific precision in all aspects of a forensic study.

Monday, July 28 (HealthDay News) – Researchers have discovered a soaring increase in the number of fatal medication errors that occur in people's homes.

The report incidentally follows the death earlier this year of Heath Ledger, the 28-year-old actor who died from an accidental overdose of prescription drugs in his apartment in New York City.

"[There was] large-scale evidence that the death rate from prescription errors was going up very fast, but I didn't know until this paper that they were going up extremely fast in particular circumstances, namely at home and when alcohol and/or street drugs are involved," said study author David P. Phillips, a professor of sociology at the University of California at San Diego.

"I also didn't know from this paper that the number of years of potential life lost from potential medication errors are greater than the number of years of potential life lost from all accidents combined, including falls and drowning," he said.

According to background information in the paper, published in the July 28 issue of the *Archives of Internal Medicine*, there has recently been a dramatic shift in fatal overdoses *away* from inpatient settings to outpatient settings. More and more medications are taken outside of the hospital or clinic, with far less oversight from health-care professionals, the researchers said.

At the same time, more medications that once were available only by prescription are now bought over-the-counter, and more people are taking more than one medication.

All of this makes it easier for individuals to combine medications with alcohol and/or street drugs. But despite this shift, few if any studies have looked at drug errors outside clinical settings. Almost 50 million death certificates were filed in the United States between January 1, 1983 and December 31, 2004, with 224,355 of them involving fatal medication errors (FMEs). After examining all of these documents, it was discovered that the overall death rate from fatal medical errors increased by 360.5 percent during that time period.

The surge in FMEs differed by type. FMEs occurring at home and combined with alcohol and/or street drugs increased the most, by 3,196 percent. FMEs not happening at home and not involving alcohol and/or street drugs showed the smallest increase, at 5 percent.

Meanwhile, at-home FMEs not involving alcohol and/or street drugs increased by 564 percent, while at-home FMEs involving alcohol or street drugs increased by 555 percent.

Overall, the increase in FMEs was particularly pronounced among people aged 40 to 59, where the increase was 890.8 percent. "People should no longer just focus on medication errors in clinical settings and caused by clinical staff," Phillips said. "There's a whole new world out there that needs to be investigated, that is to say, fatal medication errors occurring at home and not in clinical settings, and apparently influenced by patients and not by staff."

Another expert agreed.

"Most of the information we have about medication errors and their effect take place within the hospital setting," noted Lisa Killam-Worrall, director of drug information and assistant professor of pharmacy practice at Texas A&M Health Science Center Irma Lerma Rangel College of Pharmacy.

But she said there's a real challenge in finding out exactly what substances people might be taking along with their prescription medications.

"As pharmacists, we always try to counsel people when medications could interact with alcohol or other medications, but there aren't that many studies looking at interactions with street drugs," Killam-Worrall said. "We normally don't ask people, 'Are you using street drugs and which ones are you using?' We normally try to ask people, "What other medications are you taking, prescription, over-the-counter, herbal supplements?' But usually with illicit drug use, you're not going to garner a lot of information."

The findings also have policy implications in terms of patient care , Phillips added.

"Asking patients to be part of the quality-control team is not something you can just automatically do," he said. "It's true that keeping shorter times in hospitals saves money, but it apparently loses lives, and a way to try to ameliorate that would be to spend more time in educating the patient about the risks of taking these powerful medicines and the risks, particularly, of taking these powerful medicines in conjunction with alcohol and/or street drugs."

Public death as a studied scientific phenomenon provides a unique opportunity for the understanding of the human condition and its attributes. This study of the death during the year 2008 of a small cluster of Louisianians whose death became public as determined by their willful consumption of controlled substances and drugs will provide the reader with a privileged insight into these actions. The study has defined boundaries.

The deaths are in single geopolitical area, under a single authority, had no pre-established descriptors save that the deaths are secondary to drug use investigation, were in a precise timeframe of one year, had a uniform management in all details, and most importantly had professional scientific establishment of the cause and the nature of the death through detailed pathological and toxicological studies. The expenses of the study are secondary to the established budgetary standards of this government. These high standards are dictated by the important and constant use of the data and the conclusions derived therefrom to maintain the order of a complicated modern society.

More information
The U.S. Food and Drug Administration has more on medication errors.
SOURCES: David P. Phillips, Ph.D., professor, sociology, University of California at San Diego, La Jolla; Lisa Killam-Worrall, Pharm.D., BCPS, director, drug information and assistant professor, pharmacy practice, Texas A&M Health Science Center, Irma Lerma Rangel College of Pharmacy, Kingsville, Tex; July 28, 2008, *Archives of Internal Medicine*

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Public Death, Fatal Oral Ingestion, Population Studies

G27 Complex Suicide: A Case Report

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After attending this presentation, attendees will appreciate the need of a high index of suspicion for the diagnosis of a complex suicide and the importance of a full and careful autopsy.

This presentation will impact the forensic science community by describing the diagnosis of complex suicides.

In 1974, Marcinkowski had proposed a general division of suicide. In this classification, suicides are first divided into simple versus complex. The term "complex suicide" refers to suicides in which more than one suicide method is applied and usually a distinction is made between planned and unplanned complex suicides. In planned complex suicides, the combination of two or more methods of suicide are previously planned and employed simultaneously in order to make sure that death will occur even if one method fails. On the other hand, in unplanned complex suicides, several other methods of suicide are tried after the first method chosen failed, if death occurs too slowly or when it proves to be too painful.

In planned complex suicides, typically two of the common methods of suicide (e.g., ingestion of hypnotics or other medicaments, hanging, drowning, use of firearms, jumping from a height) are combined. In unplanned complex suicides, injuries by sharp force, especially cutting the wrists, are often found as the primary act of suicide and then an appropriated method of suicide is use, more frequently hanging or jumping from a height.

A case of a complex suicide is presented where the victim shot himself in the head and hanged himself. The death scene investigation associated with the findings at the autopsy was very important to classify this complex suicide as an unplanned one.

The need, in some situations, of a high index of suspicion for the diagnosis of this entity is emphasized. So, a full and careful autopsy, including toxicological analysis, combined with the investigation of the death scene is mandatory in these cases. First, to exclude the possibility of intervention of another person in the death; and second, to allow a distinction between planned and unplanned complex suicide.

Suicide, Complex, Autopsy

G28 Fire Death of Two Lovers: An Immunohistochemical and Toxicological Study

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After attending this presentation, attendees will understand investigation of deaths due to phosgene intoxication and the importance of an integrated analysis of histological and toxicological data to determine the manner and the cause of death in such cases.

This presentation will impact the forensic science community by underlining the importance of sampling and analyzing burned materials when phosgene intoxication is suspected. This compound is not detectable in body fluids and tissues due to its rapid conversion to hydrochloric acid.

The rate of annual deaths related to fire is about 13 per million inhabitants in the United States and Canada. These are mostly accidents followed by suicides. Homicides with subsequent burning of the victim or killings by burning are comparatively rare in Europe just as in the United States and Japan and are reported more often from India or South Africa.

The morphological findings in burned bodies may cover a broad spectrum. They can range from minor, local, superficial burns of the skin to calcined skeletal remains without any soft tissue left and total incineration. In most cases the effects of heat on the body continue beyond death, consequently, the changes found are largely of postmortem origin. The forensic investigation of deaths related to fire is important in order to determine the manner and cause of death and the vitality of the findings. The issues of vitality and cause of death are closely linked: the basis of the assessment is a careful evaluation of autopsy findings to distinguish morphological consequences of the effects of heat during life and after death.

A case will be presented where two burned bodies found early in the morning inside a joust (largely made of polyvinyl chloride – PVC and named "Wrestling labyrinth"), that burned in a town square after a festival. The victims were reportedly lovers (the boy 20 and the girl 16-years-old).

At external examination the corpses showed a typical boxer's attitude with general incineration, exposure of body cavities, bone fractures and partial amputation of extremities. To analyze the morphology of the fractures and their location a high-resolution computed tomography (CT) was performed, indicating that all fractures were a result of thermal effect.

Major internal findings consisted of hemorrhagic pulmonary edema and "puppet organs." Foam and soot particle depostis were detected inside the respiratory tract of both victims.

At histological examination of the lungs, ninety-five percent of the alveoli were flooded with edema and erythrocytes. There was no evidence of fibrin and inflammatory infiltrates. Immunohistochemistry, using epithelial (epithelial membrane antigen and cytokeratin) and endothelial (CD-34 and F-VIII) markers, revealed severe alveolar necrosis without endothelial damage of the vessels.

Systematic toxicological analyzes, performed on postmortem blood and urine, excluded alcohol and drugs intoxication. Monoxide-hemoglobin (CO-Hb) and cyanides concentrations were well below lethal values.

The presence of soot deposits and mucus inside the respiratory tract (not occluding the airways) along with a heat damage of the mucosa of the upper respiratory tract (edema, mucosal bleeding and vesicular detachment) suggest that the victims were alive during the fire and breathed fire-fumes.

The combined analysis of histological and immunohistochemical findings led us to identify the origin of the lung damage in the inhalation of an irritative gas. Laboratory tests, performed on burned samples of the joust (collected at death scene) and on samples of a similar undamaged joust, demonstrated an extensive production of phosgene during experimental burning.

Phosgene is a combustion, thermal decomposition or photodecomposition product of certain volatile chlorinated hydrocarbons (for example, trichloroethylene or perchloroethylene). These chlorinated hydrocarbon compounds can evolve phosgene if they come into contact with very hot metal, flame, or ultraviolet light. Phosgene is a colorless, extremely volatile gas which, at low concentrations, smells sweet, like freshly mown hay, whereas at high concentration has a pungent and

objectionable odor. When aspirated, it combines with the water of the mucous membranes being rapidly converted to hydrochloric acid, with subsequent injury to the lungs (hemorrhagic pulmonary edema).

In this cases, even in the presence of extensive direct thermal injuries, the integration of histological and immunohistochemical findings suggests as principal mechanism of death an asphyxia by airway submersion related to the inhalation of phosgene (called "dry land drowning"). Indeed, the detected hemorrhagic pulmonary edema was of such an extension (involving more than ninety five percent of the alveolar space) to be clearly incompatible with life, and capable of causing a rapid death.

In conclusion, the reported cases highlight the following teaching messages:

1. Histological and immunohistochemical investigations may enhance the identification of the real cause and mechanism of death in fire accidents.
2. Sampling and analyzing burned materials may be of valuable importance when dealing with phosgene intoxications. This compound is not detectable in body fluids and tissues due to its rapid conversion to hydrochloric acid.

Phosgene Intoxications, Fire Deaths, Immunohistochemistry

G29 Non-Traumatic Subdural Hematoma in Adults

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The goal of this presentation is to provide attendees with knowledge of the range of causes of subdural hematoma in adults and the key clinical and anatomic features that distinguish nontraumatic from traumatic subdural bleeding.

This presentation will impact the forensic science community by enhancing the efficiency and accuracy of investigation and certification of deaths from subdural bleeding.

While head trauma is the commonest cause of subdural hematoma both in hospital and in medicolegal autopsy settings, some patients presenting with subdural hemorrhage have a non-traumatic etiology. Because rapid demise may preclude angiography and other procedures to establish the source of subdural blood, these cases often come to the attention of the medical examiner. Distinguishing such "spontaneous" subdural hemorrhage from the more common traumatic subdural hematoma rapidly and with confidence can be a challenge to the forensic and neuropathologist. Complete radiologic reports often are not available at the time of the report of death, allegations of head impact during collapse may complicate the investigation, and neuropathologic examination of the brain at autopsy is best preceded by fixation of the brain prior to dissection. Certain historical and gross autopsy findings should prompt a heightened index of suspicion of nontraumatic etiology in subdural hemorrhage. The entities most often associated with spontaneous subdural bleeding include subdural extension of intracerebral hemorrhage, cerebral arteriovenous malformations and aneurysms, and metastatic tumors. Impaired coagulation from medications or from natural conditions such as hematologic or hepatic disorders also can result in subdural hemorrhage. In cases of nontraumatic subdural hemorrhage, the face and scalp will lack abrasions or contusions. When the brain is examined grossly on removal, focal, thick subarachnoid hemorrhage, especially if located other than in the parasagittal cerebrum, is suggestive of a source of subdural hemorrhage within the brain rather than from rupture of bridging veins as is usual in trauma. Five cases of non-traumatic subdural hemorrhage in adults are presented with case histories, radiologic data when available, autopsy findings and a review of the literature. The information presented will enhance the efficiency and accuracy of investigation and certification of deaths from subdural bleeding.

Subdural Hematoma, Death Investigation, Neuropathology

G30 Accidental Carbon Monoxide Poisoning: A Review of Environmental and Cultural Risk Factors of Fatal Cases in King County

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After attending the presentation, the attendees will be able to identify certain environmental and cultural factors that may increase accidental death by carbon monoxide inhalation.

This presentation will impact the forensic science community by increasing awareness of environmental and cultural factors that influence the misuse of carbon monoxide producing devices and will suggest ways to decrease the incidence of accidental deaths.

Introduction: Carbon monoxide (CO) is an odorless, colorless gas that forms as a result of incomplete combustion of carbon-containing fuels. While trace levels of CO are found in the atmosphere, fatal levels are found in exhaust from multiple sources including automobiles, generators, propane heaters and charcoal burning grills. Accidental carbon monoxide poisoning is responsible for up to fifty percent of the yearly carbon monoxide related fatalities in King County (five accidental deaths in ten total carbon monoxide deaths in 2007).

Purpose: Risk factors of accidental CO related deaths in King County from 1996 to 2008 were reviewed in an attempt to reveal preventable causes.

Methods and materials: Between 1995 and 2008, 221 cases of carbon monoxide poisoning were identified between 1995 and 2008 within the King County Medical Examiner's information database. Forty-three of which were results of accidental CO poisoning between 1996 and 2008. These cases were analyzed with respect to scene investigation reports and circumstances surrounding fatality.

Findings: CO producing devices were found placed within single family residences in 19 of the 43 accidental deaths. Eleven cases involved CO producing products within vehicles used for residence including trailers, RVs, campers, and vans. Seven of the deceased were found in their cars in their garage, four died from house fires, and the exact location of the source of CO was unclear in two cases (outside versus inside the home). Further review indicated generator exhaust as the most common source of accidental CO poisoning, with 18 of 43 total accidental deaths. Other sources of CO in decreasing incidence included exhaust from vehicles (7), heaters (6), charcoal burning (6), house fires (4), furnaces (2), a hot water heater (1), and an engine from an industrial carpet-cleaning machine. Nine deaths were due to generator exhaust or charcoal burning during power outages, including eight during a windstorm during December 2006. Four incidents included deaths of more than one individual with three paired deaths (6 total deaths) and one Vietnamese family (5 total deaths). 69% (30) of the CO victims during this time were White, 7% (3) were Black, 7% (3) were Hispanic and 16% (7) were Asian/Pacific Islander. The majority of these cases involve people who are unfamiliar with the proper use of generators or charcoal products, either due to inexperience or inability to gain information about certain products in their native language. No carbon monoxide monitors were identified in any scene investigation reports.

Discussion: The most significant environmental and cultural risk factors identified were unfamiliarity with CO producing products and the inability to receive information about these products in various

languages. Preventing accidental deaths in cities with multiple ethnic groups begins with increased availability of educational information in several languages. Many of these products are purchased directly before power outages in a rush to provide heat and power and the proper educational information is not exchanged. The Vietnamese family mentioned earlier, had a receipt for their generator, which was purchased one day prior to death.

After identifying these products in stores, many of the instructions and warning labels are written in English and Spanish, however, warning labels in less frequently spoken languages may help prevent CO poisoning. Ways to educate consumers include increasing awareness via television, the internet through downloadable brochures available in multiple languages and product education including the additional or paired purchase of carbon monoxide monitors, especially prior to anticipated power outages. While the most important time to discuss product education occurs during the purchase of the product, education about CO producing products should occur through multiple methods.

Carbon Monoxide, Poisoning, Accidental Death

G31 Differences in Scene Reenactment of Pediatric Death: Homicide Versus Others

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After attending this presentation, attendees will be able to critically apply information gathered from the experience of the City of St. Louis Medical Examiner's office. The main goal is to help differentiate homicide from other manners of death such as accident and undetermined when dealing with pediatric death. Scene reenactment as part of the investigation is an invaluable tool in assessing these difficult cases.

This presentation will impact the forensic science community by discussing key differences observed while investigating pediatric deaths with the aid of scene reenactment.

Pediatric deaths can be complicated cases for the medicolegal system, not to mention the families involved. Determination of cause and manner of death is the driving principle behind the investigation. Key parts of the investigation consist of scene investigation, postmortem studies including autopsy, radiographs, ancillary studies such as toxicology, and if pertinent, microbiology testing. Thorough photographic documentation during the initial visit to the scene as well as at the time of the autopsy is vital to assessing pediatric deaths. Scene investigation is usually performed by medicolegal death investigators who may conduct their inquiry either via telephone or actual visit to the scene.

All pediatric cases (ages 0-5) referred to the St. Louis City Medical Examiner's office during a five-year period, from January 2003 to December 2008 were analyzed. The cases were stratified according to the manner of death of either homicide, accident, or undetermined. The differences in cases that underwent scene reenactments and correlated them with the postmortem studies were compared. Some of the cases were investigated with phone interviews, usually due to traveling or jurisdictional constraints. Telephone interview investigation findings will also be discussed.

One of the most difficult aspects of pediatric deaths for the family is that the event is generally unexpected, unless there is history of natural disease. SIDS (Sudden Infant Death Syndrome) is a diagnosis of exclusion, reserved for cases for which no cause of death is found after a thorough investigation. The scene reenactments conducted in our office frequently demonstrate bed sharing or positional asphyxia as a cause of the child's death. These cases are no longer classified as SIDS as a result of this investigative tool. Additionally, our investigators use a standardized questionnaire published by Missouri Department of Social Services titled Death Scene Investigative Checklist for Child Fatalities. The form covers minimum necessary information which maybe used later on in the death certification process. It covers key points such as prenatal history, events surrounding death, condition and position of the child, as well as social and environmental conditions.

While natural, accidental and undetermined manner of death is distressing to the family, homicide has its own caveats. The perpetrator is frequently known to the family and is usually not biologically related to the deceased. Most pediatric homicides are crimes of spontaneous impulsive behavior**.** The killing is not usually premeditated, but rather a reaction to the child's behavior such as loud crying or poor feeding. Most frequently the assailant uses their own body (i.e., hands, feet, torso) to inflict the fatal injuries onto the child. The troubling aspect of pediatric death for medicolegal investigators, law enforcement and forensic pathologists is that homicide within this population does not always exhibit overt trauma. In instances of mechanical asphyxia and unusual poisoning, even a diligent postmortem examination and standard toxicology panel may not reveal the cause and manner of death. Therefore, we must rely on either keen investigative techniques or await perpetrator's confession. While in most sudden infant deaths, the parents or caretakers appear distressed, the stories and reenactments of in cases of homicide frequently shift during the investigation. Investigations in these deaths often reveal an inconsistency or improbability during the scene reenactment.

Scene Reenactment, Pediatric Death Investigation, Manner of Death

G32 Suicide by Multiple Gunshots From Automatic Weapons

Paul Uribe, MD, 7807 Mineral Springs Drive, Gaithersburg, MD 20877*

After attending this presentation, attendees will be able to describe the characteristics of selective fire and "full-auto" weapons and become familiar with the patterns of injury associated with self-inflicted injuries using these types of weapons.

This presentation will impact the forensic science community by providing a case series of a self-influcted pattern of injury that has rarely been discussed in the forensic literature.

Eight cases of suicide from multiple gunshot wounds by use of automatic weapons will be discussed. Automatic weapons are either solely automatic or have selective fire mechanisms. Selective fire mechanisms include settings for semi-automatic, three round burst, and "full-auto" modes of fire. Weapons with either selective fire settings or that are solely automatic can rapidly discharge multiple rounds in immediate succession when the trigger is pulled. In this case series, there was a strong predilection for wounds of the head (7/8) and only one (1/8) had recovery of the projectile fragments. The recoil produced from firing an automatic weapon can produce considerable distance between entrance wounds. In all of the cases studied, two or more rounds discharged and each had at least two entrance wounds; however, in two cases the number of rounds discharged could not be determined due to the extent of the injuries, co-mingling of trajectory paths, and shared entrance and exit wounds. Thorough scene investigation is essential in these cases to in an effort to determine how many shots were fired, what type weapon was used, and if a selective fire setting was used. Reconstructive computed tomography can also be useful in illustrating wound paths and assisting the determination of how many shots were fired.

Suicide, Gunshots, Automatic

G33 EBV (+) T-Cell Lymphoproliferative Disorder of Childhood Causing Sudden Death: A Case Report

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After attending this presentation, attendees will become familiar with this unusual disorder that can have a rapid course with high mortality such that medical examiner/coroners (ME/Cs) are involved in the investigation. Attendees will learn the value of special testing in autopsy cases, such as immunohistochemistry, EBER-ISH, and T-cell receptor gene rearrangement studies.

This presentation will impact the forensic science community by stressing the need for access by medical examiner/coroner's offices of good immunohistochemistry testing, in-situ hybridization testing, and gene rearrangement studies. Lack of access to these modern techniques can lead to many death investigations remaining unsolved, or misdiagnosed.

Systemic Epstein-Barr virus (EBV) positive T-cell Lymphoproliferative disorder (LPD) of childhood is a life-threatening illness of children that may be associated with chronic active EBV infection or following a primary acute EBV infection. This entity is most prevalent in Asia and rarely reported in the West. Common sites of involvement include the liver, spleen, lymph nodes, bone marrow, skin and lungs. It has a fulminant clinical course with development of hepatosplenomegaly, liver failure, lymphadenopathy, rapidly progressing to multiorgan failure. Other complications such as hemophagocytic syndrome and sepsis can occur. The prognosis in most cases is dismal with death resulting in days to weeks.

We present a case of a 3½-year-old, previously healthy, Hmong girl who presented with to a hospital ER with nausea and vomiting. Initial CBC revealed leukocytosis with an absolute neutrophilia and lymhocytosis. Over the next twenty-four hours, the decedent developed rapidly progressive hepatic failure, became lethargic and unresponsive. Her hematological parameters were as follows: Fibrinogen=152, PTT=41.8, PT=32.1, INR=3, D-dimers: 1869 (n<250ng/ml). Her liver function tests were markedly elevated AST: 4770, ALT: 5030, Ammonia: 421. Mushroom poisoning was strongly considered. Immunoassays for RSV, Influenza A & B, Adenovirus and Hepatitis A & B were negative. EBV serology showed antibodies to EBV (EBV VCA IgG: 1185 (Normal<100) and EBVNA IgG: 1392 (Normal <100). On day two of admission, a CT scan of the head showed cerebral edema with tonsilar herniation. Due to the extremely poor prognosis of the critically ill patient, care was ultimately withdrawn.

Significant findings at autopsy were cerebral edema with tonsilar herniation, hepatic necrosis, splenomegaly (96.9 grams) and massive mesenteric lymphadenopathy. Multiple matted mesenteric lymph nodes were noted; the largest measuring 3 cm in greatest dimension. Sections revealed homogenous tan-pink cut surfaces.

Microscopic examination of the liver showed moderate portal acute and chronic inflammation with hepatocellular necrosis. Sections of spleen showed atypical lymphoid cell infiltrates. Histological examination of an enlarged mesenteric lymph node revealed complete effacement of nodal architecture by medium to large, atypical lymphocytes with irregular nuclear contours and occasional nucleoli, and abundant mitoses. Immunohistochemical stains performed on the lymph node showed a predominant T-cell population (CD3+/CD5+ cells) with high proliferation index (MIB-1: 70-80%) and a small population of scattered B-cells (CD20+). EBV encoded RNA (EBER) was positive by in-situ hybridization (ISH) in the mesenteric lymph node and spleen. A T-cell receptor gene rearrangement study was performed confirming a clonal population of T-cells.

Neuropathologic examination performed after brain fixation revealed hypoxic encephalopathy with marked swelling and cerebellar tonsillar herniation. Alzheimer type II astrocytes were noted in globus pallidus, neostriatum, thalamus, medulla and cerebellar dentate nucleus consistent with hepatic encephalopathy.

In the work-up of sudden unexpected deaths in children and young adults with similar presentations, especially in Asians, EBV positive T-cell lymphoproliferative disorder should be considered. Since the clinical course is usually rapid and the mortality rate is high, medical examiner/coroners are often involved in investigating the cause of death. Antemortem EBV serology and relevant histological evaluation of liver, spleen, lymph nodes, and bone marrow aid in the initial diagnostic work-up. Immunohistochemistry, EBER-ISH & T-cell receptor gene rearrangement studies that can all be performed on paraffin embedded blocks are additional valuable tools in clinching the diagnosis.

Epstein-Barr Virus, T-cell Lymphoproliferative Disorder, EBER-ISH

G34 Temporal Variation of Ethanol Related Firearm Deaths

Rameen S. Starling-Roney, MD, Anna Rubio, MD, Donna M. Vincenti, MD, and David R. Fowler, MD, State of Maryland Office of the Chief Medical Examiner, 111 Penn Street, Baltimore, MD 21201*

After attending this presentation, attendees will understand the potential risk of ethanol use and subsequent homicidal death by firearms (gunshot and shotgun), and the seasonal temporal variation in homicides in which the decedent was under the influence of ethanol.

This presentation will impact the forensic community by examining the association between ethanol intoxication and firearm related homicides. Previous reports have shown a direct correlation between ethanol intoxication and suicides and accidental deaths (specifically motor-vehicle accidents). However, a definitive association between ethanol intoxication and homicides has not been established.

A review of all homicides in the State of Maryland between 2003 and 2007 was performed for cases in which death was due to firearms and in which heart blood was available and evaluated for toxicology (cases in which complications occurred were omitted). Cases were classified by whether the decedent's heart blood ethanol level was above or below the legal limit of intoxication (0.08 g/dl). Predictors of elevated blood ethanol were examined by logistic regression analysis with multiple independent variables including age, gender, week of the year, day of the week, month, and season. Statistical significance was determined by likelihood ratio tests. The numbers of total homicides were compared for different days of the week and month of the year by Poisson regression analysis, aggregating the five years of the study period.

A total of 1,571 cases were identified using the above criteria. The median age for the cases was 26-years-old, 91.4% of the decedents were male and 86.4% were African-American. Statistically significant temporal variation was noted in the aggregate number of homicides by day of the week (greater on Saturday) and month of the year (greater in July and January). Of all cases, 271 (17.3 percent) had a blood ethanol level of 0.08% g/dl or greater. There was statistically significant temporal variation in ethanol related homicides by day of week (increased on Saturday and Sunday) and month of the year (increased between May and August with peaks in June and July). In addition there was a significant increase in ethanol related homicides in the summer when compared to the remaining seasons. No temporal variation was seen in non-alcohol related homicides. A direct relationship was not seen between increased ethanol related homicides and increased total homicides when compared to month of the year and season, however a trend was seen when compared to the day of the week (increased on Saturday).

In conclusion this study shows temporal variations in overall firearm homicides and ethanol related firearm homicides. However a direct association in terms of increased ethanol consumption was not established.

Ethanol, Firearm, Temporal Variation

G35 Axonal Injury in Pediatric Head Trauma: A Study of the Interpretation of ß-Amyloid Precursor Protein (ß-APP) Expression in Trauma and Non-Trauma Cases

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After attending this presentation, attendees will understand that although beta amyloid precursor protein expression (β-APP) can be useful in confirming axonal injury, its presence or absence cannot in and of itself, prove or disprove traumatic injury.

This presentation will impact the forensic community by illustrating the complexities of interpretation of amyloid precursor protein expression as evidence of axonal injury

The purpose of this presentation is to illustrate the utility of β-APP immunohistochemistry as morphologic evidence of traumatic brain injury. Often special studies are suggested and/or warranted to rule out the possibility of occult trauma in cases of sudden unexpected death of young children. A number of reports, over the past decade, have described various patterns of β-APP expression in axonal injury. Brain material from a group of twenty-seven young children in order to test the application and interpretation of β-APP immunohistochemical staining were examined.

In 1999, the State of Maryland Office of the Chief Medical Examiner (OCME) investigated 153 deaths of subjects three years of age or younger. Of these, 97 deaths were natural [including 56 cases attributed to Sudden Infant Death Syndrome (SIDS)], 24 were accidental, 18 were homicides, and 14 were undetermined. Among the homicides, seven children sustained blunt force injuries to the head. The staining pattern of β-APP in multiple brain regions (frontal, temporal, and parietal cortices, cingulate cortex/corpus callosum, and the cervicomedullary junction) was evaluated. Compared, in a blinded fashion, the β-APP staining of the homicide cases to similar brain regions from seven age matched cases, in which death was due to a non-traumatic disease (other than SIDS), and ten cases with similar ages, from the same calendar year in which death was attributed to SIDS.

Three reviewers achieved consensus regarding the β-APP staining by using a simplified semi-quantitative scoring method based on 1) staining density per high power microscopic field and 2) the presence or absence of multifocal staining within a single microscopic slide from a single brain region. Upon consensus interpretation, the reviewers agreed that significant β-APP axonal expression was present in five of the seven homicides (71%). Subsequent unblinded review of autopsy records demonstrated that in these cases there was gross evidence of intracranial hemorrhage at the time of autopsy. In the other two homicides cases, the reviewers agreed there was not evidence of axonal injury by immunohistochemistry. These two homicide cases had superficial cranial injuries with significant traumatic injury only to the thoracic spinal cord, determined at autopsy. Two (2) of the SIDS cases and one of the non-trauma cases displayed axonal immunostaining with density and pattern similar to that in the traumatic cases, and the reviewers could not, with certainty, differentiate these cases from the five homicides by immunohistochemical staining alone.

The specifics of the cases to illustrate the complexities involved in interpreting β-APP deposition in cerebral tissues and to make recommendations regarding the use of adjunct immunohistochemical studies in suspicious infantile deaths will be discussed. Perspective of trends, since 1999, in the evaluation of SIDS versus sudden unexplained death of an infant (SUDI)—especially with regards to co-sleeping factors that might result in asphyxia and hypoxic ischemic injury will also be discussed. Data confirms that while β-APP staining can be useful and corroborative, immunohistochemistry cannot be used independently to determine the presence or absence of traumatic injury

Amyloid Precursor Protein, Axonal Injury, Trauma

G36 Association of Retinal Hemorrhages With Fatal Head Injuries in Infant Monkeys

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After attending this presentation, attendees will gain familiarity with the use of animal models for shaking injuries and appreciate the potential for further study of retinal hemorrhages using accidental head injuries in infant monkeys.

This presentation will impact the forensic science community by providing objective scientific data about the natural history of retinal hemorrhages, which will assist forensic pathologists, pediatricians, ophthalmologists, and emergency medicine physicians by offering a better understanding of the pathogenesis of retinal hemorrhages.

Published studies about the specificity of retinal hemorrhages for Abusive Head Trauma (Shaken Baby Syndrome) are controversial. A diagnosis of child abuse based on the presence, number and distribution of retinal hemorrhages has serious consequences, and thus deserves unbiased scientific investigation. Some authors claim that retinal hemorrhages are virtually pathognomonic of a shaking (acceleration-deceleration) injury, but for such a purportedly specific finding, this claim has never been scientifically proven. Many papers have been written on the subject; however, disproportionately few have had significant substantive value. To date, no reasonably scientific, reliable and ethical animal model for retinal hemorrhages has been identified. Consequently, an exhaustive list of situations and conditions in which retinal hemorrhages can be seen has not been established. Based on the experience of this institution, observational data suggests that retinal hemorrhages occur fairly commonly in the absence of shaking or other non-accidental injury. The goal of this study is to help elucidate these situations though the use of a natural animal model for retinal hemorrhages. This study is intended to serve as a pilot study to evaluate the possibility of using baby monkeys that have died as a result of trauma to demonstrate the presence of retinal hemorrhages in the absence of shaking.

Trauma is a well-documented cause of neonatal and infant mortality in certain non-human primate breeding colonies. One mechanism of trauma is related to changes in the carrying behavior of captive dams, including more frequent cradling of the infant monkeys. Cradling of the infants has resulted in an increased number of fatal accidental head

injuries in these monkeys. The injury occurs when the mother's chest touches the ground as she jumps and lands, thus allowing the infant's head to hit the ground with significant force. Previously published necropsy data for infant squirrel monkeys (*Saimiri sciureus*) has revealed both open and closed skull fractures. No non-lethal or incidental skull fractures have been reported in any captive monkey populations. Unfortunately, none of these studies examined the eyes of the infant monkeys for the presence of retinal hemorrhages.

The heads of seventeen infant monkeys (*Callithrix jacchus* or *Saguinus oedipus*) who died from either trauma or natural disease were provided by the New England Primate Center following necropsy and selective histological examination (KGM). Information initially provided to the primary investigators (CHS, PEL, CAS, KAS and JHB) included the species, animal number and necropsy number. All monkey heads received CT scans (KAS, JHB) using the Siemens MicroCT [Resolution: Bin x 4 = .0732 (73 micron)] followed by pathological examination (CHS, PEL, CAS) including external examination, gross dissection and microscopic examination of the brains and eyes. Findings were digitally photographed including all brains and retinas. The examinations demonstrated eleven animals with apparent head injuries. Nine monkeys had skull fractures; five fractures were identified both radiographically and grossly, three fractures were only identified grossly and one fracture was only identified radiographically. Microscopically evident retinal hemorrhages were present in at least one eye in all specimens with skull fractures and were unilaterally present in one specimen without evidence of a head injury. Because of poor preservation, several of the retinas were fragmented, thus hindering interpretation. Following completion of the examinations, the age, date of birth, date of death, dam and sire numbers, type of postmortem examinations originally performed, postmortem interval, and cause of death for each animal was revealed. All animals were born and died in 2002, with a mean and median age of 1.88 and 2 days at death, respectively. The majority of animals (13/17) died or were euthanized (5) as a result of suspected parental neglect and inanition. Of the remainder, two died of infection, one was stillborn and one died of unspecified cause(s). Postmortem interval was less than twelve hours with the exception of the euthanatized animals, which were examined with in two hours. Based on the above information, this study demonstrates a possible association between skull fractures and retinal hemorrhages. Although more studies are necessary to identify a causal relationship between accidental head injuries and retinal hemorrhages, these results suggest that this type of animal model may be of use in studying retinal hemorrhages not associated with alleged shaking incidents.

Retinal Hemorrhages, Abusive Head Trauma, Animal Model

G37 Postmortem Pulmonary Findings by Computed Tomography Compared With Conventional Autopsy

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After attending this presentation, attendees will improve their knowledge about interpretation of postmortem CT scanning images of the lungs and to distinguish them from pathological changes developed before death.

The presentation will impact the forensic science community by demonstrating an important contribution to the new practical knowledge that the forensic pathologist should know regarding the role of CT scanning in autopsy (virtopsy) with reference to the new ACCME criteria.

Postmortem CT scanning (PMCT) is becoming an increasingly important supplement to the medicolegal autopsy. It contributes significantly to the description of skeletal lesions, thereby clarifying the mechanisms of trauma. Gas and foreign bodies are readily identified, and it provides insight in the process of decomposition, in case of which visualization of organs such as the brain is also improved. Interpretation of the CT images acquired from dead people is in many ways different as compared to living people. Evidently, the circulation stopped, resulting in reduced blood filling in the arterial system and sedimentation of blood and other body fluids in the soft tissues. Decomposition of the body begins and is clearly visible as air formation in the soft tissues at a very early stage. It can be difficult to discern the various postmortem changes from pathological conditions in the organs and other soft tissues, especially because experience with PMCT is very limited in contrast to the widespread knowledge in clinical CT scanning.

The purpose of this study was to compare the findings in the lungs by PMCT with the findings and diagnosis made by conventional autopsy, and to learn how to identify common postmortem changes in the lungs in PMCT and to distinguish them from pathological changes developed before death. Internal lividity can be present in all organs, but they are easier to recognize in the lungs both at the autopsy table as well as on PMCT images, because the presence of air in the lung tissue acts as a contrast to the denser appearance of blood and tissue. Internal lividity of the lungs is often seen in the posterior parts due to the frequently supine positioning of the body. In many cases, internal lividity is easily recognized as such. However, differential diagnoses should always be considered, e.g. pneumonia, edema, contusion, and infarction.

The material consisted of 100 forensic cases which were autopsied in 2008-2009 at the Institute of Forensic Medicine, preceded by PMCT by using an in-house Siemens Definition 64 slice scanner. Whole-body scanning was performed in all cases. The torso scanning was obtained with 140 kV and 500 mAs; a beam collimation of 1 mm and pitch 0.75. From the PMCT data axial images were made using different algorithms (H20S smooth and H60S sharp) provided by the manufacturer. Evaluation of the axial images was supplemented by secondary multiplanar reconstructions obtained with available software at the workstation. The PMCT images were initially evaluated by an experienced forensic pathologist and in selected cases a senior radiologist with postmortem radiology experience also evaluated the images. Following the initial evaluation all thoracic axial slices obtained in each of the cases were reviewed by the authors in order to complete a detailed description of the lungs with respect to internal lividity and pathological findings, using the standard settings for viewing of the lungs (window width 1200 HU, center -600 HU) and the mediastinum (window width 400 HU, center 40 HU). The results of the PMCT were compared with the macro- and microscopic findings at autopsy.

The results will be presented and discussed.

Postmortem CT Scanning, Virtopsy, Lung Pathology

G38 Forensic Imaging: Yes, We Scan! New Challenges for a Radiographer

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After attending this presentation, attendees will be able to understand the role of radiographers in forensic imaging regarding CT (computed tomography) angiography and will know the different responsibilities of forensic radiographers such as sample collection for toxicological analyzes (postmortem liquid puncture), sample collection for additional analysis such as histology or bacteriology (postmortem biopsy), and the performance of postmortem angiography including the use of a perfusion machine.

This presentation will impact the forensic science community by displaying the first experiences and future possibilities of this new opportunity. It will also introduce the radiographer and his skills to the medicolegal public.

It is a logical fact, that the implication of a radiographer into a team of forensic radiologist and pathologists can increase the radiological quality of examinations. With the application of postmortem angiography in forensic cases, the importance of such a specialist is again increasing, because this examination is complex and needs experience in handling a CT-scan. Additionally, it brings other needs with it, such as the necessity to perform sample collection for toxicological analysis, before injecting a contrast agent into the corpse. These responsibilities can be fulfilled by the radiographer. His technical knowledge facilitates also the control of the perfusion machine, which is necessary for postmortem angiography.

Sample collection for toxicological analyzes: During the process of postmortem angiography, a contrast agent is injected into the corpse and the blood is rinsed out of the vascular system. Such treatment could eventually alter the findings in toxicological analysis. To avoid this problem, samples of liquids used for these analyzes are collected before angiography. To get samples of vitreous humour, bile, urine, cardiac blood and peripheral blood, punctures are done manually by the radiographer.

Postmortem biopsy: For some additional analyzes such as histology (especially search for fatty embolism) or bacteriology, samples can be collected already before performing angiography in order to avoid contamination of the tissue of interest. For this purpose, postmortem biopsies can be performed by the radiographer.

Performance of postmortem angiography: After sample collection, the radiographer performs the postmortem angiography. He prepares the perfusion machine and the body. The body-preparation includes the correct positioning on the CT-table as well as preparation of the femoral vessels and inserting cannulas into them. After connecting the perfusion machine with those cannulas, the postmortem angiography is performed. Hereby, CT-acquisition and the perfusion machine have to be well synchronized.

For a radiographer, the switch from living patients to dead bodies might be difficult in the beginning. With skills in technology (imaging acquisition, reconstruction of 2D and 3D images, etc.) and anatomical knowledge, (vascular anatomy, positioning of the body, etc.) the radiographer is predisposed to become a member of a forensic team.

The radiographer represents a profession that is necessary to guaranty good quality of radiological examinations and allows a rapid investigation, which is important to implement biopsies and angiography in the daily routine of forensic medicine. This collaboration is well accepted in the forensic team. The interdisciplinary exchange of forensic pathologists, radiologist and radiographers leads to fructuous discussions and successful collaborations between those specialists. Regarding the increase of radiological exams in forensic departments, this new radiographer allows to save much time in the daily routine.

Radiographer, Forensic Imaging, Postmortem Angiography

G39 Benefits and Limitations of Postmortem Multislice Computed Tomography as Adjunct to the Perinatal and Pediatric Autopsy

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After attending this presentation, attendees will understand the basics of the radiologic investigation of perinatal and pediatric death by Multislice Computed Tomography (MSCT) as well as the advantages and the limitations of this method.

This presentation will impact the forensic science community by serving as an introduction of postmortem MSCT as a useful noninvasive adjunct to classic autopsy or even as a potential replacement in cases when autopsy is refused by the next of kin.

Perinatal and pediatric autopsy provides essential diagnostic information not only for parents but also for medical audit and clinical trials. The autopsy rate is decreasing throughout the world for numerous reasons. Medical imaging has always been part of the autopsy process, but in the last decade there has been increased interest in imaging as additional to or a replacement for autopsy. A retrospective data analysis of thirty child autopsies will be presented with correlation in all cases with previously performed MSCT. Postmortem whole body six slice CT imaging was performed on average of twenty-three hours after death. Reconstructions in 1.25mm thickness (soft tissue and lung kernel). Radiological diagnosis was carried out by two radiologists, each with three years experience in postmortem/pediatric radiology. The comparison between autopsy and cross sectional imaging showed a high diagnostic accuracy for intracranial hemorrhage, pulmonary pathologies, the visualization of other (partly) gas containing structures like the intestines and bony pathologies like fractures or tumor caused erosions of bony structures. Obvious weaknesses of the unenhanced CT imaging lied in the detection of cardiovascular vascular pathologies and subtle pathologies of the central nervous system. CT imaging does not provide a histological diagnosis, although histopathologic examination contributes often important information regarding the cause of death. This is clearly a crucial issue if CT is to be used to replace autopsy. A possible solution is the application of CT-guided biopsies to gain histological specimens. The emerging field of postmortem CT angiography could help to close the gap in vascular imaging. This study shows that postmortem CT imaging alone is not a sufficient complete replacement of classic autopsy in the perinatal and pediatric death. Despite the drawbacks, we are convinced of the potential of this method as a planning tool and complement to the classical pediatric autopsy and as the method of choice when autopsy is refused by the next of kin.

Postmortem CT, Perinatal Autopsy, Pediatric Autopsy

G40 Multidetector Computed Tomographic (MDCT) Autopsy in Suicide by Gunshot to the Head

Thoedore Harcke, MD, Craig T. Mallak, JD, MD, and Terrill Top, MD, Armed Forces Institute of Pathology, 1413 Research Boulevard, Rockville, MD 21771*

After attending this presentation, attendees will be able to discuss the ability of MDCT to identify critical forensic elements in suicide by gunshot to the head. The discussion will include both strengths and limitations of MDCT imaging.

This presentation will impact the forensic science community by showing the potential for postmortem MDCT imaging to simplify cause of death determination in selected cases of suicide.

Postmortem MDCT has been showed to be accurate in the evaluation of gunshot wounds with regard to presence of ballistic fragments, entry and exit wound determination, and determination of wound track. Two-dimensional and three-dimensional CT images from a consecutive series of ten cases (nine male, one female; age range 19-32 years) with history of self-inflicted gunshot wound(s) to the head by small arms were studied retrospectively by a radiologist and forensic pathologist. Neither individual had knowledge of the autopsy findings. Using a computer workstation to view axial images and 2D/3D computer reconstructions, determinations of number of shots, entry and exit wounds, soot/stippling, beveling, and wound direction were ascertained. The results were compared to the autopsy findings. All autopsies were performed by board certified medical examiners with access to 2D radiographic images.

The radiographic conclusion that all cases were single shot perforating wounds (one with residual metal fragments) agreed with autopsy reports. There was agreement in designation of all entry and exit wounds (20); entry wounds were submental (1), glabellar area (3), right temporal region (5) and intraoral (1). Three-dimensional surface rendering of scalp wounds was not as helpful as skull findings in classifying wounds. Presence of soot was not mentioned in any of the radiographic assessments but was described at autopsy in all cases. Stippling was not noted in either the MDCT or autopsy findings. Presence of beveling was agreed upon at 9/18 sites, in 8/18 sites MDCT was positive for beveling but not mentioned or called negative in the autopsy report. At one entry site, the autopsy noted beveling whereas the radiology review did not call it (intraoral and submental entry sites are often not subject to beveling).

There was agreement in 10/10 cases regarding the track direction (anterior vs posterior, left vs right, up vs down) with only a minor variance in one case (horizontal track by MDCT vs downward by autopsy measure from vertex). The internal description of brain injury reflected some differences in terminology. While the MDCT tended to describe direction and distribution of bone fragments and pathway, autopsy was more descriptive of hemorrhage and brain anatomy but overall the pathways were in agreement.

Self inflicted, perforating GSW's of the head were correctly described by MDCT in regard to number of shots, entry and exit wound determination and description of wound direction and track. Significant limitations of MDCT are its inability to assess the external soft tissue findings at entry and exit sites and in particular to determine the presence of soot. This study shows that MDCT adds objective information to the invasive part of the cranial autopsy in cause of death determination for cases of suicide with perforating GSW's; however, it cannot replace external assessment of wounds.

However, the combination of hands-on external/internal autopsy assessments and non-invasive internal evaluation by MDCT are not enough. The knowledge of the circumstances leading up to the death and laboratory tests are required to strengthen the medical examiner's ability to objectively establish the cause and manner of death in cases involving self inflicted, perforating GSW of the head.

Suicide, MCDT Autopsy, GSW to Head

G41 Classification of Asphyxia: The Need for Standardization

Anny Sauvageau, MD, Office of the Chief Medical Examiner, 7007, 116 Street, Edmonton, AB T6H 5R8, CANADA*

After attending this presentation, attendees will better understand the lack of uniformity in the classification of asphyxia and the need for standardization.

This presentation will impact the forensic science community by proposing a unified system of classification of asphyxia.

Introduction: Asphyxial deaths are common in forensic practice. Unfortunately, the classification of asphyxia and the definition of its subtypes are far from being uniform, varying widely from one textbook to another and from one paper to the next. This presentation will begin by summarizing the definitions that are currently described in the literature and highlighting their discrepancies. An attempt will then be made to draw on the mainstream definitions to create a unified system of classification.

Classification and definition of types of asphyxia in the literature: A comprehensive review of the different classifications of asphyxia found in the literature will be presented as well as a thorough compilation of definitions of each term. From this complete review, the most widely accepted views will be drawn. The following recommendations will be discussed, with their underlying rationale:

a) *Unified classification model:* It is proposed that asphyxia should be classified into four main categories: suffocation, strangulation, mechanical asphyxia, and drowning. Suffocation subdivides into smothering, choking and confined spaces/ entrapment/ vitiated atmosphere. Strangulation includes three separate forms: manual, ligature and hanging. Mechanical asphyxia encompasses positional as well as traumatic asphyxia.

b) *Suffocation:* Some authors confusingly use this term synonymously with smothering. Considering the lack of specificity of this term, its use is strongly discouraged in death certificates and requires replacement with a more precise descriptor.

c) *Smothering and choking*: There is no consensus as to the anatomical landmark serving as a boundary between these entities. The epiglottis is proposed as a standardized anatomical landmark. If confronted with an obstruction extending above as well as below the epiglottis, it is recommended to use the lowest level of airway obstruction in classifying the case.

d) *Mechanical asphyxia:* Mechanical asphyxia has been defined by different authors as either a specific entity characterized by restriction of respiratory movements by external pressure on the chest or abdomen or as a broad term encompassing several types of asphyxia caused by various mechanical means. To avoid confusion, it is recommended to keep the phrase mechanical asphyxia as a specific term to designate asphyxia by restriction of respiratory movements.

e) *Strangulation and hanging:* The classification of hanging is controversial: several authors consider hanging to be a type of strangulation or a subtype of ligature strangulation, whereas other authors consider strangulation and hanging as different entities. It is recommended that hanging should be regarded as a type of strangulation, along with manual and ligature strangulation. Some authors believe that accidental hanging can also occur without a ligature: it is however recommended to restrict the appellation of hanging for cases involving some type of ligature tightened by the weight of the body. Furthermore, it is recommended that all asphyxial deaths caused by external pressure on the neck structures should be labeled strangulation and terms such as

positional asphyxia should be avoided in these circumstances. If a strangulation does not fall into the category of manual, ligature or hanging it should be labeled as strangulation NOS (not otherwise specified).

f) *Drowning:* It is recommended that drowning should be included in the forensic classification of asphyxia. However, this inclusion does not necessarily mean that the entity should be discussed in the chapter of asphyxia in textbooks or formal teaching. A better approach would be to include drowning in the classification of asphyxia but discuss it further in the context of the investigation of bodies recovered in water.

Conclusion: At this point in time, there is so much variation in the classification and definitions of terms that research and practice are inevitably tainted by confusion. Unfortunately, similar research designs can lead to totally different results depending on the definitions used. Closely comparable cases are called differently by equally competent forensic pathologists. The proposed unified model in this study was designed in an effort to standardize the classification of asphyxia in the forensic context.

Forensic Pathology, Asphyxia, Classification

G42 Discrimination of Falls and Blows in Blunt Head Trauma: A Multi-Criteria Approach

Anny Sauvageau, MD, Office of the Chief Medical, Examiner, 7007, 116 Street, Edmonton, AB T6H 5R8, CANADA*

After attending this presentation, attendees will have better knowledge of the criteria pointing towards blows or falls in blunt head trauma.

This presentation will impact the forensic science community by providing tools to improve the discrimination between falls and blows.

The distinction between accidental falls and homicidal blows is an important one in forensic pathology as it occurs frequently, but most importantly, because of the legal branching related to a homicide. Indeed, autopsy findings are often used to corroborate or complement investigative information. In the discrimination of falls versus blows, the hat brim line (HBL) rule is mentioned in several textbooks as the most useful single criterion. According to this rule, an injury located at the level where the brim of a hat would lie is more likely the result of a fall, while a blow would generally produce a wound above this line. Recent studies however have found that the HBL rule is only moderately valid and that its use on its own is not recommended. The HBL rule should instead be used in conjunction with other tested criteria, such as the side lateralization and number of lacerations and the length of lacerations. The purpose of this research is first to find additional individually useful criteria in the distinction of falls from blows, and second to construct a decision tree by selecting and combining criteria with the highest predictability rates.

Materials and Methods: This retrospective study used autopsy cases from the Montreal Laboratoire de sciences judiciaires et de médecine légale spanning a six-year period (2000-2005). The selected cases represented falls downstairs, falls from one's own height and homicidal blows to the head by a blunt weapon. Designation of cases as falls or blows was not solely based on head examination but on a thorough case review, including scene investigation, witness testimony, perpetrators confession and other autopsy findings. The cases where a victim was struck while lying on the ground were excluded from the sample. For each case, the following features were compiled: the number of lacerations, the location of lacerations and fractures in relation to the HBL, the side lateralization of lacerations and fractures, scalp laceration length; calvaria fracture type; number of facial abrasions, contusions, and lacerations (including mouth lesions); presence of lacerations on the ear; presence of facial fractures; pattern of post-cranial osseous and visceral trauma; and the quantity of alcohol (mg/100ml) when toxicology reports were available. The HBL definition used in this study is the following: the area located between two lines parallel to a line inspired by the Frankfort horizontal plane (horizontal plane passing through right and left porion points and the left orbitale), the superior margin passing through the glabella (G line) and the inferior margin passing through the center of the external auditory meatus (EAM line).

Results and Conclusion: A total of 113 cases were studied: 29 cases of falls from one's own height, 21 cases of falls downstairs, and 63 cases of homicidal blows. Cases of falls downstairs revealed a male:female ratio of 6:1 with an average age of 50 (± 14.3 years ranging from 26 to 79 years), while the ratio for falls from one's own height was 8.7:1 with an average age of 51.5 (± 17.5 years ranging from 15 to 85 years). Cases of blunt head trauma to the head showed a male:female ratio of 2.9:1 with an average age of 44 (± 19.8 years ranging from 9 to 81 years).

The goal of this study was to improve the discrimination between falls and homicidal blows by a blunt weapon in a forensic pathology setting. The request to give an expert opinion on this distinction is a common and crucial one given the legal consequences. Overall, based on the present study as well as previous ones, the criteria pointing towards blows are:

1. More than three lacerations
2. Laceration length of seven cm or more
3. Comminuted or depressed calvarial fractures
4. Lacerations or fractures located above the HBL
5. A left side lateralization of lacerations or fractures
6. More than four facial contusions or lacerations
7. Presence of ear lacerations
8. Presence of facial fractures
9. Presence of post-cranial osseous and/or visceral trauma

Blunt Head Trauma, Falls, Homicide

G43 Glioblastoma – Cause of Sudden Death on an Apparently Healthy Woman

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After attending this presentation, attendees will learn the importance of performing a complete autopsy in cases of sudden unexpected death, completed with a meticulous neuropathological examination, mainly in the cases where an extracranial cause of death was not found.

This presentation will impact the forensic science community by the report of a very rare case of sudden unexpected death by an undiagnosed glioblastoma.

Sudden unexpected deaths due to primary brain tumors are very rare in forensic pathology practice. Nowadays, most fatal brain tumors are diagnosed before a fatal outcome, based upon neurological manifestations and imaging techniques, such as computed tomography and magnetic resonance imaging. Gliobastomas are the most common primary brain neoplasms and account for more than fifty percent of the malignant gliomas. Usually they cause headaches, seizures and focal neurological deficits according to their anatomic location in the brain.

A case of a 44-year-old woman, who was found dead in her bed, resting naked with her body lying down ventrally. According to relative's statement she was apparently a healthy woman.

The autopsy revealed a vast "froth mushroom" covering her mouth and nostrils, as well as a marked cerebral edema with a cystic yellow lesion on the white matter of the right fronto-parietal lobe, surrounded by hemorrhagic foci. Neuropathological examination established the diagnosis of glioblastoma, grade IV according to WHO (World Health Organization).

The importance of performing a complete autopsy in cases of sudden unexpected death, complemented with a meticulous neuropathological examination, mainly in the cases where an extracranial cause of death wasn't found will be highlighted.

Glioblastoma, Brain Tumor, Sudden Death

G44 Stab Wounds, Incised Wounds, or Blunt Trauma With Single or Multiple Weapons – How to Read Soft Tissue and Bone Injuries

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The goal of this presentation is to remind attendees of the importance of careful observation in all autopsies performed (either on the skin or internally in soft tissues, organs and even bones), in order to know how to correctly classify injuries, as well as to establish a relationship between both the external and internal injuries and the weapon(s) involved. By combining the knowledge of all these elements, the pathologist will then be able to better read the wounds' language.

This presentation will impact the forensic science community by advocating a return to the basics in the analysis of wounds. Also defended is the need for pathologists to be highly trained in clearly distinguishing incised, blunt and ballistic trauma, and to be prepared to solve difficult cases with mixed and atypical injuries, such as the one presented here. It is argued that the best interpretation of autopsies will come from those who use all these capacities and experience in every case, providing good answers to the questions aroused from the criminal investigation.

A young woman that was found dead in her home, laying on the bed, dressed; the body, clothing, and sheets stained of blood. Profuse blood spatters were visible on the walls and floor. Fragments of cement were found aside of the left hip. The victim presented at autopsy with typical incised wounds in the arms, neck and in the scalp, some of them with a tail. The scalp wounds had an internal translation as bone cut marks. However, these marks had different shapes and particular patterns. Underneath one of the incised scalp wounds there was also a skull fracture of the right zygomatic and frontal bones and cerebral laceration.

The injuries of the head, neck, and arms, suggested at first a knife. However, after examination of the deeper head injuries, it was found that although they appeared incised, the margins were not so clean as usual, and some of the bone cut marks showed one clear cut margin and little splinters on the other margin. Consequently, the knife assumption was discarded and instead, an axe or a similar tool was considered as a hypothesis, reinforced by the blunt trauma seen on the right side of the skull. Nevertheless, one abraded tangential lesion of the skull and the undulated shape of one of the cut marks lead us to look for another weapon that could produce blunt trauma and incised-blunt trauma at the same time – or to consider two different weapons.

This presentation will discuss the possible weapon(s) used to produce the different and complex injuries described, matched to the skin, subcutaneous tissues, organs and bones patterns of wound. The lethal wounds will be identified and possible defense lesions among the multiple injuries observed. Hypothesizing the existence of one or more aggressors and estimating the position versus the victim is also debated.

The solution of this case was found by the police in the main suspect's van (the victim´s husband) near other material that as a builder, worked with: a bloody shovel – that fit with all the injuries found.

It was concluded that, facing complex and contradictory lesions such as the ones presented in our case, the pathologist should interpret them all, provide information about the weapon or weapons probably involved, determine those that produced the death, and the position of the aggressor vs. the victim, among other objectives that may appear during the investigation. He/she must be prepared, experienced, and able to read the wound language written in different morphological supports, including skin, soft tissues, and bone.

Cut Marks, Blunt, Shovel

G45 Sudden Infant Death Syndrome and Infant Mortality in Serbia

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After attending this presentation, attendees will understand possible pitfalls in infant death evaluation, in particular, related to sudden infant death syndrome (SIDS). The attendees should also become familiar with major gaps in data integration between forensic pathology institution and public health system.

This presentation will impact the forensic science community by providing figures on SIDS cases for a ten-year period (1998-2007). Data from two sources, autopsy records from the Institute of Forensic Medicine in Belgrade and the State Office of Statistics are provided, compared, and commented.

A review of 93 cases of SIDS will be presented within a ten years period where 6,980 deaths of children under the age of one year have been recorded. Issues of SIDS autopsy diagnostic and current legislation pertinent to postmortem examination is widely discussed.

Infant Death Evaluation, Sudden Infant Death Syndrome, Public Health

G46 Fatty Versus Fibrofatty Involvement of the Myocardium in Sudden Death and Heart Failure

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After attending this presentation, attendees will recognize the pattern of pathologic and histologic findings as correlated to clinical information from cases within the spectrum of fatty cardiomyopathy including arrhythmogenic right ventricular cardiomyopathy.

This presentation will impact the forensic science community by reviewing clinical and pathological data as well as associated histology for sudden cardiac death cases from the spectrum of fatty cardiomyopathy and arrhythmogenic right ventricular cardiomyopathy. Forensic and cardiovascular pathologists, as well as other forensic scientists, may find this information useful for comparison with observations from their home institutions and practices.

Arrhythmogenic right ventricular cardiomyopathy (ARVC) is a genetically determined heart muscle disease characterized by fibrofatty replacement of myocardium in the right ventricle (RV) and to lesser degree in the left ventricle. ARVC is commonly associated with sudden death and heart failure. Isolated infiltration of the RV by fat alone is also believed to be associated with sudden death. However, the ARVC phenotype versus that characterized by isolated fatty infiltration alone have an unclear separation. Such lack of clarity makes pathological evaluation of sudden death in these circumstances very challenging. While genetic testing for mutations in genes known to be associated with ARVC would aid in rendering a diagnosis, that approach is not practical in everyday pathology practice. One other possible strategy in better delineating phenotypic variation might be immunohistochemical staining and quantitative evaluation of proteins related to genetic mutations underlying some ARVC phenotypes.

Purpose and Approach: In this study, heart case materials from autopsy (8) and cardiac transplantation (2) from patients with ARVC and fatty infiltration of the RV are characterized. Each case was accessioned in the iCAPTURE Cardiovascular (CV) Biobank at St. Paul's Hospital/University of British Columbia and each case was referred to a cardiovascular pathologist at the CV Biobank for assessment. Under approved ethics protocols, patient data were obtained from medical records or referring pathologists. The CV Biobank, a research and educational tool, was established in 1982 and includes cardiovascular tissue specimens from surgery and autopsy, along with their accompanying annotations and data held in a secure database.

Methods & Results: The Ten sets of case materials were archived between 1993 and 2008. All hearts were assessed for their macroscopic and microscopic features with confirmation by at least two observers. The specimens were found to fit into one of two patterns. Nearly two-thirds demonstrated **fibrofatty** (6 male, age = 17-36 years) replacement of the RV myocardium, while about a 1/3 showed a pattern of predominantly **fatty** replacement (2 male, 2 female; age = 15-64 years). Within the fatty replacement group, individuals died during non-strenuous activity and at rest. In this group, one individual had a history of fainting and clinical intervention for arrhythmia and one patient had a history of anorexia and bulimia. In the fibrofatty replacement, group patients died following non-strenuous activity, during strenuous activity and at rest. This group of patients included one individual with documented familial ventricular tachycardia for which he received treatment, one patient with dilated cardiomyopathy and mitral valve regurgitation, and one individual with sudden death of a brother due to an unspecified "aneurysm". Quantitative computer-assisted morphometric analysis confirmed two pathological phenotypes, fibrofatty and fatty. Of interest, the distribution and extent of involvement differed substantially between fibrofatty and fatty patterns, with changes being more extreme and widely distributed in the fibrofatty group, while localized to the anterolateral apex and lateral base in the fatty category. None of the hearts studied had a notable cellular inflammatory element. Further, immunohistochemical staining was performed on all heart cases for desmosomal protein plakoglobin, a protein that links adhesion molecules at the intercalated disk to the cytoskeleton and is thought to aid in the evaluation of ARVC.

Summary and Conclusion: Fibrofatty replacement of the RV, characteristic of ARVC, and fatty infiltration of the RV alone are distinctive phenotypes in the setting of sudden cardiac death and heart failure. The distinctly different extent and distribution of involvement between the two morphological patterns supports the concept that they represent different disease processes. Further, preliminary quantitative analysis of immunohistochemical staining for plakoglobin suggests that such staining may aid in the assessment and distinction of these two conditions.

ARVC/ Fatty Cardiomyopathy, Cardiovascular Pathology, Sudden Cardiac Death

G47 A Homicide Due to an Atypical Asphyxiation Tool: A Rolling Pin

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The goal of this presentation is to present an unusual case of homicide asphyxia due to an atypical compression of the neck by a rolling pin.

This presentation will impact the forensic community by dicussing the rarity of the deaths due to rolling pins utilized as an asphyxiation tool, the particular features of macroscopic lesions caused by the tool, and for the importance of a careful autopsy examination with an immunohistochemical study in order to clarify the exact mechanism of the death.

Death by asphyxia can present in various different ways. It is usually determined by typical actions imputable to an asphyxial agent of compression on the neck, usually classified as throttling, strangulation, hanging, and mugging. All these tools can cause an external compression of the neck. Various atypical forms have been described, caused by rods or sticks used to compress the neck anteroposteriorly, by wooden rods with cords or screws attached to their extremities used in garroting, by violent pulling of the neck backwards in a pincer movement between the forearm and arm in mugging, or by compression of the victim's neck by the aggressor's knee or foot. In this case, the tool used to kill was a rolling pin.

On December 1, 2008, at 3:00 p.m., a man called the police and said that he found his wife dead. The police and the forensic pathologist went to the crime scene and found the body of a 74-year-old Caucasian woman inside of the kitchen of her own house. The woman lived in the house with her husband and her only son. The corpse was lying supine on the floor. She was fully and tidily dressed, the head rested on a pillow, the arms were adduced to the trunk, the forearms were on the abdomen, and the legs were extended and slightly spread.

Close to the shoulder of the woman, on the floor, under a metallic feet-stool, was a brown wood rolling pin with a length of 79.5 cm, maximum circumference of 11 cm, diameter of 3.5 cm, and weight of 530 g. The thanatological data recorded by the forensic pathologist called to the scene stated that, at the time of discovery (4,00 p.m.), the corpse did not show rigor mortis, and the hypostasis blanched with finger pressure but was congruous with body position. The rectal temperature was 35 °C and ambient temperature was 24 °C. The prosecutor arranged for an autopsy because the circumstances of the death suggested that it was an homicide, and made inquiries about the son and the husband.

A complete autopsy was performed twenty-four hours after death. The external examination showed a remarkable cyanosis of the face, lips and nails; skin petechial hemorrhages in frontal and periorbital region, and mucosal petechiae on the oral vestibule and conjunctivae. On the neck were two parallel, horizontal, oval shape, mild blue bruise areas, the first on the anterior face of the neck (measuring 2,3 cm x 1.8 cm) and the second on the left mandibular region (measuring 2,8 cm x 2.4 cm). Dissection of the neck revealed thin hemorrhages in the subcutaneous tissues and in both sternohyoid and sternothyroid muscles and right thyrohyoid muscle. The esophagus, larynx, and trachea were unremarkable. Subpericardial and subpleural petechiae were observed. The other organs did not show specific alterations except for an intense vascular congestion. Skin sections for histological examination were removed at the neck in long strips perpendicular to bruises. Sample of

muscle tissue were also taken at the neck (sternohyoid, sternothyroid and thyrohyoid muscle). The histological examination showed mild hemorrhages in the cutaneous and subcutaneous tissues, and in the muscles. The stratum corneum of the epidermidis was detached and the dermis was split from the epidermis. An immunohistochemical study was performed to assess the vitality of the skin injury with antibodies to CD 15, IL15, and tryptase and the microscopical observations showed a strong positivity of tryptase, IL15 and weaker reaction to CD 15. Moreover, histological investigation of other organs showed mild cerebral and pulmonary edema, focal emphysema, and perivascular and intra-alveolar hemorrhages. The toxicological analysis was negative. According to the examination of neck bruises, autopsy findings and histological data, the mechanisms of death was consistent with asphyxia. Death was attributed to an external neck compression, and the tool that caused the death was perfectly compatible with the rolling pin found on the floor near the body. Fingerprints belonging to the son were identified on the rolling pin. Detailed examination of the crime scene and autopsy, along with the investigation of the psychological background of the son produced clear evidence that killer was the son and few days he confessed to the murder.

Rolling Pin, Athypical Asphyxia, Vitality Lesions

G48 Use of Volatile Organic Compounds and Chemometric Procedures to Determine Postmortem Interval

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After attending this presentation, attendees will be familiar with the use of volatile organic compounds and chemometric procedures for the estimation of postmortem interval (PMI).

This presentation will impact the forensic science community by further developing a chemical method to estimate the postmortem interval, which can be applied to death investigations, when traditional PMI estimations may fail.

An important aspect of any death investigation is to determine time since death, or postmortem interval (PMI). Establishing the PMI is important for identifying and eliminating suspects as well as helping to reconstruct the crime. However, unless eye-witnesses are known, it is difficult to establish when the death occurred. Many of the current methods that are used for PMI estimation involve gross changes to the body and are only useful for the first few days after death. However, after death, chemical changes also occur within a body. This research has focused on the chemical changes that occur in individual viscera to estimate the PMI. The purpose of this initial work was to identify biomarkers that can be useful for the estimation of the PMI.

An initial *in vitro* study was conducted on four viscera (heart, lung, liver, and kidney) harvested from two different pigs. Samples were collected from all viscera and from different areas within each viscus throughout the decomposition process. All samples were homogenized in a tissue grinder, extracted, and derivatized prior to analysis by gas chromatography-mass spectrometry (GC-MS). Total ion chromatograms (TICs) were assessed initially and, through mass spectral interpretation, major volatile organic compounds (VOCs) that are potentially important biomarkers, were identified. Principal components analysis (PCA) was then applied to identify differences in VOCs for samples collected from different areas of the same viscus, as well as differences in VOCs in different viscera. Compounds that showed minimal variation within a viscus and between viscera were selected as biomarkers for PMI estimation. It is important to identify biomarkers that do not have wide variability, in order to allow for accurate PMI estimation. The changes in abundance of these biomarkers in each viscus, over time, were observed and used to create a model that could be used to estimate the PMI. Samples from each viscus were collected from both pigs over time and analyzed by GC-MS. The abundances of the VOC biomarkers were normalized to an internal standard and plotted as a function of accumulative degree days (ADDs) in order to estimate the PMI. The results of these studies will be presented and discussed along with the implications for PMI determinations using the developed model.

Postmortem Interval, Chemometrics, Volatile Organic Compounds

G49 A Comparison of Drug-Related Deaths in Tarrant County, Texas, With Law Enforcement Seizures of Illicit Substances Over a Similar Time Frame

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After attending this presentation, attendees will have an awareness of the most recent pattern of abuse of illicit substance use in Tarrant County and understand which substances are responsible for the most lethal intoxications in this Texas county.

This presentation will impact the forensic science community by sharing recent information on substance abuse and lethal intoxication in one community. It should also encourage similar studies and the sharing of this information between law enforcement and forensic laboratory personnel.

Hypothesis: There is a change in the pattern of drug-related deaths and substance abuse in Tarrant County.

Methods: Information covering the last twelve months, from three laboratories which do testing for law enforcement agencies in Tarrant County, Texas have been gathered and synthesized. These laboratories perform toxicological analysis on autopsy fluid and tissue, and on evidence seized by law enforcement officers. The results and pattern of substances in fatal intoxications and in drug seizures over a related period of time have been compared.

Results: Tarrant County is a Texas county with a population of approximately 1.7 million which includes its largest two cities, Fort Worth and Arlington which have populations of approximately 650,000 and 650, 000 respectively. The county covers an area of 897 square miles, over thirty incorporated cities and towns and covers urban and rural territory. The demographics of the population include a diverse racial and age makeup and includes more than fifteen different school districts. The Tarrant County Medical Examiner's Office, along with two regional labs serves over 100 county law enforcement agencies. All three labs have cooperated to produce this data.

Although there are differences in the statistics gathered by each laboratory, all have seen a distinct change in the pattern of drug abuse over the last few years. These changes include the emerging popularity of certain prescription drugs as well as illicit drugs, and the appearance of new designer drugs such as "cheese", benzylpiperazine (BZP), 3-trifluoromethylphenylpiperazine (TFMPP) and others. The three laboratories serve different size towns and cities and the drugs seized from these communities follow certain trends, so the laboratories see a different spread of cases in seizures from the small towns than in seizures from the larger communities. In the small towns, law enforcement seizures tend to yield the highest incidence of methamphetamine, ecstasy and pharmaceuticals. The larger towns and cities' cases more frequently involve cocaine and heroin. These findings are consistent with national reports.

Conclusion: The pattern of drug-related deaths and abuse of illicit substances has changed through the years. This study reports some of the changes seen recently. These include the increase in popularity of

certain prescription drugs and the appearance of "new" drugs of abuse and a change in the drugs responsible for acute intoxication and fatal overdose.

Substance Abuse, Lethal Intoxication, Illegal Substances

G50 Nocturnal Oviposition of Blow Flies (Diptera: Calliphoridae) in the Lower Mainland of British Columbia, Canada

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After attending this presentation, attendees will better understand the nocturnal egg-laying behavior of several of the blow fly (Diptera: Calliphoridae) species that commonly inhabit suburban regions of the Lower Mainland of British Columbia, Canada.

This presentation will impact the forensic science community as it will discuss the potential implications of nocturnal oviposition of blow flies (Diptera: Calliphoridae) on postmortem interval (PMI) estimations in human homicide investigations.

The most important and common use of forensic entomology is to estimate the elapsed time since death. Specifically, the postmortem interval (PMI), defined as the minimum time that has elapsed since death, is determined through the analysis and identification of the forensically important insect species present at the crime scene. An accurate PMI estimation has been proven very valuable in homicide investigations as it points the investigators toward the correct time frame.

Nocturnal oviposition of blow flies has not been investigated in Canada; therefore, the potential effect of its presence on the PMI was unknown. If some or all of the blow fly species in British Columbia were found to lay eggs at night, this could have major implications in the Canadian Criminal Justice System, as the presence of nocturnal oviposition could alter the PMI by up to eight to twelve hours. Such an error rate could lead to the appeal of previous cases in which conviction was based on the assumption that nocturnal oviposition does not occur. This may also play a role in unsolved homicides, as suspects would have originally been interrogated based on a time of death that was incorrect.

In this study, six beef liver baited inverted cone traps were put outside in a suburban garden on individual days in July and August in order to monitor the egg-laying behavior of local blow fly species. Individual experimental days were chosen based on an expected nocturnal minimum temperature of greater than 12ºC. Oviposition was monitored over twenty-four hour periods in two locations, one with complete darkness nocturnally and one in the presence of artificial light produced from a high pressure sodium street light. The bait was replaced with fresh bait every four hours and the number of eggs was visually estimated. The eggs were then reared to adulthood at the Centre for Forensic Research at Simon Fraser University, for species identification. The use of these traps also allowed for the nocturnal activity levels of blow flies to be assessed as active adults were caught in the plastic bag attached to the top of the trap.

In this experiment, no eggs were ever found after sunset or prior to sunrise on any of the experimental days. The artificial street light was not sufficient to stimulate egg laying at night. The three species that were primarily caught were *Calliphora vicina* (Robineau-Desvoidy), *Lucilia sericata* (Meigen), and *Lucilia illustris* (Meigen). No calliphorid adults were caught after sunset or before sunrise, except on one night, in which three *L. sericata* adults were caught post sunset in two different traps. Based on these results, forensically-important blow fly species in this region do not nocturnally oviposit or remain active at night.

This experiment is the first of its kind to be done in Canada and therefore, these results suggest that the assumption of no nocturnal oviposition that has been used for many years by the Canadian Criminal Justice System and local forensic entomologists is likely to be accurate. As a result, this research will allow forensic entomologists to estimate time of death in future B.C. homicide investigations with greater accuracy and confidence.

Forensic Entomology, Nocturnal Oviposition, Blow Flies

G51 Blood Aspiration as a Vital Sign Detected by CT Imaging and Postmortem CT Guided Biopsy

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After attending this presentation, attendees will have learned about the possible contribution of multi-detector computed tomography in forensic investigations on blood aspiration.

This presentation will impact the forensic science community by suggesting that the execution of a CT scanning prior to autopsy in cases suspected for occurrence of blood aspiration may avoid misdiagnoses and provide an easier and immediate visualization of distribution and severity of aspiration.

Based on the proved efficient role of the modern cross-sectional techniques as complementary/additional tool to traditional forensic methods, the aim of this study was to examine the value of postmortem CT imaging in evaluating pulmonary findings related to blood aspiration, compared to traditional forensic pathology techniques.

Identification and correct interpretation of blood aspiration is of substantial importance in forensic cases, as this finding can provide the forensic pathologist with information on whether an injury occurred intravital or postmortem, and give suggestions on the cause of death.

Between January 2005 and December 2008, at the Institute of Forensic Medicine in Bern a total of 359 human corpses underwent MSCT scanning prior to autopsy, within the project. Thirty-seven non-decomposed bodies where blood aspiration was documented with the traditional examinations, or where blood or bloody fluids were found in the airways from larynx to small bronchi were selected. A total of thirty-one cases had demonstration of aspiration in lung parenchyma on autopsy inspection or on histological analysis. The remaining six cases all showed blood or bloody fluids in the airways. Blood aspiration was reported in final autopsy reports as being the primary, assisting or competing cause of death in seven cases. All cases underwent body CT scanning on a six slice scanner. Two- and three-dimensional reconstructions were obtained at a workstation. The images were assessed for presence, entity, density and composition of material in the airways, and for presence, entity and distribution of lung density alterations. The possibility to consider blood aspiration as cause or assisting cause of death was also assessed.

In one exemplary case, biopsy-specimens from abnormal regions of the lungs have been obtained under CT fluoroscopy guidance for histological examination.

The thirty-one cases with traditional demonstration of aspiration in lung parenchyma had ground glass opacities suggestive for blood aspiration on pulmonary CT imaging. In the six remaining cases CT imaging detected pulmonary abnormalities suspected for blood aspiration that was not mentioned in the final autopsy reports. In two cases among these, the route of aspiration was evaluated on the basis of injuries detected by whole body CT images as being anterograde and of

scarce severity, in one case retrograde, and in three combined. The biopsy specimens obtained in the one case confirmed the occurrence of blood aspiration. The concordance between post-mortal CT imaging and traditional techniques in attributing primary, assisting or competing cause of death to blood aspiration was of 71%.

Our results show the superior sensitivity of post-mortal CT imaging in detecting areas suspected for blood aspiration in some particular cases of blood aspiration of scarce severity, or when pulmonary injuries are associated. In these circumstances, the typical macroscopical findings on the lung inspection may be absent or be largely concealed by other alterations. Thus, postmortem CT can be excellently used in these cases to guide the forensic pathologist during lung tissue investigation, and to provide focused specimens for the histological examination.

Moreover, postmortem two and three dimensional CT techniques have been proven by this study to be a great device to better analyze distribution and amount of aspirated blood and to document and conduce hypothesises on the cause of death. With the traditional diagnosis of a fatal blood aspiration (made through the analysis of just few slices of the lung tissues considered representative for the whole pulmonary volume) information about the real extent and distribution of this phenomenon is lost. On the contrary, CT imaging techniques can provide a complete collection and documentation.

The analysis of post-mortal CT images of lungs and airways alone doesn't offer in many cases enough data to distinguish with certainty pulmonary findings due to blood aspiration and lung alterations due to other causes. Nevertheless, it should be considered a fundamental, highly suggested complementary tool to traditional autopsy techniques in cases of blood aspiration to avoid misdiagnoses and to provide complete and exhaustive description of the severity of the phenomenon.

Blood Aspiration, Postmortem CT, Postmortem Needle Biopsy

G52 Brain Tissue Responses After Traumatic Brain Injury in Animal Models

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After attending this presentation, attendees will more clearly understand the types of animal models of traumatic brain injury (TBI), the significance of experimental studies of TBI and the mechanisms of brain damage after TBI.

This presentation will impact the forensic science community in aiding the understanding of the mechanisms of brain damage after closed and open head injuries. These studies also show the sequential changes occurring in the brain after TBI: changes that should be useful for estimating the time after trauma in cases of head injury.

TBI can be caused both directly, by immediate mechanical disruption of brain tissue, and indirectly, by delayed injury mechanisms that include intracranial hemorrhage, brain edema, and hypoxic/ischemic damage. Whereas human TBI is a highly complex multifactorial disorder, animal models of TBI are able to focus on various specific factors involved in TBI and so have helped develop a better understanding of pathophysiology after brain injury, including changes in cellular and molecular pathways. The commonly used models that replicate human closed head injuries are fluid percussion, controlled cortical impact, weight drop and freeze injury models. Utilizing these models allows us to produce a controlled range of severity of brain injury.

The magnitude- and time-dependent changes after TBI in a rat fluid percussion model was studied. The focus was on synaptophysin (SYP), a molecular marker of synapse. SYP immunoreactivity increased in both the cortex and subcortical white matter with increasing magnitude of injury and time after trauma. Increased SYP immunoreactivity was accompanied with neuronal degeneration and glial cell proliferation. The amount of SYP remained unchanged in brains after trauma. These findings indicated that after trauma, SYP accumulates at injured sites of neurons without any change in SYP content. The increased SYP immunoreactivity in the cerebral cortex following traumatic injury reflects an inhibition of synaptic vesicle transportation and synaptic dysfunction, thus providing a histological substrate for brain dysfunction.

In cases of open head injuries, a foreign body may remain in the brain for a period of time after the trauma. A animal model incorporating a foreign body in the brain was developed. The time-dependent brain changes caused by a foreign body was studied. A lead or a glass ball was used as the foreign body and was implanted in the cerebral cortex of rats. Brains were analyzed at various times between twelve hours and four weeks after implantation. Results from brains with a lead ball were compared with those with a glass one. The number of macrophages increased significantly with increasing time after implantation of a lead ball. Multinucleated giant cells appeared at three weeks in brains with a lead ball. The immunoreactivity of metallothionein, a metal binding protein, increased significantly in astrocytes and endothelial cells with increasing time after implantation of a lead ball. Moreover, apoptotic cells were identified at two weeks, but had mostly disappeared at four weeks after implantation of a lead ball. Apoptotic cells were not observed in brains with a glass ball. This study showed that lead leached from a lead ball induces macrophage infiltration, metallothionein expression and apoptosis in the brain.

Forensic Neuropathology, Head Injury, Experimental Model

G53 Determination of Procalcitonin, C-Reactive Protein, Tumor Necrosis Factor-Alpha, Interleukin-6, and Interleukin-8 Levels in Serum, Vitreous Humor, and Cerebrospinal Fluid as Markers of Sepsis

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The goal of this presentation is to evaluate the potential role of procalcitonin, C-reactive protein, tumor necrosis factor alpha, interleukin-6 and interleukin-8 levels in different biological fluids (serum, vitreous humor and cerebrospinal fluid) as markers of sepsis, to evaluate the stability of these markers at different measurement times after collection, and to evaluate additional benefits of combined analysis of the mentioned markers compared to procalcitonin and C-reactive protein alone.

This presentation will impact the forensic science community by evaluating different markers that can be useful in postmortem diagnosis of sepsis.

In forensic pathology routine, a well-documented medical history is often not available for a deceased person and sepsis as the cause of death remain difficult to diagnose. In fact, postmortem blood cultures are often contaminated by putrefaction processes and macroscopic postmortem findings (such as myocardial ischemia, pulmonary edema and hemorrhages, hypoxic liver damage, mesenteric and gastrointestinal hemorrhages, spleen infarctions and septic spleen alterations, kidney ischemia, and brain edema), as well as routine histological findings, may have an infectious or non-infectious origin and are neither specific nor sensitive for recognizing sepsis-associated fatalities.

The observation by Assicot and coworkers that serum procalcitonin levels increase above normal values in patients with bacterial sepsis, but not in patients with viral infection or without infection, has generated considerable interest in this marker.

A large number of clinical studies have investigated procalcitonin levels and courses of procalcitonin levels under various clinical conditions and they concluded that procalcitonin is valuable as a marker of serious bacterial sepsis and show a good correlation with the severity of the disease. In different groups of patients with sepsis, procalcitonin was compared to C-reactive protein (CRP), tumor necrosis factor alpha (TNF-α), interleukin-6 (IL-6), interleukin-2 (IL-2), interleukin-10 (IL-10) and interleukin-8 (IL-8) as a diagnostic and prognostic parameter. The results commonly showed that procalcitonin exhibits a greater sensitivity and specificity in differentiating patients with systemic inflammatory response syndrome (SIRS) from those with sepsis.

Tsokos and co-workers have investigated procalcitonin, C-reactive protein and interleukin-6 in postmortem serum as a marker of sepsis. Their results show that serum procalcitonin levels can be considered as a valuable postmortem marker to distinguish sepsis-associated fatalities from other non-septic causes of death. Compared to other potential biochemical postmortem markers of sepsis, procalcitonin has several advantages: in contrast to tumor necrosis factor alpha and interleukin-6, procalcitonin has a long half-life (25 to 30 hours); in comparison to cytokines, procalcitonin is a very stable protein, even at room temperature; procalcitonin concentrations do not differ in arterial and venous blood samples from living persons; repeated freezing and unfreezing of the blood samples does not significantly influence procalcitonin concentration.

Levels of C-reactive protein and interleukin-6 may increase very rapidly in response to inflammation of infectious origin; however, significantly elevated C-reactive protein and interleukin-6 levels can also be demonstrated in a large number of life-threatening clinical conditions, such as major trauma, extensive surgical procedures or burn injury, as a result of the systemic inflammatory response syndrome, irrespective whether the patient develops a sepsis or not.

Statement of the Method: Postmortem blood, vitreous humour and cerebrospinal fluid samples were collected at autopsy. Two study groups were formed according to whether there was an underlying septic condition as the cause of death based on the subject medical records as well as autopsy findings. Marker levels were measured at different times after collection. In the sepsis group, cause of death was multiple organ failure. In the non-sepsis group, cardiopulmonary resuscitation was not attempted in any case. Autopsy findings did not give any cause to suspect an underlying infectious disease.

Results will be presented and compared with published results in the literature.

Postmortem Chemistry, Sepsis, Diagnostics

G54 Sudden Death Due to Mesothelioma of the Atrio-Ventricular Node

Géraldine Maulean, MD, Alain Tabib, PhD, Daniel Malicier, and Laurent Fanton, PhD, Institut of Legal Medicine, 12 Avenue Rockefeller, Lyon, 69008, FRANCE*

After attending this presentation, attendees will gain much knowledge on sudden cardiac deaths, and understand that sudden cardiac deaths constitute a major health problem as one of the central topics in forensic literature. Although most cases are still attributed to complications of cardiomyopathies or coronary artery diseases, functional dysregulations are nowadays reported with an increasing frequency, due to the development of molecular autopsy. The role played by primitive cardiac tumors in sudden deaths is smaller as their prevalence is estimated to 0.05% of autopsies. Despite its rareness, mesothelioma of the atrioventricular node should be considered in the differential diagnosis of heart block in children or young adults.

This presentation will impact the forensic science community by informing attendees that the clinical presentation of a mesothelioma of the atrio-ventricular node is non-specific and may considerably vary from sudden death to an asymptomatic patient. This presentation is the third case of sudden death in patients with pace makers. The role played by primitive cardiac tumors in sudden deaths is small as their prevalence is estimated to 0.05% of autopsies. Among such lesions, mesothelioma of the atrio-ventricular node is rare and has only been reported about seventy-five times since its first description in 1911.

Case: A 35-year-old man was found dead in the early morning by one of his friends, while he was lying on his sofa, after having lived it up with some friends. The emergency physician could only certify death. Six years previously, the man had a syncopal episode while coming out from his truck. Electrocardiography showed a type I second degree atrioventricular block. Echocardiography was normal and no curable etiology could be found. He finally had a duel-chamber pacemaker fitted a few weeks later, which had been reliably effective and well tolerated up to his sudden death. Considering the young age of the man and the sudden character of his death, a medicolegal autopsy was ordered to determine the cause of death.

On external examination, the body was that of a young Caucasian man, 164 cm in height and 80 kg in weight. Nonspecific abrasions were detected on both the right and left frontal scalp. Toxicological investigations, including alcohol, were negative. At autopsy, the only gross abnormality was a left atrophic kidney, which was 24 g in weight. The heart weighted 420 g; there was no abnormality in the epicardium or in the valves. The coronary arteries only showed a few lipidic striae. One endocavitary pacemaker lead was found located in the atrial cavity, and was involved by noninfectious vegetations. The other pacemaker lead, which was observed in the right ventricular cavity, was also affected by some fibrosis. The myocardium showed fibrosis blocks and recent left subendocardic ischemia. Left and right ventricular walls were respectively 18 and 8 mm thick. Histopathological examination revealed an extensive infiltration of the atrioventricular node and of the his bundle trunk, corresponding to a benign tumor called a mesothelioma. This tumor consisted in tubular adenoid micronodules of various sizes, lined by mesothelial cells. In the lumens, pseudo colloid eosinophilic material was found. Some areas of the tumor also showed a moderate degree of fibrosis.

On the basis of these findings, arrhythmia-related death was diagnosed, directly caused by a mesothelioma of the atrioventricular node, despite the presence of a pace maker.

Discussion: The clinical presentation of a mesothelioma of the atrioventricular node is nonspecific and may considerably vary from sudden death to asymptomatic patient, including syncopal episodes related to severe atrioventricular block, with a possible familial occurrence discussed by Travers. No correlation was found in the literature between the size of the tumor and the symptomatology observed.

This explains that the precise incidence of such a disease is quite difficult to estimate, as much as diagnosis is most often done after death when an autopsy is ordered, only nine cases having been successfully treated antemortem.

Conclusion: This report is the third case of sudden death in patients with pace maker. Despite its rareness, mesothelioma of the atrioventricular node should be considered in the differential diagnosis of heart block in children or young adults.

Sudden Death, Mesothelioma, Atrio-Ventricular Node

G55 Accidental Drowning Deaths in a Coastal Region of South India – A Ten Year Study

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After attending this presentation, attendees will identify with the pattern and trend of drowning deaths in a coastal region of South India. This presentation will impact the forensic science community by developing an understanding of the burden of accidental drowning in the coastal region and to develop preventive strategies so that precious human lives are saved.

Accidental drowning constitutes a significant public health problem that is often neglected in our country. This study will describe the epidemiology and pattern of accidental drowning deaths in Manipal, a coastal region in South India. This study is a registry based descriptive research spanning over a period of ten years from January 1998 to December 2007. All medicolegal autopsy case records were retrospectively reviewed and the cases of death due to drowning were studied**.** The information obtained from autopsy reports, police investigations and toxicological analysis was registered in a database and analyzed. All deaths where the manner was recorded as suicidal or homicidal were excluded from the study.

During the study period forty cases of drowning deaths were reported. Males accounted for 82.5% of cases, male- female ratio being 4.7:1. Majority of the victims were in 2nd and 3rd decades, together accounting for 55% of drowning deaths followed by children in the first decade (15%). Fresh water drowning was reported in 70% cases. Rivers constituted the most common sites of drowning (35%) followed by sea (27.5%). Wells, canals, lakes, ponds, and water tanks were the other sites of drowning. Most (87.5%) victims of drowning were found dead. The remaining five cases died in hospitals later on. The maximum period of stay in hospital before a fatal outcome was three and a half days. Most of the accidental drownings (45%) were reported in the post monsoon period. Nearly one-third (30%) of the total drowning deaths were reported in the years 2006 and 2007.

Drowning is a major global public health problem which is amenable to prevention. The study highlights the pattern of accidental drowning deaths in Manipal, a coastal region of South India. Morbidity and mortality due to drowning can be prevented by understanding its epidemiology, common patterns and educating people about prevention. This is especially when hindsight often shows that many deaths from drowning are preventable.

Drowning, Accidents, South India

G56 Sudden Death From Atypical Pneumonia in a Healthy Adolescent

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After attending this presentation, attendees will become familiar with the possibility that a completely asymptomatic atypical pneumonia may induce sudden death, even in a previously healthy adolescent, with absence of histological signs of diffuse alveolar damage.

This presentation will impact the forensic science community by making attendees aware of the insidious development of atypical pneumonia in immunocompetent subjects, focusing the possible responsible mechanisms of sudden death in such cases, in the absence of ARDS and histological signs of diffuse alveolar damage.

The most common causes of atypical pneumonia are Mycoplasma pneumoniae, Chlamydophila pneumoniae and Legionella pneumophila which cause fifteen percent to as much as fifty percent of cases of community-acquired pneumonia. Other organisms include viruses; few cases are due to zoonotic agents like *Chlamydophila psittaci*, *Coxiella burneti* and *Francisella tularensis*. Clinical and pathological patterns range from mild upper respiratory infection to severe lower respiratory tract disease. Atypical pneumonia generally is benign, with systemic complaints often more prominent than respiratory ones; fever, headache and myalgia are common. Although the clinical course is often self-limited, these pathogens can cause severe community-acquired pneumonia. The inflammatory reaction is localized in the alveolar septa that appear thickened, edematous, with infiltrates of leukocytes. In severe cases, fibrinous thrombi inside alveolar capillaries and haemorrhagic necrosis of alveolar walls are visible. Alveoli may contain scant exudate. Fibrin and hyaline membranes line the denudated alveolar walls, due to diffuse alveolar damage. Superimposed bacterial infection is common.

Case Report: A 16-year-old boy who spent all the day with his family, went to sleep after dinner. His brother checked on him after one hour and found him agonizing in an anomalous prone position, with the legs out of bed. Immediately he turned the body supine, called the ambulance, and tried to resuscitate him. When the doctor arrived, after the attempting with reanimation maneuvers, pronounced the adolescent dead. The boy had a negative history (except for a mild headache) and a negative family history for sudden death. He was a basketball player on the school team and was not known as a drug abuser. Death scene investigation was unremarkable. External examination was insignificant except for the presence of a little superficial wound on the right frontal scalp. The internal examination revealed polyvisceral congestion, cerebral and pulmonary edema, free fluid in the pleural cavities, and release of foamy material on sectioning of both lungs. The left ventricle showed a concentric hypertrophy (anterior wall 2 cm, lateral 2.4 cm, posterior 2 cm, septal 2.2 cm). The histological examination showed a pattern of massive diffuse interstitial pneumonia with markedly thickened alveolar septa with extreme congestion of capillaries, the presence of abundant eosinophilic material, and infiltrates of leukocytes. In the adjacent fields there were some amorphous eosinophilic material and erythrocytes inside the alveoli. The immunohistochemical stains revealed that the pulmonary infiltrates consisted of lymphocytes, histiocytes and plasma cells. There were some foci of leukocytes within the epicardium, and focal areas of patchy myocardial fibrosis and perivascular fibrosis were visible, with a mild degree of myocardial hypertrophy. The encephalon showed leukocytic meningitis with subarachnoid infiltrates of lymphocytes and mild perivascular edema. The immunohistochemical analsysis (RSV, HSV1, HSV2,VZV,CMV, HHV A and B, Parainfluenza Virus 1, 2 and 3, Adenovirus, Aspergillus spp., P. carinii, T. gondii) gave negative results. Additional tests were carried out to identify possible pathogenic agents through microbiological studies. Toxicological screening was negative. Molecular genetic analysis was conducted and excluded underlying heritable diseases. The decedent's parents indicated that the boy did not have the scalp injury before going to sleep, so it's possible that the boy suddenly fell to the bed, striking the bedside table and arresting in the anomalous position described by his brother. To explain the occurrence of sudden death in this case, two possible mechanisms of acute respiratory failure are hypothesized: (1) the underlying respiratory acidosis (well tolerated by a young active boy, by means of an induced tachypnoea) and hypoxemia may have conducted to tachycardia and deteriorating hemodynamics. This instability may have elicited a lethal ventricular arrhythmia supported by a mechanism of re-entry, considering that the boy's heart showed diffuse areas of patchy fibrosis; and (2) the irritation of the adjacent cerebral cortex by inflamed meninges may have caused epileptic seizures. Seizure activity can disrupt normal physiological regulation and control of respiratory and cardiac activity (similar to mechanisms operating in cases of sudden

death in epilepsy), precipitating the unstable equilibrium present at lung level (reduction in gas exchange due to massive interstitial pneumonia), causing an acute respiratory insufficiency.

Sudden Death, Atypical Pneumonia, Meningitis

G57 Virtopsy Project - Postmortem Needle Biopsy of the Lungs: A Feasible Tool for the Study of Fat Embolism as Vital Reaction

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After attending this presentation, attendees will learn how to overcome the diagnostic gap of postmortal cross-sectional imaging in detecting the occurrence of fat embolism as vital reaction, by using percutaneous needle biopsy techniques.

This presentation will impact the forensic science community by demonstrating how percutaneous needle biopsy technique can improve the diagnostic accuracy of postmortem imaging investigations on pulmonary fat embolism as vital reaction within the concept of a minimally invasive virtual autopsy.

Pulmonary fat embolism, usually, and pulmonary embolism of bone marrow, always, can be considered indicative for antemortem violence. In fact, it is a vital phenomenon after trauma, depending on the pumping action of the heart and an intact circulation. The postmortem diagnosis of pulmonary fat embolism is traditionally based on the histological demonstration and analysis of fat droplets within the lung microcirculation.

The study population consisted of twenty-six randomly selected autopsy cases examined from September 2008 to November 2008, delivered to the Institute of Forensic Medicine of the University of Berne.

In each case, probes from both lungs were obtained using two different sampling methods. Prior to the autopsy, multiple postmortem biopsies from both lungs were executed using clinically approved and postmortem tested ACN-III biopsy core needles (14 gauge -160 mm) with an automatic pistol device. Then, during the traditional autopsy of the same cases, other thin slices of lung tissue from both lungs were taken, using a double-edge knife technique. The double-edge knife consists of a blade sharpened on one or both slides to which a second blade, similar in size and shape, is added on the side, folded out by means of a joint. A knurled nut regulates the distance between the blades, and thus the slice thickness.

All the samples were subjected to water storage and Sudan III staining. The microscopical examination was then performed by six board certified forensic pathologists, and scores were assigned according to the grading scale by Falzi et al. A comparison was made between the results of the histological examinations on both lung specimens from the twenty-six death cases, obtained with postmortem needle biopsy and double edge knife techniques respectively. A statistical analysis of the results was performed.

The statistical analysis conducted separately for each sampling technique showed no significant differences in the grading score for the samples from both lungs obtained with the two techniques. Moreover, it was demonstrated that the six forensic pathologists evaluated homogeneously the slides obtained by both lungs. Absence of pulmonary fat embolism was detected in the same cases investigated by both techniques. With respect to the assigned grading score, a statistically relevant discrepancy between the results of the histological examination conducted on samples by the needle biopsy and double edge knife techniques was found in six cases. Nevertheless, the discrepancy was not systematic, because in three cases the analysis conducted with needle biopsy gave results bigger than that with double edge knife, and in the other three smaller.

In conclusion, this study demonstrates that postmortem pulmonary biopsy, if compared with double edge knife technique, can represent a feasible method of specimen collection for detecting and analyzing pulmonary fat embolism as vital reaction.

Although further studies are needed, the application of post-mortal percutaneous needle biopsy methods to forensic investigations on fat embolism as vital reaction could be able to improve the diagnostic accuracy of postmortem imaging examinations, and even more, the possibility of a minimally invasive virtual autopsy can be envisaged for select cases.

Pulmonary Fat Embolism, Percutaneous Needle Biopsy, Postmortem Imaging

G58 Cerebral Artery Thrombosis After Penetrating Oral Trauma: An Exceptional Autopsy Case

Renaud Clement, MD, 1 Rue Gaston Veil, Nantes, 44093, FRANCE*

After attending this presentation, attendees will understand the mechanisms of interruption of intracranial cerebral circulation by thrombosis arising in the anterior cerebral artery as a result of penetrating oral trauma.

This presentation will impact the forensic science community by presenting the forensic examination supported by the histological findings. Microscopic examination made it possible to establish the exact causes and vascular consequences of the impalement; they explain perfectly the clinical symptomatology, as well as its neurologic evolution.

A young man fell onto a metal rod at a construction site. The accident resulted in perforation of the oropharynx. After several hours, right hemiplegia developed.

Complementary examinations revealed left middle cerebral artery thrombosis. Forensic autopsy performed after the death of the patient revealed left sylvian artery thrombosis extending into the left intracranial carotid sulcus, into the left internal carotid artery and into the left anterior cerebral artery. Skull base exploration demonstrated a fracture of the left internal tip of the petrous bone. There was a breach of the intima in the anterior communicating artery and extensive thrombosis extending to the anterior, middle and internal cerebral arteries, and to the internal carotid arteries. As the adventitia was spared, this indicated indirect injury to the anterior communicating cerebral artery. This is the first description of cerebral artery thrombosis caused by indirect traumatic injury to this artery. Although the case is clinically similar to internal carotid arterial thrombosis by perforating trauma of the palate in young children, the initial clinical symptoms and signs were different, with hypoesthesia in the territories of the V2 and V3 branches of the fifth cranial nerve. These clinical findings indicated traumatic injury to the base of the skull.

Anterior Communicating Cerebral Artery, Thrombotic Process, Penetrating Trauma

G59 Does Embalming Impact Vitreous Glucose Levels?

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After attending this presentation, attendees will understand how embalming may impact the level of glucose found in vitreous fluid obtained during autopsy.

This presentation will impact the forensic science community by educating the viewer on the utility of analyzing vitreous glucose in embalmed decedents and by informing people of the valuable resource of human body donors and how they can be used to further forensic science.

This case involves an 80-year-old female who was known to be a brittle diabetic. Because of a presumed natural cause of death, the body was originally released to the funeral home. Adult Protective Services requested the coroner perform an investigation into the death due to allegations of elder abuse/neglect by a home care provider. The decedent was embalmed six days prior to autopsy using Ultra 27 (Pierce Chemicals/Royal Bond, Inc) as the arterial preservative and Restorative (The Dodge Company); both fluids are rich tissue hydrators. Most mortuary chemicals use glycerol as the main humectant. The vitreous glucose was analyzed at University of California Davis Medical Center using a GLUCm reagent on a Beckman Coulter Synchron System. The concentration of glucose is determined by measuring the rate of oxygen consumption based on the following chemical reaction:

Vitreous fluid collected at autopsy had an elevated level of glucose (544 mg/dL). The cause of death was determined to be from hyperglycemia due to diabetes mellitus with hypertensive cardiovascular disease listed as a contributing condition. The caregiver, a registered nurse, is facing criminal charges of elder abuse/neglect for failing to provide medical care.

It is not uncommon for the forensic pathologist to perform an autopsy on an individual who has already been embalmed. The interpretation of tests perform on the blood is clearly limited due to the dilution effects of the embalming process, but what about the vitreous fluid within the eyes? Is this fluid protected from the embalming process and can it be used to aid in postmortem examination? Can the value of an elevated glucose level in a post-embalmed individual be trusted or is the result falsely elevated due to contamination by an embalming fluid with high glycerol content? Was the analytical method used to measure the glucose specific for this analyte or was it unable to distinguish glycerol from glucose?

An experiment was designed to test the vitreous glucose levels on a body donor before and after embalming. The body donor was a 78-year-old female, average height and weight that died from respiratory failure and interstitial lung disease. Standard anatomical embalming was performed. The donor remains were arterially injected, and the preservation was supplemented by hypodermic injection to poorly preserved areas. The total amount of fluid injected was 951oz., much more than the funeral home had injected. The embalming solution used consists of various preservatives, disinfectants, water correctives, and humectants. A total of three samples of vitreous were obtained; the first an unadulterated sample from the un-embalmed donor, the second, also from the un-embalmed donor, was "spiked" with embalming solution by adding a drop to the test tube, and the final sample was obtained post-embalming. All samples were sent for glucose testing by the same service that tested the autopsy sample.

Results: There was a very slight increase in the post-embalming glucose level compared to the pre-embalming samples (15 mg/dL vs. 7 mg/dL), but not enough to be clinically significant. Both pre-embalming samples (neat and spiked) had the exact same result (7 mg/dL).

Conclusion: Embalming does not interfere with the analysis of glucose in the vitreous fluid when using the Beckman Coulter Synchron System with the GLUCm reagent. This study supports what has been previously published in the literature.

Autopsy, Embalm, Glucose

G60 Analysis of an Unusual Misfire of a Common Handgun

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After attending this presentation, attendees will be informed of an unusual mechanism accounting for the misfire of a common handgun.

This presentation will impact the forensic science community by illustrating the utility of cooperation between experts from different disciplines in reconstructing incidents.

There are many circumstances in which an apparent live cartridge may misfire even though the firing pin has struck the primer. Factors that contribute to those circumstances include design, manufacture, and condition of the ammunition and firearm as well as the actions of the individuals involved in the case.

In this report, a case will be illustrated in which two unusual misfired cartridges were found at the scene of the suicide of a 53-year-old woman by means of gunshot using a Glock 9 millimeter handgun.

Expert examination of the firearm and ammunition involved determined that the main factors contributing to the misfiring of the cartridges were likely the design of the firearm in conjunction with the actions of the decedent. The examination supported the conclusion that the misfires were caused by the decedent pressing the firearm slightly against her head in such a way that a safety mechanism was activated.

Questions outside of particular investigators' areas of expertise can arise during any investigation. In such cases, cooperation between experts from different disciplines is essential to understand the complexities of reconstructing incidents.

Misfire, Handgun, Glock

G61 Fatal Cardiac Perforation During Percutaneous Treatment in Iliac Artery Occlusion

Alessandro Bonsignore, MD, Massimo Gallo, MD, Francesco Ventura, PhD, and Francesco De Stefano, MD, Department of Legal and Forensic Medicine, University of Genova, Via De Toni 12, Genova, 16132, ITALY*

After attending this presentation, attendees will have learned of an extremely rare complication of percutaneous transluminal angioplasty (PTA) and stenting for iliac artery occlusive disease; attendees will also understand the cause of the error and verify the professional liability profiles derived from this case.

This presentation will impact the forensic science community by reminding researchers of this rare complication and the opportunity to avoid this event.

Only a complete forensic approach by means of autopsy and microscopy examination led to the conclusion for cardiac tamponade due to left ventricular wall rupture.

Aortoiliac occlusive disease (AIOD) is a common manifestation of atherosclerosis that may lead to lower limb ischemia. In this case the Trans Atlantic Inter-Society Consensus (TASC) offers guidelines for the treatment of such disease. In particular total unilateral iliac occlusions should be treated by primary stenting, reducing the risk of embolisation in iliac stenoses, and moreover the periprocedural morbidity and mortality rates. In addition, primary stenting is indicated in the presence of specific risk factors as ulcer/gangrene, smoking history, and chronic renal failure with hemodialysis. Following these directives the use of endovascular interventions for arterial occlusive lesions continues to increase consequently causing the detriment of open surgical revascularization. A careful evaluation of the various restraining parameters should precede the choice of surgical approach, to ensure the selection of the most suitable technique in each individual patient on the grounds of clinical presentation of the disease. For example, TASC lesions type A or B are best treated with angioplasty and stenting, while TASC lesions type C and D show better results with surgical treatment.

Technically PTA provides for an ipsilateral, or less frequently controlateral, common femoral artery access, crossing the lesion with a guide wire, dilating the vessel with an angioplasty balloon catheter and placing a self-expandable stent. Sometimes a brachial approach is preferred, especially when many lower limb vessels are impaired. In this kind of approach it is important to pay attention at some neurological complications (i.e., hematoma that compresses the brachial plexus leading to a sensory-motor deficit) and vascular ones (i.e., pseudoaneurysm, local thrombosis or distal embolism) which have a low incidence, estimated between 2 and 13,4% (Tsetis et al, 2008).

A 68-year-old male smoker presented to the hospital with a history of bilateral and severe lower limb arterial disease. He was suffering a left common iliac arterial occlusive lesion as showed by the arteriographic examination. The patient was treated with PTA and stenting through the left brachial artery, instead of controlateral femoral approach, due to the presence of small lesions in the right leg vessels. During the procedure, the radiologist used videoscopic to help to see the part of the iliac artery concerned the occlusion without following the entire route taken by the guide wire. By doing this he did not notice that he had taken a wrong direction, passing through the ascending aorta and then going into the cardiac chambers; in a second attempt he finally was able to enter the descending aorta and reach the left common iliac artery where the stent was successfully located.

Two hours after PTA the patient suddenly died. An autopsy was arranged for investigating any professional liability profiles. A complete postmortem examination was performed three days after death.

External examination was insignificant. The internal examination revealed a cardiac tamponade without identifying the breaking point, but with evidence of hemorrhagic infiltration area in the epicardium and throughout the thickness of the myocardium at the distal part of the left ventricle. At the aortic cone level a small area of hemorrhagic infiltration, in contact with the fibrous pericardium, was found. The presence of a correctly positioned stent in the left common iliac artery was observed. Other findings concerned polyvisceral congestion, cerebral, and pulmonary edema.

The histological heart examination, performed with routine hematoxylin-eosin, revealed hemorrhagic dissection of myocardial tissue at left ventricle level consistent with a rupture of the heart, excluding natural causes of death as myocardial infarction.

In conclusion, the cause of death was attributed to a cardiac tamponade due to traumatic left ventricular rupture during PTA procedure.

This case, which has attracted medicolegal interest because of medical liability profiles that were assumed as the doctors' fault, shows a fatal PTA complication particularly uncommon, as reported by literature. The complications rate for angioplasty selective stenting, indeed, is generally very low both for perioperative deaths (0,03-0,06% - Aburahma et al, 2007) and immediate total complications (0,7% - Kudo et al, 2005).

Iliac Artery Occlusion, Percutaneous Transluminal Angioplasty, Fatal Left Ventricular Rupture

G62 Swiss Virtobot (Virtual Autopsy) Documentation and Analysis: Work Flow and Procedure

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The goal of this presentation is to discuss the 2009 report concerning "Medical Examiners and Coroners Systems: Current and Future Needs" of the "National Academy of Sciences", it is written, that modern imaging technologies (Virtual autopsy, Virtopsy, www.virtopsy.com) has a great potential to detect forensic relevant findings. In the lecture, based on the experiences obtained up until now, the possibilities and realization of a process-optimized forensic examination procedure, including the subsequent analysis process, are illustrated.

This presentation will impact the forensic science community by presenting an overview of the techniques of forensic imaging and virtual autopsy and the effect to forensics in future and in correlation with the 2009 National Academy of Sciences report concerning, "Medical Examiners and Coroners Systems: Current and Future Needs".

Over ten years ago, the Virtopsy Project with its systematic integration of various technologies and modalities, such as photogrammetric 3D surface scanning, computer tomography and magnetic resonance scanning as well as in the area of clinical and postmortem forensic medicine as well as postmortem biopsy and angiography and synthetic somatic modeling development, was perceived by professional circles as being revolutionary.

After a decade, these technologies at the University Forensic Institute Bern have been integrated as an evolutionary process development in daily forensic practice.

The almost completed documentation procedure in the postmortem area has also influenced future image-based documentation and analysis processes in clinical forensic medicine.

Forensic Imaging, Virtual Autopsy, Virtopsy

G63 Mortuary Management in the Aftermath of the 2009 Australian Bush Fires

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After attending this presentation, attendees will have a greater understanding of the principles and logistics behind mortuary management following a mass fatality incident.

This presentation will impact the forensic science community by serving as a reference for improving the management of the dead and encouraging greater emergency preparedness within communities.

The Victorian Institute of Forensic Medicine (VIFM) is a statutory body with the responsibility to provide forensic pathological, clinical forensic medical, and related services to the State of Victoria, Australia. This includes the conduct of postmortem examinations and the provision of a range of forensic scientific investigations in cases referred by the coroner.

One of the roles of the VIFM is to provide scientific services in the event of multiple fatalities within the State of Victoria and extending to around Australia where necessary. Some of these past incidents include the 1996 Port Arthur Massacre, 2003 Bali Bombing, 2004 Tsunami and the Australian Embassy bombing in Jakarta.

On February 8, 2009 now known as Black Saturday, the State of Victoria, Australia suffered the deadliest bushfires recorded in its history. There were 173 fatalities and over 2,200 homes were destroyed. Over the following days 298 suspected human remains were admitted to VIFM.

On the day of the fires VIFM activated its emergency plan. Within 48-hours, a temporary mortuary was constructed adjacent to the existing mortuary facility. This temporary mortuary had the capacity to store up to 300 deceased persons. It was linked to the main building by a series of marquee walkways, was completely undercover and surrounded by security fencing. Additional catering and office spaces were also constructed.

Pathologists, anthropologists, odontologists, police, and mortuary assistants responded from all around Australia, New Zealand and Indonesia. The mortuary facility and staff were divided into two areas: DVI (Disaster Victim Identification) and "normal operations."

A high priority for the mortuary was to ensure all "normal" admissions of deceased persons (those cases which were not related to the bushfires) were handled concurrently and in a timely manner. The VIFM examines approximately 3,000 deceased persons per year and in 2005 a multi-slice CT scanner was installed. This scanner has become integral to the day to day operations of the VIFM and played a major role in the identification of the victims.

On admission, each bush fire victim was given both a unique DVI and a coroner's case number. The case was CT scanned, examined by a pathology team, an anthropologist, an odontologist, and in some instances a fingerprint expert. Where possible a DNA sample was taken. All processes, samples, labels, and paperwork underwent a quality assurance check prior to the case completion. Regular audits were conducted. The majority of postmortem examinations were completed within twenty days of admission

Occupational health and safety issues of the staff were paramount; this included correct manual handling, infection control, and psychological debriefings. During the operation it was found that some remains were contaminated with asbestos. Procedures were set in place to manage these cases individually and each was isolated to reduce the exposure to staff.

On May 1, 2009 the identifications of all missing persons was complete. Of the 164 missing persons, 163 were found, identified, and the remains returned to the families. Nine deceased persons died in hospital or related circumstances and did not undergo the formal DVI process.

This operation identified a number of significant challenges, in particular the management of multiple parts of human remains for one individual. A new procedure was developed to ensure all human remains, where possible, were reconciled with deceased persons prior to the release to the funeral director.

Finally, no mass disaster operation can function successfully without a close working relationship between police, mortuary, medical examiners, and coronial staff. This operation highlighted the value of cultivating this relationship during the "quiet" times to ensure efficient activation of an emergency response, timely identifications, and ultimately some degree of closure for the victim's families.

Mortuary, Disaster, Bush Fires

G64 A Uniform Protocol to Address the Rapidly Accumulating Unidentified Human Remains and Missing Persons in the United States — A Nation's Silent Mass Disaster

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After attending this presentation, attendees will understand the problems involved with the investigation of unidentified human remains (UHR). The strengths and limitations of current technologies and resources available for investigating UHR cases will be discussed as well as presenting for the first time, a uniform protocol and procedures for the identification of UHR.

The presentation of this protocol will impact the forensic science community by serving as a guideline as it can expedite and augment UHR identification efforts by presenting the resources available in an organized and consistent format. As a direct result, utilization of this protocol may help identify the tens of thousands of UHR that are currently being held within medical examiner/coroner's (ME/C) offices throughout the United States. More importantly, families of these deceased individuals will no longer wonder what happened to their loved ones and struggle with the agony of possibly never having the ability of laying their loved ones to rest.

Statistical data from UHR cases at the San Diego County Medical Examiner's Office (SDMEO) from 1997-2007 will impact the forensic science community by demonstrating the effectiveness of this new protocol.

No uniform protocol or procedure exists describing every avenue currently available to facilitate the identification of UHR. Therefore, many jurisdictions lack consistent guidelines for pursuing the identification of UHR and continue to be unaware of the most current resources available to aid in their investigations. This study was conducted to determine whether a uniform protocol could be developed to aid in streamlining the process of identification. Many avenues currently available to aid in the identification of UHR were examined and combined to create a comprehensive and universal procedure that can be followed by any agency or organization in the forensic science community tasked with the identification of unidentified persons.

During a brief time period from January 2007 to January 2008, when components of the uniform protocol were used for the investigation of specific UHR cases at the San Diego County Medical Examiner's Office (SDMEO), there were seventeen "cold" UHR cases from the 1997-2007 time period that were identified. Furthermore, there were only four UHR cases recorded in 2007, a significant decrease from the average number of fourteen UHR cases per year. An obvious decline in the number of unidentified persons was yielded, which correlated to the utilization of components of the uniform protocol.

A uniform protocol as will be presented can be created to assist in the identification of current and "cold case" UHR and linking them to missing person cases, which can further assist law enforcement in any related criminal investigations.

Collaboration and organized, consistent protocols among local, state, and federal agencies tasked with the identification of missing and unidentified persons will expedite the collection and distribution of information crucial to these investigations. Thus, a consistency of

incoming information will be established, allowing the searching and correlating of case information and as a result, increasing the probability of UHR cases being linked to missing person cases. This will likely result saving millions of dollars and countless hours of time that could be used more efficiently by the agencies involved with the identification of UHR.

Specific resources and supporting data for the application of the uniform protocol in ME/C offices in the United States will be presented. It is recommended that ME/C offices and agencies tasked with the identification of UHR become familiar with the various UHR identification avenues available that the protocol will exhibit.

Unidentified Human Remains, Missing Persons, Investigation

G65 Request for Uniform Autopsy Protocols on Certain Drowning Victims

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The attendees will learn indicators that may determine whether drowning victims may require additional forensic examination to assess whether the drowning is in fact a homicide staged to look like an accident. Attendees can anticipate implementing autopsy protocols that help identify the need to conduct examinations that assist law enforcement in investigating suspicious or inadequately corroborated deaths while proactively addressing potential threats to vulnerable populations of abuse/neglect.

This presentation will impact the forensic science community by providing key indicators to identify drowning cases of interest, improving their understanding of a certain class of victim (victims of unobserved and inadequately corroborated drowning) resulting in improved forensic evidence collection, enhancing the accuracy and utility of the autopsy on these victims, and increasing the ability for law enforcement to respond and investigate viable/scientifically-driven time sensitive leads.

Use of Indicators for Positive Impact: A plan of action to improve forensic evidence collection related to victims of unobserved or inadequately corroborated drowning will enhance the utility of the autopsy, and positively impact the medical examiner (M.E.)/forensic scientist community, law enforcement (L.E.) partners, victims' families and the safety of both children and adults. Oftentimes, the M.E./forensic scientist community is best situated to provide investigators tools to recognize a homicide staged to look like an accident; excluding natural, traumatic, and toxicological factors in the medical cause of death (COD) are critically important.

Preservation of Forensic Evidence: Frequently, forensic evidence indicating criminal conduct is destroyed or washed away in victims of unobserved or suspicious drowning. While the accurate assessment of autopsy findings requires thorough examination of circumstances preceding death and circumstances of recovery – without advance evidence of foul play, when victims are recovered from the water, the circumstances, manner of death (MOD), and water entry point often lack thorough examination. NCMEC request consistent initial drowning examinations to complement L.E. efforts nationwide – as timely information on MOD can lead L.E. to water entry point analysis and other investigative leads prior to the disappearance of critical evidence.

Methodology Changes: NCMEC request the AAFS support the establishment of uniform nationwide protocols for the examination of unobserved drowning victims and for victims recovered in the water under suspicious or inadequately corroborated circumstances. Treating these investigations as homicides from initiation is vital to judicious evidence recovery and adoption of certain examinations (including testing for sexual assault, subcutaneous bruising, predatory drugs, etc.) under a defined set of circumstances can provide vital forensic clues regarding the MOD, and potential prevent serial or repeat murders.

Drowning, Protocols, Homicide

G66 MAPS: How a Statewide Pharmaceutical Database Improves Death Investigation

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After attending this presentation, the attendee will have a better understanding of the benefits of using a controlled substance pharmaceutical database such as the Michigan Automated Prescription System (MAPS) when obtaining a decedent's medical history. Attendees will be presented with several case studies illustrating how the MAPS system can provide missing information and potentially change the cause and/or manner of death.

This presentation will impact the forensic science community by raising awareness among all parties involved in death investigation, specifically medical examiners, by describing the Michigan Automated Prescription System (MAPS) and its use in aiding in the investigation of deaths reported to medical examiners.

Accurate patient medical history is essential to the success of every death investigation. However, gaps in patient histories and medical records can sometimes lead to incorrect interpretation of data and may compromise the opinion rendered by the medical examiner. Obtaining accurate information regarding a decedent is critical to a high quality investigation and the interpretation of postmortem toxicology. The Michigan Automated Prescription System allows the medical examiner to gather information regarding controlled substances prescribed to the decedent for months before the death.

MAPS grants physicians with a DEA number the ability to access pharmaceutical dispensing data statewide to determine all controlled substances dispensed to a particular patient. The MAPS requires pharmacists, veterinarians, and dispensing physicians to report electronically (or by mail) all controlled substances dispensed in Schedules 2-5. Michigan launched the service in its current form in January 2003, and any previously existing prescription, patient, and healthcare provider data were entered into the new system. With over 1.2 million prescriptions reported each month, the MAPS system was built for ease of use, fast report generation (average turnaround time for individual reports is less than ten minutes), and prescription trend watching.

In cases of suspected drug overdose due to a controlled substance with "positive" toxicology, the medical examiner makes an inquiry into the database using the name and date-of-birth of the decedent. The report generated may indicate no information is available for an individual with the particular information. More commonly, the report generates a list of the controlled substances(s) prescribed, the quantity dispensed, the date dispensed, the prescribing physician(s), and the dispensing pharmacy(s).

The use of information provided by MAPS led to the prospective review of seventeen deaths since February 2009. Of the seventeen deaths, the MAPS report in three deaths did not change the opinion or assist the medical examiner in the investigation, the report in ten confirmed or supported the medical examiner's opinion, and in four cases, a change of the cause and/or manner of death occurred based on information contained in the MAPS report.

Example cases will be presented in detail to demonstrate how the information available in a database of controlled substances dispensed to

patients contributes to the investigation of deaths of individuals with postmortem drug screens "positive" for prescription medications in which drug intoxication may have caused or contributed to the death.

Death investigators should be aware of this advantageous tool. With a better understanding of the patient's history, investigators can paint a more accurate picture of the life of the decedent, which, in turn, gives the medical examiner better tools to properly evaluate the situation and return a more confident ruling regarding cause and manner of death.

Toxicology, Death Investigation, Drug Related Fatalities

G67 Death Investigation and Organ and Tissue Donation in Clark County, Nevada

Alane Olson, MD, Clark County Coroner's Office, 1704 Pinto Lane, Las Vegas, NV 89106*

After attending this presentation, attendees will be acquainted with alternatives and compromises which have been adopted between a medicolegal death investigation agency and the local organ procurement organization in an effort to optimize medicolegal death investigations and organ and tissue procurement.

The presentation will impact the forensic science community by providing knowledge of some successful alternatives in meeting the needs of coroner/medical examiner offices and organ procurement organizations.

During its 2007 session, the Nevada Legislature considered model legislation to modify the Uniform Anatomical Gift Act. At the same time, the Clark County Office of the Coroner/Medical Examiner and the Nevada Donor Network initiated discussions aimed at tailoring the model legislation to better accommodate specific needs and existing relationships. As a result of these activities, the legislation finally enacted contains provisions which, among other things, allow the coroner's office to refuse organ and tissue donation if it will interfere with the death investigation, attend the procurement if necessary, be reimbursed for attending the procurement, and obtain video and photographic documentation before, during, and after the procurement. In order to accommodate the anticipated need for photo documentation, the coroner's office formed the Forensic Investigative Rapid Support Team (FIRST), which is composed of experienced autopsy technicians who are on-call and available to respond to hospitals in conjunction with the coroner investigator for the purpose of photographing prospective donors. When the coroner's office is notified of a request for donation, on-call medical examiner is responsible for deciding if the procurement can take place, and the FIRST team is activated at his/her discretion. The coroner's office and organ procurement organization consider this a reasonable compromise between optimizing recovery of organs and tissues, and the requirements for conducting thorough medicolegal death investigations.

Death Investigation, Organ Procurement, Legislation

G68 Fatal Sexual Violence Database for Postmortem Genital Examinations With Colposcopy

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The goals of this presentation are to provide a systematic method of data collection and storage that will enable us to better understand the nature and appearance of the anogenital tissues at various postmortem intervals; to integrate a taxonomy that is consistent with conventional terminology, e.g., terms used in forensic pathology and forensic odontology; and to study the reliability of previously-presented methodology for postmortem genital examinations, with colposcopy.

This presentation will impact the forensic science community by improving the diagnostic acumen of the forensic examiner and serve as a format for quality improvement; providing a framework for the evaluation of fatal sexual violence against women; and increasing the reliability and validity of both taxonomy and techniques (methodology) used to examine victims of fatal sexual violence.

This paper describes ongoing clinical research of postmortem genital anatomy and a methodology to capture data gleaned both from baseline studies and presenting cases of fatal sexual violence.

The nature of these crimes, coupled with a lack of a detailed history from the victim, predicates adoption of the most accurate methodology and technology available; these victims are not available for follow-up examinations.

A fatal sexual violence database provides a relational system in which to record, analyze, and compare data from both baseline studies of normal anogenital anatomy and cases of sexual homicide. While it is helpful for the forensic examiner to be cognizant of previous classification systems used to describe findings in living subjects (Fraser: WHO, 1999), a taxonomy germane to the postmortem arena should incorporate salient terms that will be consistent and universally applicable and acceptable within the forensic community (Crowley & Peterson: AAFS, 2004). Inclusion of these findings into a relational database will permit aggregate summaries of individual and population-based summaries.

Materials and Methods: Initial case documentation for the baseline clinical study conducted at the Donated Body Program of University of California Davis, Sacramento, is via the *Postmortem Genital Examination Case Worksheet*. A hardcopy of this form is completed in the morgue. It contains all data fields, with essential elements of the case, methods of examination, and summary of findings.

For these cases of normative controls, some fields in the database will not be populated; other variables are common to both sexual homicide and control groups. Because the strictest efforts are enacted by the Donated Body Program to protect identifying data and personal information of the donors, some information is simply not available, e.g., date of birth (only age is used), address, disposition of the body, time body found, position of the body, social history and lifestyle, gynecological history, clothing, and other personal items on the body at the time of death. Conversely, for cases of sexual violence, the aforementioned variables, plus date of birth, elements of the crime scene, restraints and bindings, body positioning, nongenital trauma, including bitemarks and other patterned injuries, genital trauma, and all biological and forensic specimens for the Sexual Assault Evidence Kit are germane to the case composite. Some techniques for examination would be relevant to medical-legal cases, but might not routinely be available for normative studies, e.g., Wood's Lamp, alternate light source, or reflective light imaging.

Some variables common to both normative and sexual homicide cases include age and reproductive status, (pre-pubertal, reproductive age, peri-menopausal, and post-menopausal) and genital examination techniques (gross visualization, colposcopy, single lens reflex (SLR) camera photography, speculum and anoscopic examination, and the use of balloon-tipped swabs). Also, the same twelve anatomic sites are visualized, inspected, and photographed: *labia majora, peri-clitoral area, peri-urethral area, labia minora, hymen, vagina, cervix, perineum, fossa navicularis, posterior fourchette, anus, and rectum.*

Other common variables include the unique case identifier, date and time of the examination, interval from death to arrival in forensic science morgue (£ 24 hrs., 24-48 hrs., 48-72 hrs., 72-96 hrs., ³ 5 days); general condition of body; race and ethnicity (per CDC definitions); cause of death, and contributory and/or concomitant medical and gynecological conditions, especially those presenting lesions.

Postmortem artifact, such as mucosal autolysis and skin slip that is visualized in the anogenital tissues is documented for each anatomic site where it is noted.

Initially, a spreadsheet was utilized for its capability to easily record, sort, and organize the various data elements. A relational database, e.g., ACCESSâ, permits data to be divided into many subject fields and represented only once. Divided information can be re-synthesized via common, related subject-based tables. This will remove data redundancy and help ensure accurate information. The rows and columns in the tables are expanded data collections of the postmortem examination worksheets for documentation of data during the course of the clinical examination. Data can eventually be exported into other data systems, e.g., SPSSâ, for more advanced statistical analysis.

Discussion: In addition to the multiple variables present during any female genital examination, the postmortem arena superimposes a unique set of factors onto the scene. Many of these were not previously been studied or sufficiently documented in the literature. A fatal sexual violence database serves as an efficient repository of data accumulated during the Donated Body Program baseline study, in addition to any concomitant, presenting sexual homicide cases.

Missing data may also be significant e.g., the fact that a body of a Jane Doe found without any identifying information, e.g., driver's license, passport, could be a potential link to human trafficking (Crowley: AAFS, 2009). Records of actual fatal sexual violence cases will have many variables that are not germane to the baseline controls. Thus, a relational database is an ideal method to simplify and quantify data for interpretation, analysis, and linkage to other cases.

Storage and evaluation of data will help avoid ambiguity in the interpretation of findings for this target population. Analysis and interpretation of data will increase the diagnostic acumen of the forensic examiner. It will also facilitate effective and reliable communication within the forensic and legal community, via a more descriptive taxonomy. An effective database will allow eventual comparison of the genital findings in fatal sexual homicide victims to a control group of individuals who died of other causes, i.e., natural, accidental, suicide, and non-sexual homicide.

Finally, the ultimate goal of this research is to improve our understanding of what is normal, and what is not, for the anogenital anatomy during the postmortem interval. To this end, data gleaned from a fatal sexual violence database can be used to expand and enhance our knowledge. The forensic examiner is presented with the challenge to "capture" in hardcopy and electronic systems, a myriad of variables and conditions presented by each body in the morgue. Until recent years, a paucity of information existed on the appearance of the anogenital tissues during the postmortem interval. Comparisons to either living sexual assault victims or postmortem cases of non-sexual etiology were extremely difficult. Thus, it is paramount that the examiner always be cognizant of the need to perform these examinations with optimal levels of expertise and to permanently chronicle vital information. In this manner, our capacity and understanding of fatal sexual violence against women will continue to grow.

Fatal Sexual Violence, Colposcopy, Forensic Clinical Nurse Specialist

G69 Grant Solicitations: New Opportunities for Medical Examiners and Coroners – Tips on the Process

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After attending this presentation, attendees will be able to avoid pitfalls in the process of preparing grant solicitations.

The availability of Federal grants for medical examiners and coroners has been limited. In contrast to academics, medical examiners and coroners do not have much experience in preparing grant solicitations. With new funding available, this presentation will impact the forensic science community by demonstrating how medical examiners could benefit from some tips on pitfalls in the process.

Grant funding for medical examiners and coroners has previously been limited. New federal funding sources are now available with more expected in the future. Preparing a grant solicitation may appear to be a daunting task. This presentation will offer some simple tips to make a grant solicitation more appealing to reviewers and some pitfalls to avoid.

Grant Solicitations, Grant Pitfalls, Grant Tips

G70 Development of Standard Operating Procedures for Conducting Arthropod Succession Studies: Improving Postmortem Estimates Through Ecology

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The goal of this presentation is to provide attendees with a better understanding of experimental design as it relates to arthropod-based decomposition studies.

This presentation will impact the forensic science community by demonstrating the development of standard operating procedures for conducting arthropod succession studies in the field.

The period of insect activity (PIA) encompasses the time from discovery of human remains to when the remains were actually colonized. Therefore, the PIA in most cases represents the minimum postmortem interval (minimum-PMI). The amount of the PMI encompassed by the PIA can vary depending on a number of variables such as wind, rain, temperature, or if arthropods are excluded from the remains due to a physical barrier (i.e. wrapping, enclosed in a car or home). Consequently, understanding the variability the actual time of colonization as it relates to the actual time of death is of great importance.

Arthropod succession studies are conducted for a number of reasons. The majority of these studies are done to determine the species composition for a given location during a particular time of year to provide data that can be used to determine the "postmortem interval" of a decedent discovered in the same vicinity of the study site, and to determine the variation in time of initial colonization of remains.

A review of the forensic entomology literature indicates that a standard operating procedure is needed to in order to glean as much information from these decomposition studies as possible. Such information could lead to a better understanding of the succession and decomposition variability in different geographic regions and greater explanation of variables delaying arthropod colonization patterns on human remains. Furthermore, developing consistent practices could lead to data sets that can be combined in meta-analyses.

The following variables are suggested for inclusion in a SOP for arthropod succession studies:

1. Actual time of death of the remains used in the study
2. Storage of remains prior to use (i.e., frozen)
3. Method used for euthanasia
4. Actual time of initial colonization
5. Identification of species initiating colonization
6. Environmental conditions at the time of colonization (temperature, rain, shade, etc)
7. GPS coordinates of study site

Forensic Entomology, Ecology, Period of Insect Activity

G71 Using Biolog EcoPlatesTM as an Economical Approach to Determining Postmortem Body Dump Sites Through Microbial Community Level Physiological Profiling

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After attending this presentation attendees will have a better understanding of the role microbial communities play in the rate and ecological dynamics of decomposing remains, and how this information can be used to better understand the timing and postmortem placement of human remains in the environment. Attendees will learn how changes in microbial community level physiological profiles (MCLPPs), during community succession on a body and in the soil beneath, can be utilized to predict the location and duration of decomposing remains.

This novel approach will impact the forensic sciences community by providing a more in-depth understanding of the ecological principles governing microbial community succession. Its cost-effective framework makes it ideal for use in crime scene investigations. On a broader scope this technique will provide insight into the influence of the microbial composition and metabolic products on insect colonization of decomposing remains (i.e., forensic entomology), thus improving the science behind estimates of the period of insect activity (PIA), and hence, that of the postmortem interval (PMI).

Microbial communities are a substantial component of the decompositional ecology and processing of organic material, such as carrion and human remains. Studies in both aquatic and terrestrial systems have shown that microbial communities follow a pattern of succession by metabolizing and modifying resources in a way that makes them usable or undesirable to other organisms, such as insects. While there have been studies describing the succession and diversity of microbial communities involved in carrion decomposition, none have evaluated their potential use for determining the postmortem spatial and temporal placement of decomposing remains in the natural environment. Further, most forensic entomology studies of insect succession suggest that volatile metabolic by-products of this community cue initial blow fly attraction and colonization. Postmortem structural and functional changes in these microbial communities may thus affect the PIA on decomposing remains, having applied importance to estimates of the PMI.

One established and economical method for understanding changes in environmental microbial communities is the use of Biolog EcoPlates™. EcoPlates™ have 31 different carbon sources represented in triplicate on each plate, and were designed for describing entire microbial communities from environmental samples such as soil. The pattern, or signature, of carbon resource utilization by the microbial communities provides MCLPPs. The MCLPPs, calibrated with temperature and genomic sequencing, has the potential to provide ecological data that can predict how long a body has been decomposing, and for how long at a particular location (e.g., on soil).

The objectives of this study were to describe microbial community changes over time (i.e., succession), in a variety of environmental settings and throughout multiple seasons, using Biolog EcoPlates™ in conjunction with pyrosequencing of the microbial genome. MCLPPs from communities on decomposing remains and the soil beneath were hypothesized to change as a function of succession, and identified stages of succession could be used to determine the stage of decomposition and the spatial and temporal positioning of remains on a rural forest floor. Further, we hypothesized that microbial successional dynamics (community structure rate and sequence of change) would impact initial species-specific blow fly oviposition and colonization. We predicted that MCLPPs could be matched and calibrated with genomic-based methods of describing microbial communities, providing a more economical approach for use in crime scene investigations.

For this study, microbial samples were taken from carrion (swine) (N = 3–9) and the soil underneath (treatment soil) and at two distances lateral (0.25 and 1.0 m) of each carcass (control soil). To understand microbial community structure differences on the carcass, swabs of the buccal, urogential and shoulder skin were evaluated, and all samples were described using Biolog EcoPlates™. This study was done in two seasons and two geographic locations to understand variability and generality of these techniques. In one location, matched samples of each individual sample, or composite sample, were taken and evaluated using the Roche 454 FLX pyrosequencing platform. Each of the samples were analyzed using the bacterial tagged encoded FLX amplicon pyrosequencing (bTEFAP) method to identify patterns of organisms occurring on the decomposing tissue during the longitudinal study and calibrated to MCLPPs from the EcoPlates™.

Preliminary results found substantial change in microbial communities both on the carcass and in the soil beneath the carcass, with little change in the control soil communities over time. Variation of MCLPPs among body regions was minimal and could be combined to provide an average body MCLPP signature. During the decay stage of decomposition, MCLPPs were significantly different in soil beneath compared to soil lateral of the body; this supported the hypothesis that MCLPP have the potential to differentiate soil communities where decomposition has been occurring, and possibly predict the time since placement. Further, there was substantial MCLPP variation among inter-replicate body communities, indicating different volatile signatures which could be important to initial blow fly attraction and oviposition location; creating "founder" conditions that could influence subsequent intra- and inter-specific competition, the duration of PIA and, thus, estimates of PMI. Calibration of MCLPPs with metagenomic sequencing is on-going. We will continue to evaluate these communities during multiple seasons and habitats, providing new data important for a better understanding of the ecology of decomposition, and its relevant application to forensic science.

Biolog EcoPlatesTM, Forensic Entomology, Microbial Communities

G72 Microbes Associated With Decomposing Remains Regulate Insect Colonization

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The goal of this presentation is to give attendees a better understanding of the role microbes play in regulating colonization of decomposing remains by blow flies (Diptera: Calliphoridae).

This presentation will impact the forensic sciences community by providing a more in depth understanding of the ecological principles governing insect succession of human remains.

Explaining why insects delay their colonization of human remains in some instances while colonizing immediately in others is a fundamental question in forensic entomology. Two of the authors of this

presentation, Tomberlin and Benbow, along with others have developed and proposed a new framework for studying human decomposition. They point out that a majority of past research focuses on the post-colonization interval (post-CI) which extends backwards in time from the discovery of the insect infested remains to the point that the insects initially colonized the remains. The time of colonization estimation is viewed as the period of insect activity (PIA) and is often considered the minimum postmortem interval (minimum PMI). The time frame prior to colonization has been termed the pre-colonization interval (pre-CI). Speculations as to why insects delay colonization have been suggested and small advancements explaining this ecological unknown have been made. Known abiotic factors, such as temperature, wind, and rain play a role in regulating colonization of human remains. It is hypothesized that microbial populations associated with human remains represent a major biotic factor regulating insect colonization.

Human remains represent nutrient rich resources for many organisms ranging from microbes to vertebrate scavengers. Microbes were initially thought of only as nutrient recyclers. However, recently other hypotheses have been suggested. Some researchers speculated that microbes were resource competitors with other consumers, including insects. Microbes may alter food resources and produce toxins that affect the "appeal" of the resources, and themselves, to other consumers. It is hypothesized that volatiles emitted by microbes associated with carrion, regulate the attraction to and diversity of colonization of the remains by insects. It is futher hypothesized that volatiles emitted by microbes associated with and physiological by-products produced by blow fly larvae feeding on the remains influence the attraction and colonization of the resource by future blow fly species. It has been demonstrated that many saprophagous insects feed directly on microbes associated with decomposing material as part of their diet. In addition, microbes can have a mutualistic relationship with these arthropods. It is hypothesized that specific bacterial species which survive digestion and pupation with one fly species, may not with another fly species. Therefore, bacterial proliferation and dispersal is mitigated by colonization patterns of fly species. Such an association could, however, prove detrimental to both microbe and associated fly if the volatiles emitted also attract predators. Basically, it would be a two-way ecological chess match where the pawns are the insects and the players are the associated microbes. But, these roles can be reversed depending on those involved. This model examines if the volitles emitted by the native species, *Cochliomyia macellaria*, larvae (the prey) and associated bacteria attract the introduced predatory blow fly, *Chrysomya rufifacies*.

A series of laboratory experiments were conducted examining the interactions between microbes associated with carrion (beef liver) and the attraction of *C. rufifacies* and *C. macellaria* adults. Furthermore, two field experiments were conducted examining the interaction of microbes on carrion with the attraction of blow flies as well as the role of excretions/secretions of blow flies on the attraction of Diptera. These results will be provided in this presentation and will hopefully shed light on biotic factors governing the time span of the pre-CI.

Forensic Entomology, Microbes, Trophic Interactions

G73 Lower Temperature Threshold for Black Soldier Fly (Diptera: Stratiomyidae) Egg and Adult Eclosion

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After attending this presentation, attendees will learn the lower developmental threshold dynamics of temperature that either facilitate or impede black soldier fly egg and adult eclosion.

This presentation will impact the forensic science community by providing valuable insight into variation in developmental thresholds with respect to insect development and its application in calculating the minimum time to colonization.

Black soldier flies, *Hermetia illucens* (L.) (Diptera: Stratiomyidae) are of particular interest for their applications in forensic entomology. Initially thought to be a late colonizer (20-30 d postmortem) of carrion, recent evidence indicates they will colonize a corpse within the first week after death. Black soldier flies are native to warmer environments, including North and South America, and therefore studies on black soldier fly development have primarily focused on determining the higher temperature thresholds and optimal temperatures for development. This study determined the lower temperature thresholds for egg and adult eclosion. Preliminary studies indicate temperatures facilitating successful egg eclosion do not necessarily result in larval development and adult eclosion. For that reason, the black soldier fly has two different lower developmental thresholds; one supporting egg hatch, and one supporting egg hatch and larval development to the adult stage. In relation to the postmortem interval, not differentiating these two temperature thresholds could result in errors in calculating larval age and retrospectively, time of colonization. Black soldier fly eggs were collected in corrugated cardboard clutches from an established colony outdoors, at the Texas A&M University's F.L.I.E.S. facility in College Station, Texas and placed in three growth chambers, each maintaining a 70% RH, 14:10 [L:D] photoperiod respectively. Each growth chamber was set at 12ºC, 15ºC or 18ºC. Egg clutches were randomly assigned to each treatment. Percent hatch and survivorship to the adult stage were recorded. Larvae were provided bovine liver *ad libitum* and allowed to develop without disturbance. Egg eclosion, length of development, and adult eclosion was recorded daily.

Black Soldier Fly, Lower Developmental Threshold, Forensic Entomology

G74 Colonization Behavior of Forensically Important Blow Fly Species: Implications for Postmortem Interval Estimations

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After attending this presentation, attendees will have a better understanding of ecological interactions between various forensically important blow fly species and how this relates to PMI estimation.

This presentation will impact the forensic community by providing insight into the importance of understanding species interactions and individual colonization events and how these behaviors can impact one's estimation of the MTC. This presentation will highlight the importance of rigorous scientific testing in order to validate current assumptions in the field with respect to delays in colonization prior to their incorporation into estimations of colonization events and, ultimately, PMI estimations.

Blow fly species are known to be among the primary colonizers of remains and as a result, blow fly species composition, colonization events and successional patterns are important aspects to consider in the determination of the postmortem interval (PMI) and minimum time of colonization (MTC). Previous research and case studies have indicated that certain blow fly species may experience a delay in colonization (i.e., *Phormia regina* (Meigen) and *Chrysomya rufifacies* (Macquart)). These findings have led to a debate within the field of forensic entomology as to whether or not these delays should or should not be incorporated into MTC and PMI estimations.

It was hypothesized that the colonization behaviour of blow flies (i.e., *P. regina* and *C. rufifacies*) would be altered based upon the presence or absence of an additional blow fly species (i.e. *Lucilia sericata* (Meigen)). The colonization behaviour of three forensically

important blow fly species were examined: *L. sericata*, *P. regina* and *C. rufifacies*. Specifically, gravid adult females of *L. sericata* and *P. regina* and *L. sericata* and *C. rufifacies* were allowed to colonize fetal pig carcasses, *Sus scrofa* (Linnaeus), however, their arrival order varied according to one of five different treatment conditions. Species were allowed to colonize either on their own, in the presence of an additional species, and prior to and subsequent to an additional species. colonization events and behaviour were recorded from the time of arrival to forty hours postmortem. Upon removal of the carcasses, egg masses were examined and depth measurements were recorded. The eggs masses were then photographed and volumetric measurements were obtained using the Image J software program. A linear regression was carried out (using SPSS) with volume (mm^3) versus total number of eggs in known egg masses in order to predict the number of eggs based upon the volumetric measurements recorded.

It was determined that the colonization behaviour varied with respect to time of first colonization, location of colonization, and total number of eggs laid on an individual species basis. In particular, *P. regina* experienced a significant decrease in time to first colonization and laid more eggs in the presence of *L. sericata*, which indicates that the presence of an additional blow fly species could act to facilitate the colonization of *P. regina*. Thus, the colonization behavior of blow flies should be examined on an individual basis. Furthermore, ecological interactions between other blow fly species could play an important role in altering a species colonization behavior, specifically with respect to the time and location of colonization, as well as the amount of eggs laid.

Blow Fly, Postmortem Interval, Minimum Time of Colonization

G75 Petechiae in Hanging: A Retrospective Study of Contributing Variables

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After attending this presentation, attendees will better understand the variables contributing to the development of petechiae in hanging.

This presentation will impact the forensic science community by providing evidence-based data on the contributing variables to the development of petechiae in hanging.

Introduction: It is often stated in the literature that petechiae are more frequently observed in cases of hanging where part of the body is supporting the victim's weight, i.e., cases of incomplete hanging, because it is believed that the jugular veins become occluded while the deeper and less compressible carotid and vertebral arteries remain patent. The present study is intended to evaluate the relationship between petechiae and the type of hanging (complete vs. incomplete) as well as several other variables: victim's age, height, weight, the body mass index (BMI), type of ligature and cardiopulmonary resuscitation.

Material and Methods: A total of 309 suicidal hanging deaths were autopsied in the province of Quebec (Canada) over an 8.5-year period. Of these, one case was excluded since it was not a typical hanging but a hanging from height, with dislocation of neck vertebrae (hanging after jumping from a bridge). Additionally, fifty cases were excluded from the analysis because postmortem changes interfered with the evaluation of petechiae (significant decomposition, skeletal and charred bodies). Finally, fifty two cases were also excluded because the type of hanging was not specified in the autopsy files, thus making their analysis not applicable to the present study. Overall, a total of 206 cases were analyzed for the presence of conjunctival, palpebral, gingival and facial petechiae. For each case, the following information was also compiled: gender and age, height and weight, the type of hanging (complete or incomplete), the type of ligature used (rope, wire, clothes, sheet or lace) and the presence of alcohol or drugs. A note was also added about whether or not the victim had received cardiopulmonary resuscitatative maneuvers.

Results: *Incidence of petechiae in relation to cardiopulmonary resuscitation maneuvers:* Of the 206 hanging victims, thirty-six underwent attempts at cardiopulmonary resuscitation (CPR). No significant difference existed between the two groups ($\chi2$ =.34, df = 1, N=206, p=.56).

Incidence of petechiae in relation to the type of hanging: Of the 170 victims without reanimation manoeuvres, 128 died of an incomplete hanging and 42 of complete suspension. The incidence of petechiae in incomplete hanging (50%) was significantly higher than in complete hanging (29%) ($\chi2$ =5.87, df = 1, N=170, p=.02). The age and sex distribution was similar between both groups.

Incidence of petechiae in relation to the type of ligature: The type of ligature was known in all 170 cases of hanging victims without reanimation manoeuvres: 72 ropes, 28 electrical cords, 27 pieces of clothing, 30 bed sheets, and 13 shoe strings. These types of ligatures were regrouped into two broad categories: narrow and wide. The incidence of petechiae was similar ($\chi2$ =.66, df = 1, N=170, p=.42) for wide and narrow ligatures (47% and 40% respectively).

Incidence of petechiae in relation to age: The incidence of petechiae decreased slightly with age, from 61% in teens to 40% in adults over forty years of age. However, the differences between the three age groups was not statistically significant ($\chi2$ =2.41, df = 2, N=170, p=.30), and neither was the statistical comparison of victims older to younger than 40-years-old ($\chi2$ =.66, df = 1, N=170, p=.42).

Incidence of petechiae in relation to the BMI: In the studied population, only two hangings occurred in underweight individuals. For the remaining 204 there was no statistically significant difference between the incidence of petechiae in normal weight individuals and overweight individuals ($\chi2$ =.13, df = 1, N=204, p=.71). The comparison between the three groups (normal weight, overweight and obese) was not statistically significant either ($\chi2$ =.82, df = 2, N=204, p=.67).

Incidence of petechiae in relation to height: The incidence of petechiae varied inversely with the height of the victims: 77% in victims of less than 1.60 m, 44% in victims between 1.60 and 1.79 m and 35% in victims of 1.80 m or more ($\chi2$ =5.36, df = 2, N=204, p=.07). This is not merely attributable to a difference in the proportion of complete vs. incomplete hangings in the different height groups. Among incomplete hanging victims, a similar inverse relationship with height was noted ($\chi2$ =4.64, df = 2, N=155, p=.10).

Asphyxia, Hanging, Petechiae

G76 Fractures of the Neck Structures in Suicidal Hangings: A Retrospective Study on Contributing Variables

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After attending this presentation, attendees will better understand the variables contributing to the development of neck structures fractures in hanging.

This presentation will impact the forensic science community by contributing to a better understanding of important factors to the development of fractures of the thyroid cartilage and hyoid bone in hangings.

Introduction: Fractures of the neck structures figure among the classic autopsy findings in suicidal hangings. Several factors may play a role in the development of fractures of the neck structures in hanging. It has been repetitively demonstrated that the incidence of fractures increases with age. The role of gender is less clear: some authors found

a male predominance of fractures, whereas other observed a female predominance or no significant difference between genders. Similarly, studies on the role of several other factors have shown opposite results for the type of hanging (incomplete or complete suspension), the type of ligature, the location of the knot, the highest suspension point and the suspension time. However, most of these studies evaluated these factors independently of the age of the victims. Considering that age is probably the most important factor in the development of neck structures fractures, all other contributing factors should be studied in relation to age. The goal of the study is to evaluate the role of contributing factors to the development of neck structures fractures, taking age categories into account.

Material and Methods: Overall, a total of 206 suicidal hangings were analyzed for the presence and localization of fracture of the neck structures. For each case, the following information was also compiled: gender and age, height and weight, type of hanging (complete or incomplete), type of ligature used (rope, wire, clothes, sheet or lace) and localization of the knot (anterior, right, left or posterior).

Results: *Incidence of fracture in relation to age and gender:* The incidence of neck structures fractures increased with age ($\chi2$=21.851; p=.000). Victims of less than forty years of age presented an incidence of fracture of 18% whereas this incidence increased significantly to 49% in victims of forty years or more. The average age of victims without fractures of the neck structures was 31.7 compared to 42.6 for victims presenting fractures (t=5.66; p<.001; D=.88). As for gender, the incidence rate of fracture is significantly higher in male victims (31.4%) compared to female ones (11.8%) ($\chi2$=5.408; p=.020).

Incidence of fracture in relation to the height, weight and BMI: The incidence of fractures varied significantly with the height (t=2.19; p=.031; D=.33), weight (t=4.38; p<.001; D=.89) and BMI (t=3.84; p<.001; D=.60) (Table 3). The average height of hanging victims with fractures of the neck structures was of 1.74 m compared to 1.71 m for victims without fractures. As for the average weight and BMI of victims with fractures, it was of 78.2 kg and 25.6 respectively, compared to 68.6 kg and 23.2 in victims without fractures.

Incidence of fracture in relation to the type of hanging and the type of ligature: The incidence of fractures did not vary significantly with the type of hanging ($\chi2$=.05; p=.828; Phi=.015) and the type of ligature ($\chi2$=3.12; p=.077; Phi=.077). However, when taking the age of the victims into account, a different picture was revealed: in individuals aged forty years or more, victims with complete suspension of the body presented with a significantly higher incidence of petechiae (63.2%) compared to victims with incomplete suspension (31.0%) ($\chi2$=6.79; p=.009; Phi=.318). This difference was not present in individuals of less than forty years of age ($\chi2$=.52; p=.471; Phi=.061). As for the type of ligature, no significant difference was found in individuals of less than forty years of age ($\chi2$=.11; p=.737; Phi=.028) as well as in older victims ($\chi2$=.01; p=.936; Phi=.010)

Incidence of fracture in relation to the localisation of the knot: The incidence of fractures did not vary significantly with the localisation of the knot ($\chi2$=4.11; p=.250; Phi=.141). The side lateralization of fracture in relation to the position of the knot will also be presented.

Conclusion: Apart from age, several other factors seem to play an important role in the development of fractures of the neck structures: height, weight and BMI. The type of hanging is also an important factor in victims of more than forty years of age.

Hanging, Thyroid Cartilage, Fracture

G77 Precision of Autopsy Body Length Measurements

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After attending this session, attendees will learn the precision of body length measurements at autopsy and its importance in medicolegal death investigation. In addition they will learn how this compares to height determination precision in antemortem clinical practice.

This presentation will impact the forensic science community by introducing quantitative measures of error in an important determination made at autopsy.

In many cases, the height of a decedent is important in the investigation of his of her death. For instance, prosecutors may wish to posit hypotheticals and ask if it is physically possible for a person of a given height to commit suicide with a particular weapon, such as a long gun. In these cases, autopsy body length measurements are sometimes used as ground truth for antemortem height. This study attempts to provide a bounds on the precision of autopsy body length measurements in one facility.

Methods/Data collection: For a period of approximately two and one-half months (83 days) as cases were sequentially brought into the morgue facility, all staff members on duty and available in the autopsy area were asked to independently measure the length of each body. Measurement was done with a standard metal tape measure (Metric/English, 8m/26'). This particular facility is an academic facility with permanent staff members, student workers, resident physicians in training, and attending physicians. In most cases, only one or two staff members were available, but for those cases in which three or more were available, the body length measures were recorded. Each observer was blinded to the measurement results of other observers. The measurement by the assistant assigned to the case was recorded as the nominal "correct" body length measurement for the autopsy report. The bodies were weighed on a calibrated scale, and body mass index (BMI) was calculated using the official length recorded in the autopsy report. Visual evaluation was done to estimate the degree of body deformation due to rigor or pugilistic pose in charred remains, and recorded on a subjective scale of one (straight) to five (full fetal or pugilistic pose) by the second author, blinded to the measurements.

Study Population: A total of 74 cases had three or more measurements. Of these, 73 were adult cases. A total of eight observers were involved, including two certified Pathology Assistants, two full-time staff members, two student workers and two resident physicians. Twenty-six cases had three measurements, 33 cases had four measurements, 12 cases had five measurements, two cases had six measurements, and one case had seven measurements.

Results: The average range of measurements was 1.86 inches (4.72 cm) with a standard deviation of 1.2 inches (2.99 cm). The range varied from 0 to 5.5 inches (0-13.97 cm, Figure 1). No individual observer displayed significant systematic error (Table 1). The average range did not vary significantly with the number of measurements(Chi-square p=0.54), body length (Pearson's r = 0.08), or body deformation (Spearman's r= 0.15, two-tailed p= 0.2). There was a moderate correlation with BMI (Pearson's r = 0.27, two-tailed p=0.019).

Discussion: Autopsy body length measurements are prone to numerous errors. There are issues of posture, with some bodies being straight and other being held in flexion by rigor, heat effect, or other constraints. Obese bodies may have an artificially increased body length if the tape is laid over the panniculus. Charred and fragmented bodies may not have all body parts. The position of the feet may cause the heel to rise or fall. Hair may cause observers to incorrectly estimate the exact

position of the top of the head. Different observers may measure with different care.

This study attempted to evaluate the precision of body length measurement within one facility. This was specifically not an attempt to estimate accuracy, not merely because the nominal antemortem height was generally not known, but also because antemortem height measurements are themselves variable. The concept of "ground truth" in body length measurements may be inappropriate.

Studies on antemortem height measurement show significant variation for measurements of a single individual. Antemortem height can vary over time. It can vary significantly with posture. Further, antemortem height measurements are themselves fraught with error. Studies of the measurement of height routinely show that observer variation provides enough error to make them uninterpretable for some purposes.

Precision, Error, Autopsy

G78 "Goodness Gracious Great Balls of Fire": Genital Thermal Injuries From Airbag Exhaust

William S. Smock, MD, University of Louisville Hospital, Department of Emergency Medicine, 530 South Jackson Street, Louisville, KY 40202*

After attending this presentation, attendees will understand the potential for thermal injuries from airbag exhaust.

This presentation will impact the forensic community by expanding the investigators knowledge of airbag induced injuries, in particular second and third degree burns.

Burns, thermal and chemical, from the hot gases and chemical by-products of deploying airbags account for approximately 7-8% of all airbag-induced injuries. Three mechanisms for thermal injuries have been described: (1) the direct skin exposure to hot gases expelled from the airbag vents; (2) the melting of fibers or burning of clothing from exposure to the hot gases; and, (3) direct contact with a hot airbag.

A 25-year-old restrained driver was transferred to an urban trauma center from a suburban emergency department for evaluation of thermal injuries to his penis, scrotum, thighs and arm. The patient reported that he was involved in a single-vehicle collision on his way work after a deer ran into his path. He stated he turned his steering wheel 180-degrees to the right when the front of his vehicle impacted the rear of a parked vehicle at approximately 20 mph. Moments later he noticed two areas of flames coming from his pants, one in the area of his upper left thigh and the other over his groin. The driver quickly removed his seat belt and attempted to smother the flames with his hands and arms. He exited the driver's door, dropped to the ground and rolled to smother the remaining flames. He stated he was not wearing any underwear.

Examination of the patient's skin revealed first and second degree thermal injuries to the following areas: left forearm, left thigh, left inguinal area, scrotum and penis. Blisters were noted on the glans, scrotum and medial aspect of the left thigh. Arm and pubic hair were also burned to the skin level in some areas. The patient's pants demonstrated two areas with melted and charred fibers over the groin and left anterior thigh.

The vehicle, a 2009 Dodge Charger was examined within hours of the event. The airbag vents are located at the 1 and 11 o'clock position when the steering wheel is in a straight ahead position and in the 5 and 7 o'clock position when the wheel is turned 180-degrees. Examination of the airbag vents revealed melted nylon airbag fibers around both vent openings and charred material, presumed to be fibers from the pants, around one vent.

Hot gas is generated within an airbag from an exothermic reaction that occurs when sensors within the vehicle are activated during a sudden deceleration. The gas, principally nitrogen that is a byproduct from the rapid burning of sodium azide, is exhausted from inside the airbag through vent holes in the airbag. The temperature of the exhaust gases has been measured to be between 200 and 500 °C.

The 180-degree rotation of the steering wheel at the time of impact resulted in the vents and the associated hot exhaust gases being discharged directly toward the driver's pants in the area of his groin and left thigh. The synthetic composition of the pants, 75% polyester and 25% rayon, melted and produced a flame based upon the patient's history and confirmed from inspection of the clothing. The melting point of Rayon is 120 to 170 °C and 225 °C for polyester.

The extremely hot gases associated with airbag deployment pose a risk of burns to vehicle occupants. Thermal injuries to the male genitals and inguinal area from the exhaust gases have not been reported in the medical literature. Consideration of modifying the direction of hot vented gases from the airbag by the automotive industry and airbag manufactures maybe warranted in light of the severity of injuries sustained in this patient.

Airbag, Thermal Injury, Airbag Exhaust

G79 Histologic Diagnosis of Amniotic Fluid Embolism: Providing Context Through Immunohistochemistry

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After attending this presentation, attendees will understand that a substantial amount of cytokeratin-positive cellular material is consistently present in the vasculature of lung sections obtained at autopsy from non-gravid women, complicating the utility of keratin immunohistochemistry in the evaluation of cases of suspected amniotic fluid embolism. This cytokeratin-positive material is likely an autopsy artifact, as corroborated by the presence of TTF-1-positive cells within vascular spaces in the same lung sections. The caliber of vessel in which cytokeratin-positive material is found may help to identify true circulating keratin.

This presentation will impact the forensic science community by using immunohistochemistry to characterize the intravascular cellular material in postmortem lung specimens from non-gravid women in order to provide the appropriate context in which to assess the same immunohistochemical stains when they are employed in the evaluation of suspected cases of amniotic fluid embolism.

Amniotic fluid embolism (AFE) is among the most common natural causes of maternal death in the United States, yet AFE remains an enigmatic condition that is difficult to diagnose, the identification or confirmation of which often rests on the autopsy pathologist. The microscopic examination of multiple lung sections is essential when evaluating for AFE, with the identification of squamous cells, keratin debris, mucus, and other presumably fetal cellular debris, usually in the lungs, widely considered diagnostic in the appropriate clinical setting. Identifying these cellular elements, in particular circulating squamous cells or keratin, can be challenging despite extensive tissue sampling and thorough microscopic examination.

The difficulty in finding circulating keratinocytes is compounded by other cellular debris that may mimic their appearance, such as sloughed endothelial cells and pneumocytes. Immunohistochemistry, in particular cytokeratin AE1/AE3, has been advocated as a means to identify circulating keratinocytes. However, cytokeratin immunostains are not specific for fetal keratinocytes, and the immunohistochemical

profile of intra-vascular cellular material in autopsy lung specimens from women who are not pregnant has not been formally described. To this end, three immunohistochemical stains–cytokeratin AE1/AE3, Thyroid Transcription Factor-1 (TTF-1) and CD34–were used to characterize the intravascular cellular debris in postmortem lung sections from non-gravid women in order to provide the appropriate context in which to interpret such stains in the evaluation of suspected cases of AFE.

Fourteen cases of women who died without penetrating injuries or identifiable peri-mortem needle punctures, who were not pregnant, and who were not decomposed at the time of autopsy were selected. Lung tissue was fixed in formalin and embedded in paraffin as part of the routine histologic sampling of each autopsy. Hematoxylin and eosin (H&E), TTF-1, cytokeratin AE1/AE3 and CD34 stains were performed on sections of each block of lung tissue. For purpose of comparison, H&E stains and the same three immunohistochemical stains were also performed on blocks of lung tissue from a known case of unequivocal amniotic fluid embolism and a case of a deceased neonate with abundant intra-alveolar amniotic fluid. The H&E sections were evaluated for the presence of intra-vascular material consistent with or resembling squamous cells or keratin debris. The immunostains were evaluated for the presence or absence of positive-staining intra-vascular cellular material.

All fourteen lung sections from non-gravid women contained elongate cellular material and debris by H&E staining, most of which appeared to be sloughed endothelial cells and only superficially resembled epidermal squamous cells and keratin when compared to the known AFE case and the neonatal lung. Rarely, fragments of bronchial epithelium were located in intra-vascular spaces. In both the known AFE and the neonatal lung sections, keratin characterized by distinct basophilic, "glassy" flakes of material, often in aggregates, was easily identifiable by H&E staining. No such material was identified in the lungs of the non-gravid women. All fourteen lung sections also contained intra-vascular keratin-positive cellular material, usually in great abundance. This material consisted of round cells and debris, some of which was reminiscent of keratin. However, the keratin-positive material in these lung sections was present only in larger caliber vascular spaces and not in capillaries and arterioles. By contrast, the keratin-positive material in the known AFE case was present in both large and small caliber vessels, including capillaries and arterioles. Eleven of fourteen cases had TTF-1 positive cellular material in intra-vascular spaces, although always a small amount and consisting only of round cells. All fourteen cases had abundant intra-vascular CD-34 positive material, consisting of elongate cells and debris.

Most intra-vascular cellular material that even superficially resembled circulating squamous cells and keratin in the lung sections from fourteen non-gravid women was sloughed endothelium as confirmed by CD34 immunostaining. The cytokeratin-positive intra-vascular cellular material in the lungs of the non-gravid women most likely represented respiratory elements trans-located into the vascular spaces as an autopsy artifact, an etiology corroborated by the presence of TTF-1-positive cells within vascular spaces. The consistent abundance of intra-vascular cytokeratin-positive cellular material emphasizes the need for caution interpreting cytokeratin stains when evaluating autopsy lung sections for amniotic fluid emboli. The caliber of vessel which contains cytokeratin-positive material may help to differentiate true circulating keratin from an autopsy artifact, as only the known AFE case had keratin in capillaries and arterioles.

Amniotic Fluid, Immunohistochemistry, Maternal Mortality

G80 Utility of Large Bowel Examination in Medicolegal Death Investigation

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After attending this presentation, attendees will understand the contribution to medicolegal death investigation of examination of the lumen and mucosal surface of large bowels.

This presentation will impact the forensic science community by showing what additional information can be contributed to medicolegal autopsies by examination of the large bowel.

The mucosal surface of the large intestine is not always directly examined in cases where findings in the bowels are not suspected to be a cause or contributing cause of death. Some pathologists opt to examine the serosal surfaces and palpate the colon while others routinely open all colons during the course of the autopsy. Numerous disease processes such as ischemia, ulceration, colitis or diverticulitis, which may have contributed to death, may be overlooked if the colon is not thoroughly examined. Additionally, the autopsy provides an opportunity for surveillance for colon carcinoma or precancerous lesions. Routine thorough examination of the colon can potentially provide valuable information to the family members of the decedent if a hereditary natural disease is found, and can also provide general epidemiological data on the prevalence of early precancerous lesions in the population younger than the age currently recommended for screening by colonoscopy. To study the utility of opening colons in medicolegal autopsies, we present a series of over 200 colons examined from sets of sequential autopsies performed at our institution. Colons were opened, rinsed of their contents, and examined along their entire length internally and externally. Correlation of findings with decedent's age, sex, and cause and manner of death are presented. The most common pathological finding is diverticulosis, and after examination of over 100 colons in this ongoing study, no carcinomas have been identified.

Colon, Examination, Large Bowel

G81 Detection of KCNQ1 Genetic Variations by High Resolution Melting Analysis for the Diagnosis of Channelopathies in Postmortem Investigations

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After attending this presentation, attendees will be informed of the great interest of the high resolution melting method used for genetic variations screening in cardiac ion channel genes in postmortem investigations.

This presentation will impact the forensic science community by demonstrating the application of a recently developed molecular technique, high resolution melting (HRM), for the detection of genetic variant on genes implicated in channelopathies in postmortem investigations.

In developed countries, sudden cardiac death (SCD) is one of the most common causes of death. One of the largest epidemiological studies of unexpected deaths in young people showed that more than half of the deaths were of cardiac origin and in 29% no recognizable cause was identified at postmortem (Tester et al., 2007).[1]

Potentially lethal ion channel disorders (channelopathies) such as long QT syndromes, catecholaminergic polymorphic ventricular

tachycardia (CPTV) and the Brugada Syndrome may be responsible for a portion of such cases of sudden death in young persons.

Postmortem genetic testing for sequence variations in cardiac ion channel genes has become an important tool for elucidating the cause of sudden cardiac death (Ackerman et al, 2001; Kauferstein et al., 2009).[2] Formalin-fixed and paraffin-embedded tissue (FF-PET) as well as frozen tissue could be used as source of DNA in postmortem investigations. If frozen tissue is undoubtedly the greatest source of intact DNA, in some cases FF-PET is the unique source of genetic material.

In this context, the purpose of our study was first to validate a successful DNA extraction and purification method corresponding to the association of phenol-chloroform extraction and silica-based purification protocols. This protocol was previously reported in ancient DNA studies on archaeological bones but had not been used for DNA extraction from FF-PET. The second step consisted of genetic investigations on frozen and FF-PE tissues in each case of sudden death involving adult younger than thirty-five years with no significant morphological anomalies particularly with no cardiac structural disease and with negatives toxicological investigations. The samples studied were collected from autopsy cases performed at the Institute of legal Medicine from Strasbourg (France). The autopsy practice and modalities of sampling were realized according to the recommendations of the "European Cardiovascular pathology Association" (Basso et al. 2008).[3] The KCNQ1 gene was chosen in a first approach.

Since, according to the literature, mutations on this gene are randomly distributed, genetic screening was performed for each studied case, with the HRM method on the LightCycler 480 (Roche). The HRM is a technique that can detect sequence changes in amplicon through monitoring of the fluorescence of a double DNA binding dye which dissociates from DNA as it denatures with increasing temperature. If sequence changes are present within the amplicon, they cause a difference in the melting profile compared with wild-type. The principle of this methodology will be more developed in the presentation.

The comparison of results obtained with frozen and FF-PE samples showed that the two types of samples have a great interest in the genetic investigations. The advantages and limits of each type of samples will be discussed in details. From this study, it appeared that the HRM is a rapid, cost-effective and specific method allowing identification of KCNQ1 genetic variations and avoids systematic sequencing of the entire coding region of gene of interest in postmortem investigation of sudden cardiac death.

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High Resolution Melting, KCNQ1, Formalin-Fixed and Paraffin-Embedded Tissue

G82 Cardioinhibitory Reflex Cardiac Arrest – Myth or Reality?: A Systematic Review From Cases

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After attending this presentation, attendees will be presented a systematic review of literature concerning reported cases of death by cardioinhibitory reflex cardiac arrest due to short neck trauma and a proposal on how to diagnose it.

This presentation will impact the forensic science community by presenting constructive evidence based guidelines to diagnose death caused by death from a cardioinhibitory reflex due to short neck trauma will be proposed.

Background: Forensic physicians often evoke baroreflex cardiac arrest following short neck trauma as a cause of death. No clear evidence is available to support this hypothesis.

Objective: Construct evidence based guidelines to diagnose death caused by death from a cardioinhibitory reflex due to a short neck trauma.

Methods: A systematic review of the literature extracting case studies or reports from cases using [Medline, ISI Web of Knowledge, and Embase.] Two independent reviewers selected and extracted data. From the available data, the four authors then discussed the most probable cause of death for each case. A narrative approach was finally used to define conditions and procedures to be followed to evoke cardioinhibitory death.

Results: From the forty two cases (thirteen are anecdotes) which mention cardioinhibitory reflex as a possible cause of death, twenty two are most likely due to other causes (mechanical asphyxia, excited delirium and drug abuse). The twenty remaining cases were mainly men (15/20) and were from all ages (5 yrs to 74 yrs). From the fifteen who were autopsied, ten had local lesions at carotid bifurcation, seven had reported heart disease, and six were under the influence of alcohol.

Conclusion: Death should only be attributed to cardioinhibitory reflex when sequence of events are known, duration of trauma is certain, marcroscopic and microscopic findings reveals important subsequent trauma lesions of the carotid bifurcation, and all other possible causes of death are excluded, including excited delirium, and cerebral hypoxia due to substance abuse. Such cases are apparently extremely rare.

Neck Trauma, Baroreflex, Death

G83 Differentiation of Bullet Type Based on Analysis of Gunshot Residue Using Inductively Coupled Plasma Mass Spectrometry

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The goal of this presentation is to demonstrate a chemical means to differentiate gunshot residue (GSR) deposited by two different bullet types throughout decomposition. Porcine tissue samples shot with full-jacketed and non-jacketed bullets and analyzed using inductively coupled plasma mass spectrometry (ICP-MS) displayed differences in chemical composition of the resulting GSR, allowing differentiation between the two bullet types. Decomposing porcine tissue samples were also analyzed to identify the most persistent elements to be used for differentiation between the two bullet types at all stages of decomposition.

These research findings will impact the forensic science community by increasing the confidence of gunshot wound identification, aiding pathologists and medical examiners in cause of death determination even in corpses presented in an advanced state of decomposition. Identifying wounds as gunshot wounds also aids law enforcement agencies in their search for the perpetrator, and knowing the bullet type may provide a link between a suspect and a crime.

In decomposing corpses, the presence of GSR can be difficult to visualize due to the decomposition process and larval activity, making

chemical means of GSR identification necessary. Solution ICP-MS has been used for the determination of antimony (Sb), barium (Ba), and lead (Pb), elements characteristic of GSR, from cotton swabs spiked with these elements, from shooters' hands, and from shot cotton tissue. Preliminary studies conducted in our laboratory have demonstrated the utility of ICP-MS for the determination of Sb, Ba, and Pb in decomposing GSR-containing porcine tissue samples through all stages of decomposition. However, in order to increase confidence in GSR determination in advanced stages of decomposition, the identification of additional elements, characteristic of the bullet or the interior of the barrel, is necessary. The goals of this research were to differentiate two different bullet types based on element profiles and to investigate the persistence of GSR in decomposing tissue as a function of bullet type.

In order to study the elemental composition of GSR deposited by different bullet types, three pigs were euthanized and control (unshot) samples of skin removed from one. The other two pigs were then shot using a .357 Smith & Wesson Magnum revolver. One pig was shot with ammunition cartridges containing full-jacketed bullets, and the other with non-jacketed bullets. The fresh wounds were excised, and sections of each wound were microwave digested for ICP-MS analysis. Sections of each wound type were also removed for histology analysis, and results confirmed the presence of GSR in both wound types. The digests were initially analyzed in full mass scan mode to identify all elements present at significant levels in the GSR-containing tissue but not present in the control tissue. A selected ion monitoring (SIM) method was then developed to detect only the suite of characteristic elements from both bullet types with greater sensitivity. The significance of variation in element concentrations among full-jacketed bullet wounds, among non-jacketed bullet wounds, and between full-jacketed and non-jacketed bullet wounds were assessed statistically. Differences in element concentrations between the wound tissue (both full-jacketed and non-jacketed) and the control tissue were then assessed statistically. In this way, the two bullet types were differentiated based on differences not only terms of elements present but also based on differences in concentration of common elements.

For this research to have any impact on the forensic science community, the effect of decomposition on GSR persistence was investigated. Three euthanized pigs were obtained and wounded. One was shot with full-jacketed bullets, one was shot with non-jacketed bullets, and one was stabbed to generate open wounds to serve as control (unshot) tissue. Wounds and control tissue samples were collected throughout the decomposition process, and then digested for ICP-MS analysis. Histology was also used to detect GSR throughout decomposition, and results were compared with those from ICP-MS analysis. The tissue digests were analyzed using the SIM method developed previously for ICP-MS analysis of the characteristic suite of elements that differentiate the two bullet types. The most persistent elements throughout decomposition were identified, as they are the most useful for discrimination of bullet type.

Gunshot Residue, ICP-MS, Firearms

G84 Vehicular Emissions Systems and Their Effects on Suicides and Attempted Suicides by Carbon Monoxide

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After attending this presentation, attendees will understand the workings of vehicular emissions systems and their ability (and inability) to generate CO (Carbon Monoxide). As cars run cleaner, CO suicides in a closed space (garage) are more difficult to accomplish. The cleaner car allows for more time for a "victim" to alter his intentions. The attendee will understand these timing issues, as well as the possibility that death is brought on not by CO intoxication, but by hyperthermia.

This presentation will impact the forensic science community by showing how to properly investigate deaths associated with vehicles left running in confined spaces.

Concerns about automotive emissions, greenhouse gasses, and fuel economy have led car manufacturers to decrease CO emissions from vehicles. Over the last thirty years, CO emissions levels from tailpipes have dropped substantially. Corresponding with this drop in CO, the presenter has seen a substantial drop in his caseload of deaths brought about by acute CO intoxication (usually suicide) brought about by running cars in enclosed garages.

The modern automotive engine (gasoline) makes use of an oxygen sensor to determine how close the engine is running at ideal stoichiometry: - 14.75 parts air to one part fuel. The engine has one (or several) O2 sensors placed in the exhaust stream to measure free oxygen. In an open air atmosphere, the oxygen sensor and ECU (Engine Control Unit) work together to insure that CO emissions are kept low.

For a person attempting suicide, the effects of the emissions system can have three outcomes:

1. Non event – no fatal levels reached
2. Suicide – fatal COHb levels reached
3. Suicide – minor to moderate COHb levels reached, but death caused by hyperthermia

The non-event is perhaps the hardest for an medical examiner system to analyze, as there is neither a death or case report.

Empirically, testing of vehicles has shown that in some instances, a garage has enough "leakage" and infiltration (air changes per hour) that there is sufficient oxygen to keep the engine running clean and for CO levels to stay at a minimum. This "non-event" can manifest itself in one of three ways:

1. The emissions system 'slowed' down CO production so much that the would-be suicide candidate changed his/her mind.
2. A fatal COHb level was never achieved because the vehicle ran out of fuel, thwarting the suicide.
3. The vehicle had enough free O2 (leaky building) that under no circumstances would a fatal COHb level ever be achieved.

The fatal CO event is the easiest case to analyze. Grossly, the cherry red lividity is the telltale sign, along with supporting COHb levels at autopsy. But the fatal level raises the question: with modern cars running so clean, how does one ever achieve fatal results. Testing carried out shows the function of the O2 sensor in the exhaust stream. This sensor is a ratiometric device, comparing free O2 in the exhaust stream to free O2 in the atmosphere. The vehicle's ECU will keep CO production to remarkably low levels for some time, but there reaches a point (in a well sealed garage) that the design assumptions (IE, 20% free O2 in the atmosphere) are invalid and the vehicle become very dirty. Note that this fatal outcome is just an extension of one, above – CO production was slowed down, but the candidate's ardor was not inhibited; the death just took longer to achieve. Using empirical data, the presenter has been able to model the CO production/accumulation as a first order differential equation.

The fatal outcome with low CO is at first the most complex to analyze. The body presents with CO levels more associated with high levels of cigarette smoke: 5 to 10%, possibly higher, but never at levels associated with death. Testing done at our lab shows that temperatures can be reached in garages (closed spaces) that are untenable. The indicator that first led us to this area of inquiry was the existence of spray cans (paint, insecticides) that had bulged at their seams. It was known at what internal pressures the cans would expand, as well as the nature of the propellant gas inside. This data shows the increase in temperature over time within various garages, and the factors that work for and against this type of hyperthermic event are presented. In these cases the manner of death is still suicide, but causation has changed from acute CO intoxication to hyperthermia.

Suicide, Carbon Monoxide, Hyperthermia

G85 Pseudostrangulation

Thomas W. Young, MD, Heartland Forensic Pathology, LLC, 12717 Oakmont Drive, Kansas City, MO 64145*

After attending this presentation, attendees will recognize autopsy findings that can be misinterpreted as due to homicidal strangulation. Attendees will also learn how to avoid making false positive determinations of strangulation in cases where the body is found dead at the scene.

This presentation will impact the forensic science community by instructing forensic pathologists how to avoid concluding falsely in any case that strangulation is the cause of death. Successful application of these concepts by forensic pathologists will prevent injustices that come from false accusations made by police officers and prosecutors – accusations that may lead to false convictions and imprisonments.

The investigation of the death of a person found unexpectedly dead is critically important. Prosecuting attorneys and police officers rely on the knowledge and expertise of the forensic pathologist to determine the cause and manner of such deaths. Unfortunately, the unwary forensic pathologist may misinterpret findings in the head and neck areas of the dead person at autopsy and falsely conclude that strangulation is the cause of death and that the manner of death is homicide. Incorrect determinations such as these all too often lead to the arrests of innocent people on false charges, to confusion in the courtroom with the presentation of misinterpreted evidence, and to false imprisonments. Even in cases truly involving foul play, a falsely positive determination of strangulation may lead to a misunderstanding of the chain of events that led to the violent death.

The classic and typical autopsy findings for manual or ligature strangulation are well documented in the literature and in forensic pathology textbooks, but simply relying on autopsy findings alone to reach a proper conclusion will lead to mistakes. Without knowledge of the witness evidence and other physical evidence in a case, a pathologist at the autopsy table may misinterpret certain head and neck findings, falsely concluding that they indicate homicidal strangulation. On the other hand, knowledge of the witness evidence and other physical evidence and the proper interpretation of this evidence will prevent the pathologist from being misled at the autopsy table.

Five general sources of confusion at autopsy will be presented. These include: (1) confusion of ligature marks with band-like discolorations from decomposition; (2) confusion of asphyxial findings with artifacts from postmortem hypostasis; (3) confusion of strap muscle hemorrhages caused by blunt or sharp force with strangulation; (4) misinterpretation of blood extravasations posteriorly placed within the neck; and, (5) misinterpretation of laryngeal petechiae.

The forensic pathologist may make an erroneous determination of strangulation when he or she attempts to surmise the past events that led to the physical findings disclosed by autopsy without regard to the statements of the witness or witnesses, particularly if the witness is the defendant. In this presentation, why that approach leads to mistakes will be demonstrated. The Also demonstrated is how to correctly test witness accounts with the physical evidence in order to determine if the witness accounts are truthful.

The cases and illustrations used in this presentation come from the author's forensic pathology consultation practice. The forensic pathologists who originally performed the autopsies concluded in each case that strangulation caused each of the findings.

Strangulation, Homicide, False Positive

G86 Investigation and Autopsy Procedures in Cases Involving Conducted Energy Devices (CEDs) in the State of Maryland

Mary G. Ripple, MD, David R. Fowler, MD, and Ling Li, MD, Office of the Chief Medical Examiner, State of Maryland, 111 Penn Street, Baltimore, MD 21201*

After attending this presentation, attendees will understand the investigation and autopsy procedures necessary in cases involving the use of CED's and the demographics of their use.

This presentation will impact the forensic community by reporting investigative and autopsy findings in a group of conducted energy device cases.

Controversy exists over the possible contribution of CED use to sudden death. CEDs are primarily used as a restraint method by law enforcement personnel on aggressive individuals. The typical scene involves an acute onset of agitated and delusional behavior in a person with mental health issues and/or who is on drugs. An attempt is made to control the uncooperative individual leading to a struggle at which some point the person becomes unresponsive. Experience at the OCME has emphasized the necessity of complete investigation and autopsy in these complex cases.

From 2004 until January 2009, the OCME autopsied 12 cases involving CEDs. The most commonly used CED in Maryland is the X26 TASER®. The TASER® was used in drive stun mode only in 2/12 (16%) cases, probe deployment only in 6/12 (50%) cases, and combination of both in 4/12 (33%) cases. In 75% of the cases, the TASER® was used more than once. The average age of the individuals was 35 years old, 92% were male, 67% were black, and 33% were white. Manner of death was ruled undetermined in 58% of the cases, homicide in 25% of the cases, and accident and suicide in 8% each of the cases. In two of the homicides, gunshot wounds were the cause of death when the X26 TASER® was ineffective. Excluding these two homicides, the accident and the suicide, the TASER® probes were deployed in seven of the eight remaining cases. The time elapsed between deployment of the TASER® and the time the individual went unresponsive was several minutes in four cases and in three cases it could not be determined with certainty. In the eight remaining cases, the cause of death was generally considered to be a combination of police restraint methods, the agitated/excited delirium state of the individual, the presence of drugs or alcohol, and heart disease when these were identified. In no case was the TASER® considered the sole cause of death. Of these cases, 75% were considered to be in an agitated/excited delirium (ED) state and 87.5% had ethanol or illicit drugs including cocaine, heroin, or phencyclidine in their systems. Of the ED cases, all were obese and most had heart disease. The non-ED cases included two thin individuals who struggled with police and both cases had either ethanol or illicit drugs in their system. The temperature was not recorded in the majority of cases. The initial cardiac rhythms recorded were also evaluated.

In June of 2008, in their interim report studying deaths following electromuscular disruption, the National Institute of Justice (NIJ) published considerations in the performance of investigation and autopsy in CED cases. The OCME has adopted these considerations and added to them. Investigation should develop a timeline of events with emphasis on when the subject went unresponsive. A complete review of past medical records and incident EMS, hospital, and police records, TASER® dataport download, types of restraint used, witness reports, and any videos or photos must be performed. Autopsy procedures should include: documentation of all injuries with both black and white and color photographs, measurement of the distance between the injuries and soft tissue injury, separate anterior and posterior neck dissections, cut downs of the body, microscopic sections of organs and injury, cardiovascular and neuropathology consultations, and a full toxicology screen.

Recommendations in this report are based on the experience at the OCME and follow those put forth by the NIJ in their interim report. These complex cases should each be evaluated on an individual basis, as the correlation of the investigation and autopsy findings is critical in order for the medical examiner to come to a determination of the cause and manner of death.

Conducted Energy Device, Investigation, Autopsy

G87 Postmortem CT-Angiography Using Angiofil®

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After attending this presentation, attendees will know how to perform a postmortem CT-Angiography using Angiofil®, will understand the differences between this technique and other techniques of postmortem angiography, and will understand the advantages and limitations of postmortem angiography.

This presentation will impact the forensic science community by presenting a new technique of postmortem angiography which has the potential to be largely used for postmortem radiological examinations. The perfusion machine and other technical materials developed for the method as well as a standardized protocol makes it easy applicable and therefore interesting for postmortem examiners.

Postmortem CT-angiography using Angiofil® is a minimally-invasive technique that allows to map the vascular system of a decedent in detail and therefore to perform vascular diagnosis similar to clinical CT-angiography.

Synopsis of Contents: *Preparation of the corpse:* To perform the postmortem CT-angiography, the body is placed on the CT-table. There, a small incision is made in the inguinal region to prepare the femoral vessels. Cannulas are inserted into the vascular lumina, and connected with the tubes of a special perfusion machine.

Perfusion Machine: In the University Center of Legal Medicine Lausanne and Geneva, a special perfusion machine has been developed that is easy to handle. Its special software gives further information about the pressure measured in different regions of the vascular system and these parameters provide some information about the conditions of the investigated vessels.

Contrast Agent: Angiofil® is a mixture of paraffin oil and iodized linseed oil. Thanks to the hydrophobic abilities of this oily contrast agent, no extravasation through the intact vascular wall is observed. Therefore, infiltratation of the surrounding tissue is avoided. This is important to increase the quality of the procedure and to avoid deformation of the investigated body as it happens when using aqueous contrast agents, especially when important quantities of aquaeus contrast agent are injected.

Technique of the Angiography: To start the angiographic examination, the cannulas are inserted into the femoral vessels and connected with the tubes of the perfusion machine. The examination consists of different phases. As a first step, the arterial phase of angiography is performed. The perfusion machine is started and Angiofil® is introduced into the vascular system, entering by the femoral artery. To demonstrate the venous part, the contrast agent is injected by the femoral cannula and a further CT-acquisition is started.

As a third step, one or more further CT-acquisitions can be performed after establishing a "postmortem circulation". Hereby the contrast agent is flowing from the arterial into the venous system and quits the vascular system by the femoral vein.

Conventional autopsy: In the University Center of Legal Medicine Lausanne and Geneva the radiological findings are compared with those obtained by conventional autopsy. This procedure is important to verify the angiographic diagnoses and to define advantages and limitations of the angiographic examination.

Results: By performing a dynamic postmortem CT-angiography, the vascular system can be visualized in detail. Vascular pathologies such as ruptures of vessels, aortic dissection and cardiac tamponade can be diagnosed. By comparing the different phases of angiography, information about the rapidity of extravasation and therefore about the quantity of blood loss can be gained.

However, problems persist in the diagnosis of thrombosis and embolism, since postmortem clots have the same appearance on CT-images.

Conclusion: Postmortem dynamic CT-angiography is of great interest in forensic pathology, because the detailed mapping of the entire vascular system is almost impossible with conventional autopsy tools. The presented method and the use of the recently developed perfusion machine allow postmortem angiography in an easy and standardized way. The new method using Angiofil® as a contrast agent allows to investigate blood vessels under pressure similar to real life conditions without creating artifacts due to extravasations and therefore without deforming the corpse. By performing different phases of angiography, information about the relation between the quantity of blood loss and time can be gained.

Postmortem Angiography, Forensic Radiology, Postmortem CT

G88 Radiological Interpretation of Postmortem CT-Angiography

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After attending this presentation, attendees will have the knowledge to distinguish normal from abnormal findings on postmortem CT-angiography, to recognize the traumatic and non-traumatic pathologies, to understand the differences between clinical and postmortem CT-angiography, and to know the limitation of diagnosis in postmortem CT-angiography.

This presentation will impact the forensic science community by demonstrating the key findings of traumatic and non-traumatic vascular lesions allowing for an accurate diagnosis of the cause of death.

Postmortem CT-angiography is a minimally invasive technique which enables the diagnosis of traumatic and non-traumatic vascular lesions with confidence. However, interpretation of postmortem CT-

angiography varies from clinical CT-angiography and demands special knowledge from the interpreting radiologist.

This presentation will introduce the attendees to the general principles of postmortem CT-angiographic interpretation describing the normal and pathological presentation of the venous and arterial vascular circulation. After a short introduction on the technique of opacification we will first present the normal appearance of the organs during arterial opacification, followed by the normal appearance during the venous opacification and in the end during systemic continuous circulation with the help of a perfusion pump. The description of the pathologic findings will distinguish the traumatic and non-traumatic pathologies with special care, describing the false positive findings and how to distinguish them. The most common pathologies responsible for death and visible in CT-angiography are traumatic rupture of vessels, mostly aortic ruptures followed by aortic dissection and aneurismal ruptures. Traumatic organ lacerations are also a common finding, splenic lacerations being the most frequent, followed by renal and hepatic lacerations. These organic lacerations are by themselves most of the time not the cause of death, but accompany more vital lesions, such as aortic, cerebral and cardiopulmonary ones. On the venous side the most common pathology responsible for death are also ruptures due to trauma, followed by massive pulmonary embolism. This pathology is picturing the limitation of postmortem angiography because it is the origin of most of the diagnostic errors. The reason therefore is the presence of postmortem blood clots which are often situated in the pulmonary vessels and the heart chambers. While small exemplars of these clots can be rinsed out by an ongoing perfusion, large ones can not be removed and imitates the radiological image of thrombosis or embolism. The importance of imaging during active circulation will be discussed to distinguish embolism from postmortem thrombi, in the arterial as well venous circulation.

Conclusion: The advent of postmortem CT-angiography allows visualization of traumatic and non traumatic lesions of the arteries and veins. Clear advantages of postmortem angiography over conventional autopsy are observed in detecting sources of bleeding. By the use of our method, which includes acquisition of data during a dynamic circulation, it is even possible to quantify blood loss. This is important to confirm if a lesion may have been the cause of death and if the injury may have led to an immediate or a delayed death. The main limitation of the technique is the inherent difficulty in differentiating pre and postmortem thrombi and emboli. Another difficulty, due to the same mechanism, is to distinguish aortic dissection from sedimented postmortem blood clots, mainly in the descending thoracic aorta. Because of all these challenges in vascular diagnosis, the help of an experienced angiographer has proven useful to us.

Postmortem Angiography, Postmortem CT, Forensic Radiology

G89 Perfusion Technique for Postmortem CT-Angiography

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After attending this presentation, attendees will understand the interpretation of different pressure variations and gradients, understand the concept of a specialized perfusion machine with integrated controller and software for most-mortem CT-angiography, and know the concept of an ideal ante- or retrograde perfusion.

This presentation will impact the forensic science community by explaining the background and the development of a new technique and new equipment for postmortem CT-angiography, which is easily applicable and therefore interesting for everyone performing postmortem analysis.

By the use of special perfusion techniques and equipment, important information about the status of the vascular system can be gained, even without performing radiological imaging. The combination of such adequate perfusion and imaging by CT-angiography provides images and physical data that allow diagnoses of the vascular system.

In the University Center of Legal Medicine, Geneva – Lausanne, a research group has been created with the goal to develop a standardized protocol and special equipment for postmortem CT-angiography. Therefore, a specialized perfusion machine that should ease the use of the technique and that includes software giving information about the vascular status of the investigated body should be developed. With the knowledge of two European-board certified perfusionists, pressure values obtained during the perfusion for postmortem angiography are used for this development.

In general, the postmortem perfusion can be obtained by a femoro-femoral access. Therefore, the femoral artery and vein of one side are cannulated. Once the cannulas are connected to the tubes of the perfusion machine, the perfusion is started using the oily contrast agent Angiofil®. The arterial and the venous tubes are connected to the pressure monitor to register the pressure variations and pressure gradients.

In the first phase of the perfusion, the arterial system is filled antegrade under pressure control. In general, 1200 ml of contrast agent are introduced during ninety seconds. Increasing pressure values measured in the venous tube are signaling the integrity of the arterial system. Once the defined quantity of contrast agent is injected, the arterial and venous tubes are clamped to keep the pressure inside of the vascular system steady and the perfusion machine is stopped. Under those "static conditions" (stopped perfusion), a first acquisition of CT-images can be performed to visualize the arterial phase of angiography.

The same technique is repeated with the venous system, with the only difference that the veins are perfused retrograde. This second phase of the perfusion is made to visualize the venous phase of angiography.

During the first to phases of postmortem angiography, the most important perfusion value is the "delta p" which is indicating the pressure gradient form the arterial to the venous system. A low delta p, during an arterial perfusion is a sign for an intact arterial system, during a venous perfusion it indicates the integrity of the venous system. If this value increases, a leak of the arterial (during the arterial perfusion) or the venous system (during the venous perfusion) has to be suspected.

As a third phase in postmortem angiography a dynamical perfusion can be performed, that means that further contrast agent is injected and CT-data are obtained during the ongoing perfusion. Depending on the case, one or more acquisitions of images can be made. During the perfusion, pressure gradients are measured under a volume-controlled pump speed. This dynamic phase is especially useful if leaks of the vascular system are identified. In those cases, it can allow to quantify blood loss in cases of hemorrhages.

Conclusion: By performing a standardized perfusion technique with adequate perfusion equipment, changes of perfusion values can indicate leaks and show weather they are situated in the arterial or in the venous part. By using a contrast agent as perfusate, the perfusion can be used to perform postmortem angiography. The developed perfusion technique and special perfusion pump with integrated controller and software allows the performance of postmortem CT-angiography and the interpretation of the perfusion values, so that the technique becomes applicable in the routine of postmortem investigation.

Postmortem Angiography, Forensic Radiology, Postmortem Perfusion

G90 The Role of Microscopic Postmortem Study in Explaining Traffic-Crash Related Neck Injury: A Case Review

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After attending this presentation, attendees can expect to understand the state of the literature regarding the microscopic investigation of histopathology of traffic crash-related neck injuries.

This presentation will impact the forensic science community by discussing how the histopathologic study of traffic crash related cervical spine injuries indicate that imaging occult injury must be considered as a possible source of symptoms in patients with apparently negative plain x-ray, CT or MRI studies. The relatively high false negative rate of conventional imaging for injury to the cervical spine following traffic crash must be taken into account when a forensic medical review of such injury is conducted.

Introduction: Approximately fifty percent of occupants involved in a road traffic crash sustain a painful neck injury, ranging in severity from short lived mild discomfort to long lasting pain syndromes. Approximately ten percent of all injured patients are impaired to the point that they are disabled from their work duties. In the majority of patients objectively identifiable injury using medical imaging modalities such as x-ray, CT, and MRI are the exception rather than the norm. Since the late 1980s it has been suggested by some authors that there are crash-related spine injuries that cannot be visualized with conventional medical imaging because they are too small. Subsequent postmortem studies describing microscopic investigations of cervical spine tissue in decedents with a history of neck injury have demonstrated that such imaging occult injuries do exist. The purpose of the current review is to present a review of the literature describing histopathologic studies of the post-traumatic cervical spine.

Methods: A MEDLINE search was conducted using the Mesh terms/keywords; "Accident, Traffic", "Spine", "Autopsy", "Whiplash Injuries", and keywords; forensic imaging, imaging occult lesions, postmortem, and cervical spine. Articles describing examination of the cervical spine after fatal road traffic trauma using microscopic procedures of stained histological sections were included and retrieved articles were further crosschecked for relevant references. The included references were reviewed with regard to microscopical procedures used, microscopical findings, and diagnostic imaging procedures, to be described in a table format.

Table 1

* References arise from one large-scaled study

Results: Nine references were retrieved for review (Table 1). The number of subjects suffering from road traffic crash related deaths was not defined clearly in all studies. The microscopic procedures included the evaluation of 2 to 2.5-mm thick slices using a dissecting microscope, and stereomicroscopy of 3-mm thick slices to microscopy of 3 to 100-µm thick stained sections. The microscopic findings were defined in all studies and included injuries to the osseous cervical spine (vertebral body, lamina and articular facets), surrounding soft tissues (muscles, ligaments, joint capsules, and synovial folds), articular cartilage, bleeding in the joints, dorsal root ganglion injury, ventral root injury, nerve root avulsion, and injury to the intervertebral disc. Diagnostic imaging procedures were performed in five studies, including one or more of the following procedures; conventional radiology, microfocus radiography, computed tomography (CT) and magnetic resonance imaging (MRI).

Discussion: The current review of publication describing an investigation of microscopic injuries to the cervical spine of occupants subjected road traffic crashes identified nine studies for review. Discrete non-fatal injuries to the cervical spine were described in all nine studies. Injuries to the facet joints (synovial folds, articular cartilage, joint capsule, and haemarthrosis) as well as the nerve roots were particularly common. The majority of injuries could not be identified using conventional plain x-rays nor could they be found using advanced diagnostic imaging procedures such as CT and MRI. Although the research described herein did not investigate whiplash injuries *per se*, the injuries identified in these postmortem studies were non-fatal in severity and potentially painful. The presence of similar injuries in survivors from road traffic crashes of different severities seems likely. Three studies were not included in the current review, as they did not utilize microscopical procedures but relied on macroscopic examination and evaluation of photographs.[10-12] Even though these studies were not included, they identified very similar findings of discrete injuries to cervical spine structures and supported the finding of these being imaging occult.

Conclusions: The present review demonstrates the important role that microscopic postmortem investigation can have in elucidating traumatic pathology that is not apparent with conventional medical imaging.

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Forensic Pathology, Microscopic Lesions, Imaging Occult

G91 Lethal Consequences Arising From the Rupture of an Undetected Large Ductus Arteriosus Aneurysm During a T-12 Kyphoplasty Procedure

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After attending this presentation, attendees will appreciate the complications encountered with a patent ductus arteriosus, the necessity for repair of the ductus, and a rare case of rupture of an undetected patent ductus arteriosus aneurysm.

This presentation will impact the forensic science community by addressing the importance of diligent diagnostic assessment of all patients. The decedent had undergone numerous prior imaging studies with failed recognition of a large ductus arteriosus aneurysm, and failure to detect such lesions can have disastrous consequences. Additionally, this case illustrates the importance of a thorough autopsy examination with toxicologic assessment to clarify the circumstances of in-hospital/intraoperative deaths, recognizing the potential civil litigative pitfalls should such an approach not be pursued.

The case of an 80-year-old white female who suffered hypertensive crisis and cardiovascular collapse during T-12 kyphoplasty is reported. The decedent had been admitted to the hospital for kyphoplasty to repair a T-12 compression fracture. She had a history of prior cerebrovascular accident, hypertension, hyperlipidemia, and osteoporosis. During the procedure, the decedent experienced a spike in blood pressure to approximately 200/100 mmHg, with sudden cardiovascular collapse. Resuscitative efforts were unsuccessful. Autopsy examination revealed rupture of a large ductus arteriosus aneurysm producing a large left hemothorax. The aorta and its main branches showed marked arteriosclerotic change with Monckeberg calcific sclerosis, and the heart was enlarged, with biventricular hypertrophy. Additionally, examination revealed arterionephrosclerosis and adrenal cortical hypertrophy. The cause of death was listed as massive left hemothorax due to rupture of a large ductus arteriosus aneurysm associated with marked aortic arteriosclerotic change, with calcific sclerosis during kyphoplasty of T-12, associated with intraoperative hypertensive crisis.

The ductus arteriosus connects the aorta to the pulmonary artery and functions in the fetus to bypass the unexpanded lungs. Ordinarily, this connection closes shortly after birth, but in some infants the ductus arteriosus remains patent. A patent ductus areteriosus creates a left-to-right shunt and can lead to complications like congestive heart failure, infective endocarditis, and aneurysm with subsequent rupture. However, not all individuals with a patent ductus arteriosus become symptomatically evident, and some people can live normal lives never knowing they have this congenital abnormality. In the rare case of a patent ductus arteriosus aneurysm, the ductus must be repaired to prevent rupture of the aneurysm. Rupture of a ductus arteriosus aneurysm is a devastating event and often leads to a swift death.

Detection of a large ductus arteriosus aneurysm can often be accomplished through the acquisition of a chest x-ray, though arteriography is the definitive technique if such an anomaly is suspected. While multiple imaging studies of her chest had been conducted in the past, the decedent's large ductus arteriosus aneurysm was nonetheless not identified. It is unclear what event prompted the sudden, lethal hypertensive event which led to aneurysm rupture, though an adverse event arising from administered anaesthetic agents must be considered as a potential etiology. The tragic consequences arising from this sad sequence of events is a sobering lesson that uncommon and unsuspected diagnoses are far too commonly lethal.

Ductus Arteriosus, Aneurysm, Rupture

G92 Exploring the Potential for Nocturnal Colonization of Fresh Cadavers by Carrion Flies in the Central United States

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After attending this presentation, attendees will understand the unlikelihood of nocturnal colonization of bodies by blow flies and how this affects estimates of the postmortem interval.

This presentation will impact the forensic science community by demonstrating that while nocturnal colonization of human bodies by carrion flies is conceivable, it remains highly improbable and nocturnal colonization of carrion by flies appears to be the exception rather than the rule.

Forensic (or medicocriminal) entomology, the use of arthropods in legal investigations, is most frequently employed to estimate the postmortem interval (PMI) of victims of violent crimes or suspicious deaths. The most commonly used method of PMI estimation employs temperature-dependent developmental rates of blow fly larvae (Diptera: Calliphoridae). Retrospective scene temperatures, those temperatures which the insects experienced during development, are used in combination with known developmental rates of the species involved to estimate the age of the insects.

Because forensically important flies are known to colonize cadavers very shortly after death (often within minutes), the age of their developing offspring found on a body often corresponds closely with the time of death. One exception to this standard has traditionally been death occurring at night, when flies are not presumed to be actively searching for host carrion, and colonization is often assumed to be delayed. Recent studies both confirm and refute this assumption. However, none of the previous studies have actually examined whole carrion that has been freshly killed after dark. Previous work has been limited to butchered meats, thawed carcasses, or aged meats, all of which do not adequately replicate the conditions often encountered during medicocriminal investigations of human death; death occurring during the hours of darkness.

Live pigs (*Sus scrofa*), ranging from 23-32 kg each, were euthanized at the study site via captive-penetrating bolt device to the brain. Euthanization took place after astronomical twilight had passed, ensuring that conditions were as dark as possible. Each night of the study, three pigs were placed at a site illuminated by a mercury vapor lamp and three pigs were placed at a separate site that was kept dark. Periodic observations of the dark site were made using 3rd generation night vision equipment to observe any insect activity. Exposure of the cadavers continued until either astronomical twilight began or ambient air temperatures went below 5˚C, whichever came first, with a minimum period of exposure of four hours. Following exposure of the cadavers, the body surface and orifices of each pig were closely examined under a bright light for the presence of fly eggs, maggots, or fly artifacts (spots caused by regurgitation or defecation).

After eighteen studies in both brightly lit and completely dark field settings with dense populations of necrophilous insects, no colonization of the cadavers was observed at night. It is our opinion that estimates of PMI based on insect development should continue to exclude nighttime as potential times for colonization. The data at hand from multiple studies indicates nocturnal colonization of human bodies by carrion flies is highly improbable and appears to be the exception rather than the rule. When applied to medicocriminal investigations, the data do not support nocturnal colonization as a plausible scenario.

Forensic Entomology, Postmortem Interval, Nocturnal Colonization

G93 Suicide by Extraordinarily Numerous Blade Wounds

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After attending this presentation, attendees will understand the importance of correlating terminal events, scene investigations, and autopsy findings in determining the manner of death in a multiple stab wound suicide.

This presentation will impact the forensic science community by outlining the findings of a case of uncommon method of suicide by multiple stab wounds.

In the absence of any circumstantial information, the autopsy finding of multiple stab wounds ordinarily creates the rebuttable presumption of homicide. Classification of the manner of death always requires integration of the terminal circumstances, scene investigation and autopsy findings. This case illustrates the importance of all three in assigning manner of death.

The decedent was a 42-year-old man with a history of depression, suicidal ideations and an involuntary admission to a behavioral health institution. On the day of his death, neighbors did not see or hear any suspicious activity. He was found dead by his girlfriend on the garage floor of his undisturbed single family home, when she returned from work. The body was lying at the edge of a very large stain of smeared blood on the floor. A large, blood-stained, non-serrated, kitchen knife was on the floor. The wall opposite the bay door had smeared hand marks. The floor below had drops of blood with a pattern of vertical impact. Several bloody footprints were on the floor, and matched the decedent's shoes. The body was in a flexed position, face down on the floor, leaning to the right; numerous stab wounds to the neck, chest and forearms were visible at the scene. The death was deemed of suspicious circumstances by the police.

The autopsy revealed more than fifty four incised and stab wounds. These included Twenty three stab wounds to the right side of the neck, three stab wounds on the anterior aspect of the neck, eight stab wounds on the left side of the neck, nineteen stab wounds on the anterior aspect of the thorax, and one stab wound to the abdomen. The wounds penetrated the pharynx, pericardium, heart, left lung, and the blood vessels of the neck. The left wrist had multiple horizontally oriented superficial cuts. The configuration of wounds, i.e., shape, depth, location, etc., in correlation with the scene findings and circumstances of death indicated that the manner of death was suicide, despite the unusually high number of the injuries, and impressively complex blood stain pattern at the scene.

Multiple stab wounds are possible but not common with suicides. This case demonstrates the importance of correlating terminal events, scene investigations and autopsy findings in determining the manner of death in a multiple stab wound case.

Multiple, Stab Wound, Suicide

G94 A DNA Database for Species Identification of Forensically Important Flesh Flies (Diptera: Sarcophagidae) in the Continental United States

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The goal of this presentation is to inform attendees of the basic content for a newly developed DNA database for the identification of carrion flies in the continental United States. In particular, emphasis is placed upon the flesh flies (Diptera: Sarcophagidae), a hitherto largely unusable resource due to the lack of expertise in species identification for either adults or immature (larval or pupal) stages.

This presentation will impact the forensic science community because with this tool, species identification of sarcophagid flies is possible in a fast, precise method. This will then allow flesh flies, species commonly encountered at carrion, to be used by forensic entomologists in postmortem interval (PMI) estimation.

Species were collected from as far across their United States geographic range as possible. Geographic patterns of the mtDNA locus as well as the utility of subdivisions of the locus for species identification will be discussed.

Additionally, data is also provided for other sarcophagid species that are believed to be closely related to forensically important species, or might be confused for forensically important species from morphological examination. In total, we report on twenty three individual species, for a total of over 200 specimens. All specimens are vouchered in a collection that will be publicly available, allowing for future comparison of the original specimens if necessary.

This sarcophagid data joins the 300 plus specimens already sequenced from the families Calliphoridae and Muscidae to provide the most comprehensive database to date for the sole purpose of species identification of these flies and allows for the first time a rapid, independent verification of almost every major species found actively involved in the decomposition process.

Forensic Entomology, PMI, Diptera

G95 NMR and Bioinformatic Studies on the Metabolic Effects of Acetaminophen in Rat's and Human's in Urine: A Metabonomic Approach

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After attending this presentation, attendees will have learned how acetaminophen affects the body differently, depending on the individual, and how to identify biomarkers that are unique to that individual's response to acetaminophen.

This presentation will impact the forensic science community by discussing how once unique biomarkers are identified and correlated, and how further study can be done to help determine which individual's will have adverse side effects to certain medications.

Acetaminophen is one of the most widely used analgesic drugs in the United States today due to its therapeutic effects and high toxicity threshold. This research aims to measure the effects of various acetaminophen doses on rats and humans using ^{1}H-NMR spectroscopy. Previous work has been done to establish the therapeutic and toxic levels of acetaminophen and found them to be 10-15mg/kg and 150mg/kg respectively. The purpose of this research is to study the effects of acetaminophen on rats to determine if metabolic biomarkers can be identified and then compare those biomarkers to those found in a human study. This research will show that the unique metabolic biomarkers found are due to the specific responses of exposure to the acetaminophen. This particular experiment will involve three groups of five rats (control, low, and high dose) and two groups of five humans (control and low dose). Urine will be collected over the course of seven days post-dose. A pre-dose urine sample will also be collected and this will act as another control. Once samples have been prepared and analyzed using a water suppression method, data analysis will begin. The spectra will be analyzed using various bioinformatics methods to see if changes occurred metabolically and what those changes were. These results will then be compared to those found in the human study to see if any correlations can be established. The biomarkers identified will determine whether or not the subject in question is genetically predisposed in their metabolism of acetaminophen. This can then be expanded to other medications, including those still undergoing clinical trials, to help establish what biomarkers are indicative of certain adverse side effects of a medication. This will assist in prescribing medications to individuals who will not exhibit the adverse side effects.

Metabonomics, Acetaminophen, Biomarkers

G96 A Cold Case: A Forensic Review Nine Years After the Crime

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The goal of this presentation is to provide information about potential capabilities and limits of forensic entomology analyses on an old case in order to determine time of death.

This presentation will impact the forensic science community by underlining how our current understanding of the forensic sciences can help solve old cases and how important it is to have a DNA database of forensically important insects.

Three days after the disappearance of a teenage girl from a small city in the South of Italy the corpse of a girl was found in a wood not far from that city.

Immediately it was clear that the girl was murdered and moreover the crime scene appeared to be an execution. She was still clothed, but her hands and feet were tied with wire, her head was covered with a supermarket plastic bag and her eyes were hidden by a plastic tape. The murdered girl was recognized as the girl who disappeared.

The autopsy noted that she was not sexually abused, but there were many contradictory observations about the cause of death. The head of the girl sustained a bloody wound and the plastic bag over her head was not sealed properly, so there was a large mass of fly larvae on the head wound and in the eyes. The entomological evidence was poorly sampled and not used at the time, instead the level of humidity of the girl's clothes was used to determine a contradictory time of death. Many medicolegal professionals were consulted and each one wrote a different conclusion.

Two years later, the investigation led to a male suspect who was found with a note written by the girl. However, after two years of imprisonment he was exonerated.

The case was reopened six years later and the prosecutors who were handling the case decided to use another team of investigators and they also decided that a forensic entomology analysis might be useful to determine the time of death.

All entomological samples collected during the autopsy were destroyed some years before, so the work was performed with the collaboration of old and new investigators and based only on reports, pictures, crime scene and autopsy video, the girl's clothes and meteorological data from the area nearest to the crime scene.

Desiccated insect material was collected after eight years from the girl's clothes and because of the state of this evidence a morphological examination was not possible. Instead using mtDNA analyzes (COI) the insect material was determined to be *Lucilia sericata* (determined by a taxonomist).

To identify the instar of the desiccated larvae a lab experiment was designed in order to identify the original length of maggots before the dehydration process. This experiment revealed that the larvae from the body of the girl were 2nd instars of *Lucilia sericata.*

This information together with the environmental parameters and the ecological data helped to determine when the eggs were deposited and therefore the most probable time of death. The investigation is still in progress.

Investigation, Entomology, mtDNA

G97 Dead Men in Wells: How Forensic Science Was Used to Solve a Crime in an Aquatic Environment

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The goal of this presentation is to provide information on how three allied sciences (pathology, anthropology, and entomology) working together can produce important information on a complex crime scene in an obscure location. Furthermore, some understanding of the technical difficulties of removing a corpse from an aquatic environment while still retaining corpse integrity.

This presentation will impact the forensic science community by underlining the importance of collaboration and dialogue between forensic specialists. Moreover, this case demonstrates how important protocols are in crime scene recovery so fundamental information is not lost.

A corpse in an advanced stage of decomposition was found in late February at the bottom of a well. The well was a small hole in the ground covered by a large and heavy stone and it was situated in an open roofed dwelling of an abandoned farmhouse not far from a lake in northern Piedmont (Turin, Italy).

The extraction of the corpse was very difficult because the very small opening of the well (about 50 cm of diameter). The size was just sufficient for the entry of one man with his equipment and the air tank. The well was deep, a little more than 6 m and the corpse was floating in about 3 m of water.

The corpse was clothed but no documents were found. Because of the high decay of both tissue and bone the identity of the corpse was performed by anthropological and anthropometrical examination. It was recorded that the man disappeared in May the year before.

Further pathological, histological, and SEM EDX examination of the bone marrow was performed to determine the presence of diatoms, causes of death were identified.

Forensic entomology was used in order to calculate time of death (colonization interval) and to investigate with a possible time frame in mind as to whether following his murder he was dumped in the lake. This led to the lake being scoured for months by many civil defense and firemen volunteers.

Entomological material was sampled both from the corpse and from the water in the well which was pumped into large plastic tanks. Numerous species of flies were identified including *Calliphora vicina*, *Fannia* sp., Muscidae, Trichoceridae, Sphaeroceridae and Psychodidae.

Data on seasonal presence of Calliphoridae in the Piedmont region of Italy and stage of corpse decomposition (saponification) helped to confirm that the time when the man first disappeared coincided with the beginning of insect colonization. Moreover, it was possible to demonstrate that the corpse was never in the lake environment, thanks to information gathered from the literature about the biology of the insects found on the corpse. This fact was supported by the absence of diatoms within the marrow of long bones, and by the presence in the internal organs of the same silicates found in the water.

This case underlines the importance of collaboration and communication at crime scenes. In particular, when there are several experts such as firemen, policemen, medical examiners and other different forensic scientists (entomologists, botanists, anthropologists) present team work is essential. When a crime scene is conducted properly, relevant evidence is conserved and subsequently a complete analysis of the association of the human remains and the place of recovery can be documented.

Moreover, this case highlighted the importance of evidence recovery from water bodies and the scant information available on this topic, in particular the lack of literature on protocols and equipment.

Aquatic Environment, Anthropology, Entomology

G98 Fatal Rescue Burns

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After attending this presentation, attendees will identify with the significance of identification of a rescuer in a case of burns to ascertain if burns are sustained in an effort to save the victim, or trying to commit the crime.

This presentation will impact the forensic science community by understanding the need to prevent rescuers from becoming a victim of burn injuries, and the need to identify rescuers for medicolegal implications.

Dowry deaths in India are an investigative challenge and identification of a rescuer can have serious medicolegal implications. A case of fatal rescue burns where a six month pregnant female committed suicide by pouring kerosene and igniting herself will be reported. The father-in-law of the deceased, in trying to rescue her, got entrapped in fire and sustained fatal rescue burns. As per the preliminary investigations into the incident and eyewitnesses account, a young six month pregnant female poured kerosene and set herself ablaze following an argument with the mother-in-law. The father-in-law, in an attempt to rescue her, also sustained burn injuries. Subsequently both were rushed to the district hospital. The female aborted on the 4th day of the incident. The victim (female) and the rescuer (father-in-law) expired later. The pattern of burn injuries in the rescuer and the victim will be presented and the case details of the victims along with body involvement in burns will be discussed.

Self-immolation is a preferred method of suicide in Indian women. The death of married females due to thermal burns that is commonly reported in India is usually associated with the social evil of dowry. A fatal thermal injury in married women in India hence is a major concern for the investigating and law-enforcing authorities. It is a challenging task for the medicolegal experts to discriminate homicidal and suicidal burns in married women and comment on the manner of sustaining injuries in cases relating to dowry disputes. Pattern of distribution of burns in different circumstances have been studied and a difference has been noted in between assault and self-immolation groups as well as between males and females. The issue becomes critical in case of thermal injuries sustained to the relatives and associates of the victim (a young married woman) during such an incident. It is vital to ascertain if burns are sustained in an effort to save the victim or trying to commit the crime.

An unprofessional rescuer of a burn victim is one who tries to save the victim, in spite of the consequences of putting out the fire without any safety precautions. Menezes et al introduced the term ''rescue burns'' for such thermal injuries as an option to allow easy tracking and identification of such cases. They opined that difference between rescue burns, accidental burns, and suicidal burns can have profound ramifications to the family of the injured or deceased rescuer, or the insurance company concerned in the case, as well as the judiciary. In India, dowry is a tradition; bride burning a social problem, hence cases of thermal burns in newly married females is an investigative challenge and identification of a rescuer can have serious medicolegal implications.

Rescuers, under the influence of emotional distress and with great courage, try to save the victim. Efforts should be made so that a rescuer does not become the next victim. To prevent the rescue burns general public should be educated about precautions to be taken before trying to prevent a victim especially during their early years of life. Identification of the rescuer is vital since it has profound medicolegal implications.

Dowry Deaths, Rescuer, Rescue Burns

G99 Sports Tool as a Weapon of Assault: A Case Report

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After attending this presentation, attendees will understand the injuries produced by a rarely reported sports tool as a weapon of assault.

This presentation will impact the forensic science community by helping the officials responsible for the maintenance of law and order to administer the justice.

Trauma to different regions of the body using different types of weapons is commonly seen in literature, but there is a dearth of cases reported about sports equipment as a weapon of assault. Here a case of a moderately built male who had a homicidal attack with a hockey stick thus producing multiple injuries in head, abdomen, and genitals.

A case report will be presented of a sports tool as a weapon of assault, a rare event. It is recommended that medicolegal death investigators become familiar with such injuries in a detailed autopsy, which may ultimately prove or disprove the case, and may be of significant value to the investigating authority.

Sports Tool, Hockey Stick, Multiple Injuries

G100 Unusual Case of Blunt Chest Trauma Without Rib Fractures Leading to a Major Pulmonary Laceration

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The goal of this presentation is to describe and discuss a case of a major pulmonary laceration after a blunt chest trauma without rib fractures in an infant involved in a car accident as a passenger.

This presentation will impact the forensic science community by demonstrating an infrequently discussed mechanism of lung laceration due to a blunt chest trauma.

Pulmonary laceration is a common result of penetrating trauma but may also be caused by blunt trauma; broken ribs may perforate the lung, or the tissue may be torn due to shearing forces that result from different rates of acceleration or deceleration of different tissues of the lung

This case involved a 6-year-old, Hispanic healthy female infant who was a partially restricted backseat passenger in a compact vehicle that was traveling along a local highway. She was lying across the back seat when the driver suddenly fell asleep and collided with the back of a large truck. As a result of the impact her body was thrown against the back of the passenger's front seat and died instantaneously.

At autopsy the body corresponded to a well-developed and well nourished female infant. She was forty inches tall and weighed thirty two pounds. External examination of the anterior torso disclosed the presence of a horizontal linear abrasion over the superior aspect of the left hemithorax. Also a small elliptical contusion was over the superomedial aspect of the right hemithorax. Other small abrasions were present in the lateral aspects of the right upper and lower quadrants of the abdomen and posterior aspect of the right arm. The body had no other external signs of trauma. Upon reflection of the skin of the anterior thorax, no hemorrhagic infiltrates were present. There were no rib fractures. The left pleural space had 420 mL of liquid blood. The right pleural space and pericardium had no hemorrhages. The left lung had an extensive oblique laceration that practically transected the upper lobe, from the apex to the inferior medial aspect of the base. In addition multiple contusions were present over the anterior and posterior aspects of both lungs. The rest of the thoracic and abdominal organs had no lesions. Toxicological evaluation was negative for alcohol, cocaine, opioids and canabinoids.

Major laceration of the lung is a rare and not a well recognized complication of blunt chest trauma. Pulmonary laceration caused by blunt high-energy trauma results from a mechanical shear or puncture that disrupts the parenchyma, creating a cleavage plane within the lung. The mechanism of development of pulmonary laceration after blunt chest trauma is usually thought to be the result of direct impact leading to rib fractures and thereafter, the broken ends of the ribs directly tearing the lung. However, the absence of rib fractures in this infant makes this mechanism unlikely. In 1988 a group led by R.B. Wagner divided pulmonary lacerations into four types based on the manner in which the person was injured. In type 1 the laceration results from sudden compression of the thorax causing rupture of the lung. They usually occur in a central location of the lung and tend to be large as in this case. Type 2 laceration results from severe compression of the pliable lower thorax of younger patients. Sudden herniation of the lower lobe in front of the vertebral bodies causes a paravertebral shear injury with laceration. Type 3 lacerations result from direct puncture of the lung by a displaced rib fracture. Type 4 results from lung shearing at sites of pleural adhesions.

This case represents a particular mechanism involved in a blunt chest trauma in which a high-energy non-penetrating injury was applied to one hemithorax leading to a major unilateral pulmonary laceration without other organ involvement

Pulmonary Laceration, Chest Trauma, Car Accident

G101 Postmortem Analysis of Vitamin D Using Liquid Chromatography Tandem Mass Spectroscopy

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The goal of this presentation is to review physiology of vitamin D, review current methodologies for measuring vitamin D, and understand the utility of measuring vitamin D in postmortem blood samples.

This presentation will impact the forensic science community by providing the framework to understand the utility of measuring vitamin D in postmortem blood samples. With the recent debate regarding vitamin D deficiency, bone fractures, and questions of child abuse it seems imperative to be able to address these issues as thoroughly as possible. Often is the case in forensic cases that antemortem blood samples are not available or specific questions have not been asked by a decedent's physician prior to death. Thus, there is no way to know if a vitamin D deficient state was present prior to death. The results study will allow the forensic community to know whether or not a postmortem blood sample can or cannot be analyzed appropriately for vitamin D nutritional status.

Objective: To measure vitamin D in postmortem blood samples using our recently developed liquid chromatography-tandem mass spectrometric (LCMSMS) method. Briefly, our current method provides for measurement of the 25-hydroxy derivatives of vitamin D, specifically 25(OH)-D_2/D_3, (OHD2, OHD3) in human serum. Increasingly, current clinical practice is to measure OHD_2 and OHD_3 to assess vitamin D nutritional status. To our knowledge, methods have not been evaluated for measuring these analytes in postmortem samples. The most common assay platform used today is an immunobased assay, which relies on antibodies which are known to cross-react with many vitamin D metabolites. Such immunobased assays are particularly sensitive to sample integrity and it is likely that a postmortem blood sample may not be appropriate due to hemolysis and other postmortem artifacts.

Hypothesis: Postmortem vitamin D concentration, measured with a sensitive and specific assay such as LC-MSMS, will correlate well with antemortem concentrations. Such analysis will be helpful in those cases where antemortem vitamin D levels have not been previously measured in the primary care setting. Furthermore, with the recent debate over vitamin D deficiency (Rickets) and suspicious non-accidental bone fractures, such an assay will, without doubt be of interest in cases questioning abuse.

Materials and Methods: In preliminary studies, three recent cases of natural disease were selected. In each case, peripheral blood (iliac vein) was sampled within 24 hours of the time of pronouncement. Approximately 8 ml of peripheral blood was drawn into a red-top tube

under gentle pressure to minimize hemolysis. Each sample was allowed to clot at room temperature for one hour and then centrifuged for twenty five minutes. The serum was then transferred to a clean red-top tube and frozen at -10 C until assayed. Hexa-deuterated OHD2 and OHD3 (OHD2d6 and OHD3d6, Medical Isotopes, Inc.) were used as internal standards (IS). Calibrators were prepared in acetonitrile (ACN) at 5, 10, 20, 50, 100 and 150 ng/ml for each analyte (OHD2 and OHD3). Samples and calibrators (500 ul) were spiked with 75 ng IS, extracted in 1 ml ACN and centrifuged. Thirty ul of supernatant was injected into a Shimadzu HPLC at 70% H2O:30% ACN at 350 ul/min flow. Analytes were separated on a C18 column (100 mm x 2.1 mm x 3 um, RESTEK) and then introduced into a triple quadrupole mass spectrometer (ABI 3200 Q-trap) via an APCI source in the positive ion mode. The analytes were eluted at 100% ACN over a 13 minute run.

Results: Preliminary studies addressed whether or not vitamin D analytes are stable in postmortem blood and if so whether they can be measured with our LC-MSMS method. In each of the samples tested to date, successful and reproducible total vitamin D in levels ranging from 6.43 ng/ml to 95.3 ng/ml have been detected and quantitated. We are confident in these results because the level of quantitation (LOQ) has previously established of these assay at 5 ng/ml.

Summary: It can be shown that postmortem blood contains measurable vitamin D and can be accurately measured on our LC-MSMS platform. Immediate planned studies on adult and pediatric cases include: (1) a direct comparison of hospital admission antemortem blood with our 24 hr postmortem blood samples; (2) a direct comparison of plasma and serum samples; and, (3) a postmortem stability assay to characterize how the postmortem interval affects our ability to accurately measure vitamin D.

Vitamin D, Postmortem Analysis, LC-MSMS

G102 An Unusual Case of Homicide by Knife, Screwdriver, and a Kitchen Fork

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After attending this presentation, attendees will be familiar with wound patterns inflicted by multiple unusual means. Only a few cases of homicide by screwdriver, knife, and kitchen fork are reported in forensic literature. Sometimes it may be difficult for the forensic pathologist to identify the penetrating weapon missing from the crime scene. The importance of a thorough forensic investigation, including crime scene evaluation, analysis of circumstantial data, autopsy findings, toxicological analysis, histological, and immunohistochemical studies is emphasized.

This presentation will impact the forensic science community by presenting a homicide where the murderer assaulted the victim with a screwdriver, a knife, and a kitchen fork. The unusual injuring tools and the relevant injuries were studied and analyzed to approach the case. The confocal microscope was utilized to verify the three dimensional appearance of the cutaneous lesions.

Injuries caused by sharp or pointed objects are common. They rarely cause fatal injuries; however, and the fatality rate is estimated to be 3% at most. Most fatalities caused by sharp force are homicides. The ratio of homicide to suicide is estimated at 6:1 to 5:2. When investigating deaths owing to sharp force, the forensic pathologist is expected to give an opinion on the following points: the type of injuries; the number and anatomical distribution of injuries; the shape, size, length, and depth of injuries; the object (weapon) used; the amount of force needed to inflict the injuries; the extent of internal injuries; the cause of death; and the victim's capability to act. These points are of decisive importance for the reconstruction of the sequence of events. Most homicides by sharp force are committed by males, often under the influence of alcohol. The most common tool used is a knife, but other pointed objects, such as scissors, ice picks, forks, or broken glass, may also be used. The victims are usually family members or acquaintances. The death scene is most frequently the victim's home. Fatal stabs are usually located in the precordial or cervical region. The number of stabs does not allow the drawing of conclusions as to the mode of death, the motive, or sex of the perpetrator. When the number of stabs is higher than necessary to kill the victim, this is referred to as "overkill," and may point to a strong emotional conflict between the perpetrator and the victim.

Case Report: The lifeless body of a 18-year-old girl was found in a mansard by the owner. He was giving hospitality to a friend since three months. The girl was the former girlfriend of his guest. The body laid face down in a large pool of blood. Immediately he tried to help her and called the ambulance, but she was pronounced dead. There was a great confusion in the room, on the floor beneath the body a large pool of blood was evident, with extensive blood spatter on the surface of the wall on the right, of the cupboard on the left and of the bed, in the center of the room. The head of the decedent lied near a chest of drawers which surface was full of stripes of blood made by the girl's fingers in an attempt to getting up from the floor. The postmortem examination showed the face devastated by very numerous cross lesion of the cutis, 0.4 cm in length, ending in deep incision on the bone surface underneath. The same wounds were also on the thorax and on the dorsal face of the hands. These wound appeared similar to the shape of a phillips screwdriver tip. On the left side of the face and neck there were many linear wound that appeared always paired and of the same length, suggesting the use of a sharp and pointed object like scissors, kitchen fork, etc. There were also numerous deep linear cutaneous wound on the anterior surface of the neck, slightly oblique, with clear-cut divergent margins, exposing the underlying structures, also sectioned, and ending in linear superficial incisions at different vertebral bodies of the cervical spine. Other deep linear cutaneous wounds were localized on the right emithorax; beneath these lesions the costal cartilage was sharply sectioned at many levels, with soft tissue bleeding underneath. No pulmonary lesions were found. On the hands and the forearm the girl showed many defense lesions made by the sharp and pointed object, and by a cross-tipped mean. Immunohistochemical studies were performed on the cutaneous specimens for the determination of the vitality. The evaluation of skin samples with confocal microscope allowed researchers to observe the three-dimensional model of the different wounds. Toxicological analyzes were negative. On the basis of the autopsy results, the pathologists gave indications to policemen about possible responsible weapons. A thorough investigation of the crime scene allowed the finding of a phillips screwdriver dried with blood and a kitchen fork in a drawer; no other weapons were found. The day after the body finding, the boyfriend, who was sought by police, crashed with his car while he was escaping along the highway. Inside his car police discovered a knife, stained with blood, and locks of hair.

Knife, Screwdriver, Fork

G103 Love and a Bullet: Autoerotic Accident or Intentional Suicide?

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The goal of this presentation is to highlight the potential for confusion regarding manner of death by using an interesting example.

This presentation will impact the forensic science community by highlighting the gray area of manner of death.

Autoerotic deaths have traditionally been caused by asphyxia due to hanging. To a lesser degree, trauma secondary to electrocution and

insertion of objects have resulted in death. Based on scene investigations and the autopsy findings in these more traditional autoerotic cases, manner of death is best classified as accident. However, there does arise within the forensic spectrum cases involving autoerotism where the manner of death is more equivocal. It is in these fringe cases where excellent investigation of the scene and the victim's past medical history, is paramount. We present here an unusual case of autoerotic death in which the autoeroticism involved a gun.

The decedent, a 29-year-old man killed his father when he was thirteen-years-old. Using a handgun, he shot his father because he was repeatedly abused by him. His mother encouraged the murder. As a young man, the decedent found titillation from a toy handgun. As he grew older, he felt the need for a more powerful arsenal in order to achieve sexual arousal. During his last years, the decedent not only considered his silver .38 caliber Rossi handgun to be "sexy," but he smelled, fondled, and caressed it. The 38 Rossi was kept in a velvet bag in his bedroom, retrieved easily to be used as a sexual and masturbatory aid. His sexual routine with his beloved Rossi escalated from dry firing the empty gun, to leaving one bullet in the cylinder of the revolver while pulling the trigger. Eventually, this repeated practice resulted in his death due to a self-inflicted contact range gunshot wound to his head. A further complication in this case is the decedents past psychiatric history. He had mild depression and suffered from bouts of insomnia. So this case serves as a great illustration and topic for discussion regarding aspects of autoeroticism, cause of death, manner of death, and the less clear distinction between suicide and accident.

Gunshot Wounds, Autoerotic, Manner of Death

G104 Laryngeal and Hyoid Bone Trauma Resulting From Forces Other Than Compression of the Neck

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The goal of this presentation is to describe and discuss ten cases associated with laryngeal and hyoid bone blunt trauma.

This presentation will impact the forensic science community by demonstrating the pathological features of this infrequently discussed entity in the non-homicidal setting.

Hyoid bone fractures are usually the result of direct trauma to the neck through manual strangulation or hanging. These fractures secondary to blunt trauma other than strangulation are rarely reported and discussed. This report discusses ten cases with hyoid bone or laryngeal fractures associated to blunt trauma.

Ten head and neck trauma cases in which the autopsy disclosed the presence of hyoid bone or laryngeal fractures were reviewed. These cases occurred within the period 2008-2009 and examined at the Puerto Rico Institute of Forensic Sciences. Cases with a diagnosis of strangulation or hanging were excluded.

The ten cases are summarized in Table 1.

Eight of ten cases were male and two were women. All cases corresponded to adults between 24 to 80 years. Half of the cases were older than 50 years. Eight out of ten cases corresponded to motor vehicle accidents; one case was a small plane crash accident and one case was a homicidal blunt trauma to the head with a concrete block. The motor vehicle accident cases included three motorcyclists, three pedestrians and two car drivers.

Common autopsy findings for all cases included the presence of hyoid bone and or laryngeal fractures associated with craneofacial trauma with maxilla and mandible fractures.

The most common fractured site was the joint between the left greater cornu with the left side of the body of the hyoid bone. Five cases had only one fracture at the left side and two cases had bilateral fractures. One case had a unilateral fracture at the right side. Fractures of the hyoid body were found in two cases, including one case with multiple fractures of the hyoid bone. Cases with thyroid cartilage fractures included one left superior cornu fracture and two cases with fractures of the right and left laminae. The cause of death for each of the ten cases was Blunt Force Injuries and the manner of death for nine of the cases was accident and one case was homicide.

Hyoid bone fractures secondary to trauma due to strangulation or hanging are rare. In the forensic literature, little information of laryngohyioid trauma in victims other than compression of the neck is available. Forensic pathologists look for a fractured hyoid bone as evidence of strangulation. There are several reasons contributing to the rarity of this fracture. The first is that the hyoid bone is well protected by the mandible. Most trauma to the face results in fracture of the mandible without hyoid bone fracture. The second is that hyoid bone is protected by its mobility in all directions, so the pressure may be cushioned. The third is that it is not completely ossified in younger patients allowing for more flexibility and decreased rigidity.

In laryngohyoid fractures, three mechanisms could be involved. The first involves a direct impact of the neck structures. The second involves an indirect muscle strain on the hyoid bone or thyroid cartilage resulting from hyperextension or hyperflexion of the neck or secondary to associated local trauma such as mandible fractures. The third is a combination of direct and indirect mechanisms.

These cases could represent similar mechanisms involved during a blunt trauma in which hyoid bone and laryngeal fractures are the result of high energy forces applied to the mandible strong enough to be transmitted by its anatomical contiguity. Strong muscle strains on the mylohyoid muscle could lead to hyoid bone lesions in case of mandible fracture where this muscle is inserted. This could explain the common association of hyoid bone fractures with mandible fractures in this report.

Table 1: Ten Laryngeal and Hyoid Bone Trauma Cases

Case #	Sex	Age (years)	Circumstances	Hyoid/thyroid cartilage fracture	Facial fracture	Cause/Manner of death
1	M	80	[illegible] concrete block	[illegible]	Maxilla, Mandible	[illegible]
2	M	35	MVA Motorcyclist	Left hyoid body and greater cornu; Left lamina of thyroid	Maxilla, Mandible	BFI/Accident
3	M	60	MVA Driver	Left hyoid body and greater cornu	Maxilla, Mandible	BFI/Accident
4	M	27	MVA Pedestrian	Hyoid body; Right and Left cornu/body articulation (split)	Maxilla, Mandible	BFI/Accident
5	M	62	MVA Pedestrian	Right joint body and greater cornu; Right lamina of thyroid	Maxilla, Mandible	BFI/Accident
6	M	31	MVA Motorcyclist	Left hyoid body and greater cornu	Maxilla, Mandible	BFI/Accident
7	F	33	MVA Pedestrian	Left superior cornu of thyroid	Maxilla, Mandible	BFI/Accident
8	M	31	MVA Driver	Left hyoid body and greater cornu	Maxilla, Mandible	BFI/Accident
9	M	24	MVA Motorcyclist	Right and Left joint (body and greater cornu)	Maxilla, Mandible	BFI/Accident
10	M	30	Small plane crash [illegible]	Left hyoid body and greater cornu	Maxilla, Mandible	BFI/Accident

Hyoid Bone Fracture, Laryngeal Fracture, Mandible Fracture

G105 The Evolving Distribution of Cause and Manner of Death in HIV Positive Medical Legal Cases: Links Between ART and Traditional Categories of Chronic Disease

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The goal of this presentation to describe and evaluate the impact of HIV infection, obesity, and two linked diseases, diabetes mellitus (diabetes), and cardiovascular disease (CVD), on the forensic practice and public health roles of medical examiner/coroners. Attendees will receive an epidemiological analysis of these diseases in medicolegal (ML) cases presenting to a large urban-based medical examiner office. Specific emphasis will be placed on the interrelationships between HIV infection and traditional categories of chronic disease and on the implications of the study results for other medical examiner offices nationally.

This presentation will impact the forensic science community by illustrating the evolving status of HIV infection as a chronic disease and the effects of increased longevity of the HIV positive patient on the composition of medicolegal caseloads. The role of medical examiner offices as guardians of the public health and the practical aspects of public health reporting will be discussed.

In 2009 the Centers for Disease Control and Prevention (CDC) released the results of HIV/AIDS surveillance data collected from thirty four reporting states. An estimated 552,000 adults and adolescents were living with HIV/AIDS in these states in 2007, an increase of 16% over 2004.[1] The increase in persons living with HIV infection is well-documented in the literature and it is associated with the implementation of ART treatment (combined antiretroviral therapy and highly active antiretroviral therapy), prolonging the time interval from HIV infection to development of AIDS, and with increased HIV screening at point of care, which can lead to earlier treatment. HIV positive patients are living longer through better disease management. However, ART produces side effects that increase the HIV positive patient's susceptibility to obesity, (especially visceral fat around the waist), diabetes, hyperlipidemia and CVD.

The population sample for this retrospective study consists of ML cases investigated by the Harris County Medical Examiner's Office (HCMEO), Houston, Texas in 2008-2009 that fall within these parameters: 15+ years old, 60+ inches tall, and weight of 70+ pounds. Size limits are set to exclude young children and decedents in advanced decomposition. The incidence of CVD and diabetes is obtained from the primary and contributing causes of death, and HIV incidence from medical history and HCMEO serology results reported to the local health authority. The data presented here reflect 5794 ML cases received from January 1, 2008 through July 22, 2009. The balance of the 2009 cases and the biostatistics results will be included in the final analysis and presentation.

The population of Harris County, Texas is an ethnically diverse 3.9 million residents, of which 29% are obese (BMI >30) and the average BMI is 27-30. Approximately 8.3% of Harris County residents have been diagnosed with CVD, 7% with diabetes, and 0.5% with HIV.[2] In concordance with these data, 29% of the ML decedents have a BMI >30, with a range of 10-98 and an average BMI of 27, and in 7% of cases diabetes is the cause or contributing cause of death. Due to the nature of ML cases and the efficacy of autopsy diagnosis, the percentages of CVD and HIV in the sample are higher at 31% and 0.9%, respectively, even though these conditions may be under-reported in a forensic sample.

Among the fifty five HIV positive decedents, 13% (7) have a BMI >30. The average BMI is 24 and the range is 15-55. Examination photographs reveal that 42% (23) have a concentration of visceral fat in the belly area. Review of the medical records is underway to determine the number of these decedents in ART at death. The racial/ethnic composition is 44% black, 42% white, 13% Hispanic, and 2% Asian. The age range is 18-81 years, with a median age of 47, a relatively middle-aged distribution. The leading causes of natural death are complications of AIDS (11) and CVD (11).

As these preliminary results show, improved treatment of HIV infection may lead to a higher number of deaths from CVD, fewer AIDS-related causes of death, and fewer infectious findings at autopsy that result in a request for an HIV serology by the forensic pathologist. Medical examiner/coroners can prevent a negative impact on public health surveillance of HIV infection in forensic cases through awareness of the changing epidemiology of HIV.

References:

1 http://www.cdc.gov/hiv/topics/surveillance/resources.htm

2 Texas Department of State Health Services Epidemiology and Surveillance Branch 2008 Annual Report

HIV, Medical Examiner, Epidemiology

G106 Death in a Wine Vat

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After attending this presentation, attendees will understand the necessity of good collaboration between the different institutions that work on an undetermined death crime scene and will become familiar with the autopsy presentation of death by inhalation of carbon dioxide (CO_2).

This presentation will impact the forensic science community by increasing understanding the need for collaboration between the different institutions (e.g., police, casualty department, national toxicology department, local eco-toxicology department, regional wine institute) to get the cause of death in a unclear case.

A 42-year-old man was found unresponsive by his father with the head and the left limb in a wine vat. The father could not remove the body, so he immediately called for a help. The emergency responders found him in asystole and pronounced him dead after twenty minutes of a resuscitation attempt.

The vat of 1,750 liters (455 gallons) was fuelled at 80% with grapes the day before. To give a better aroma and flavoring to the wine, 40 kg (88 pounds) of dry ice were added into the grapes. The worker had to then check the evolution of the must. For that, he had to regularly take samples to look at the color, to smell and to taste the must, especially during the period of fermentation of alcohol (about 15 days).

Autopsy showed cyanosis of the face and the neck, conjunctival petechiae, cerebral edema, and signs of acute anoxia into the brain. Toxicological analysis was negative. The National Toxicology Department suggested that it could be an intoxication by carbon dioxide, but could not prove it, because of the evaporation of the gas (CO_2).

The day after, the scene was visited with the police to try to understand the events. The Local Eco-Toxicology Department was asked to perform the analysis of the air on the top of the vat. They found 100% of CO_2. The Regional Wine Institute speculated that the addition of dry ice produce immediately a lot of CO_2 and not progressively as in a normal fermentation. In this case, if someone breaths inside the vat, loss of consciousness can come in a few seconds and then the death in a few minutes. Finally, as a result of the police investigations, a pair of glasses were found inside the vat when it was emptied after three months. It was concluded that the worker had lost his glasses into the vat and he tried to recover them.

The medical literature contain only a few cases of intoxications by carbon dioxide, occurring in ship holds, in the brewing industry, in silos,

tunnels, sewer shafts, and poultry plants that use dry ice, but rarely in wine industry.

The cause of death was not determined on the basis of the autopsy. But the information received from the different institutions allow the determination the cause of death as an acute intoxication by carbon dioxide and the manner of death as a accident, due to the loss of glasses in the vat.

Death, Wine Vat, Carbon Dioxide

G107 Nailing the Diagnosis: Features of Fatal Injury Inflicted By Unusual Projectiles and Firearms

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After attending this presentation, attendees will recognize the distinguishing features and potential diagnostic pitfalls of injuries inflicted by uncommon projectiles and firearms.

This presentation will impact the forensic science community by discussing the pertinent characteristics of a variety of wounds inflicted by atypical ammunition or firearms. A ten-year retrospective review of case files at the Cook County Office of the Medical Examiner and a regional collar county yielded seven cases of suicide committed with atypical projectiles or firearms. These include four cases of nail gun suicide and a case of an antique firearm loaded with Phillips head screws used to commit a double homicide-suicide. Additionally, two cases of accidental death involving aerial fireworks mortars were identified which are similar in many ways to two cases of suicidal fireworks injuries that have been previously reported in the literature.

The use of a nail gun to commit suicide is extremely rare, with fewer than ten cases detailed in the literature. It has been previously reported that nails recovered from individuals who have committed suicide remain straight upon entering the body. This is in contrast to reports of accidental nail gun injury where recovered steel nails have been observed to be curved or bent most commonly as a result of ricochet. It has been suggested that one may infer a given injury is accidental if the nails are bent and suicidal if the nails are straight. A case of nail gun suicide is reported with recovery of both bent and straight nails.

The external evidence of injury inflicted by nail guns may be subtle and easily overlooked, especially if the nail is not visible externally. Blood may be minimal or absent both on the body and at the scene. Not until the autopsy examination may the devastating extent of the injuries be appreciated. In three cases of nail gun suicide involving the head and one involving the chest, the injuries were small entrance wounds typically measuring 0.1 inch or less in diameter. The individual with self-inflicted chest wounds was dead at the scene and the three remaining cases had variable survival times.

In contrast to the injuries produced by nail guns, the cases involving the use of an antique firearm produced injuries deceptively similar to close-range or contact shotgun wounds. Radiographic examination identified the atypical nature of the projectiles, short Phillips head screws. Because the load was noncommercial, the number of projectiles (screws) varied between the cases. Additionally, from two cases, paper used as patching to contain the projectiles was recovered from within the wound track.

Atypical projectiles can, of course, produce atypical patterns of injury. Two cases of accidental death involving aerial fireworks mortars show that patterns of injury and soot deposition can be distinctive and, in the absence of additional information, may help identify the use of less common incendiary powders. Although no cases of suicide involving fireworks were found, two cases of accidental death involving fireworks were identified. Both occurred outdoors and had massive craniocerebral injuries with complete or partial avulsion of the brain as well as thermal injury of the surrounding scalp and skin. The injuries were limited to the head. This pattern of injury is consistent with that seen in suicidal fireworks injuries as described in the literature and highlights the importance of a scene investigation when investigating these deaths.

Perhaps due to the ready availability of more conventional weaponry, suicide using atypical projectiles and firearms remains rare. Despite their infrequency, it is important to recognize the pertinent features of such cases. In nail gun suicide cases involving the head, both bent and straight nails were identified. Many of the wounds in these cases were very subtle and could easily be overlooked. In cases of firearms loaded with atypical ammunition, the external appearance may be that of a close-range or contact shotgun wound. Finally, cases of accidental fireworks deaths demonstrated injuries similar to those described in suicidal fireworks deaths. All of these cases emphasize the importance of obtaining a detailed history, radiographic studies, and performing a thorough scene investigation.

Nail Gun, Fireworks, Atypical Injury

G108 Please, Don't Get Angry! Two Fatal Cases of Emotional Stress-Related Death in Left Ventricular Apical Ballooning Syndrome (Tako Tsubo Cardiomyopathy)

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The goal of this presentation is to present two cases of death due to Tako Tsubo cardiomyopathy. The growing interest of the scientific community in understanding physiopathology, still far from a complete definition and the amazing of videos presented, makes the presentation absolutely peculiar.

This presentation will impact the forensic science community by highlighting characteristics of syndrome and the importance of a complete postmortem examination in rare fatal cases. This presentation demonstrates the typical histological signs of catecholamine toxicity (CBN), but further studies are still needed for further in-depth knowledge of TTC and stress-related cardiac physiopathology. In particular structural alteration of the contractile and cytoskeletal proteins could also be investigated.

Tako-tsubo cardiomyopathy (TTC) is also known as stress-induced cardiomyopathy (SICMP) or left ventricular apical ballooning syndrome (LVABS), broken heart syndrome, and ampulla cardiomyopathy. It was first described in the early 1990s in Japan in which patients (generally postmenopausal women) complained of chest pain and dyspnea, mimicking a coronary arterial disease. The name of "tako-tsubo" cardiomyopathy is derived from a pot with a short neck and a round bottom used for octopus fishing in the Japanese sea, as this resembles the left ventriculogram during the acute phase of the disease. It is characterized by a transient akinesia of the apex and compensatory basal hyperkinesis, triggered by marked psychological or physiological stress in the absence of significant epicardial coronary artery disease. TTC has been recently classified as primary, acquired cardiomyopathy and diagnostic criteria have been proposed: reversible akinesis or dyskinesis of the left ventricular apical and midventricular segments, with apical ballooning extending beyond a single epicardial vascular territory, new ECG ST-segment or T-wave abnormalities mimicking AMI, absence of exclusion criteria, including obstructive coronary disease or angiographic evidence of acute coronary plaque rupture, recent significant head trauma, etc. Although precipitating stress is not always identifiable, the stressful trigger could be emotional or physical. Multivessel epicardial spasm, myocardial dysfunction triggered by

excess of cathecolamine levels, microvascular coronary spasm or dysfunction and neurologically mediated myocardial stunning have been proposed to explain TTC. Generally the prognosis is good but complications including death have been reported with an extremely low mortality rates. Deaths in these cases generally occur as a consequence of fatal ventricular arrhythmia (VF) or cardiogenic shock due to stress-related sudden severe ventricular dysfunction. Two fatal cases of TTC will be presented.

Case 1: A 52-year-old woman complained of thoracic pain and dyspnea after a quarrel with colleagues at the workplace. She had complained of the same symptoms a few months prior. Clinical examination on ED showed moderate high BP (160/90); pulse (90 bpm) and oxygen saturation (96%) were normal. A 12 lead ECG registration was immediately performed showing ST segment reduction mimicking myocardial infarction. Cardiac markers were elevated on lab test (CK 220, troponin 5.173). A severe ventricular failure was observed on echocardiography (EF < 30%). Cardiac catheterization was unremarkable for coronary obstruction. TTC was suspected, and confirmed at ventriculogram, where a typical systolic dysfunction involving left ventricular apex was recorded. Beta-blocker therapy was introduced but few hours after charge on cardiology department, death suddenly occurred in spite of resuscitation maneuvers.

Case 2: A young 30-year-old suddenly collapsed after a violent altercation with colleagues at the workplace and immediately presented to the emergency department of the local hospital. ECG was performed, showing ventricular fibrillation. The patient died few minutes after presentation. One week before, the young man complained thoracic pain and a 12 lead ECG was performed, showing ST segment reduction mimicking myocardial infarction. A complete postmortem examination was performed few days after death, in both cases. External examination was unremarkable. Internal examination showed mild cerebral edema and heavy lungs presenting white foam on the main bronchi, in both cases. Hearts were fixed in formalin. Cardiac sizes were normal, with conical shape. Macroscopic study (cut in cross-section 3 mm intervals) of coronary arteries were unremarkable, in both cases. Histological examination revealed polyvisceral stasis, mild cerebral edema; massive pulmonary edema was also detected. The pathological myocardial picture included multiple foci of contraction band necrosis; a few areas of patch interstitial fibrosis were also detected. Cardiac microscopic study was completed by means of immunohistochemistry by means of beta2 adrenergic receptor antibodies, showing expression on myocyte membranes in both cases. Confocal laser 3D scans of myocytes was also performed. No signs of cell death (apoptosis) was detected (TUNEL). Dosage of catecholamines and their metabolites on a blood and urine samples was performed, showing high levels of catecholamines, metanephrine and vanillyl-mandelic acid. Toxicological examination was negative. Clinical data, autopsy findings, data collected from immunoistochemical and CLSM study of myocytes and laboratory analysis, led us to conclude that cardiogenic shock after intense emotional stress complicated by malignant arrhythmia (VF) in Tako-tsubo cardiomyopathy was the main cause of death in both cases.

This research demonstrates typical histological signs of catecholamine toxicity (CBN) but further studies are still needed for further in-depth knowledge of TTC and stress-related cardiac physiopathology. In particular, structural alteration of the contractile and cytoskeletal proteins could be also be investigated.

Tako Tsubo Cardiomyopathy, Emotional Stress-Related Death, Cathecolamine Toxicity

G109 A Case of Anaphylactoid Syndrome of Pregnancy

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The goal of this presentation is to explain the use of the term anaphylactoid syndrome of pregnancy and the difficulties one can encounter in making a diagnosis of amniotic fluid embolus.

This presentation will impact the forensic science cimmunity by illustrating a case of anaphylactoid syndrome of pregnancy and will include a discussion of the autopsy procedures necessary for intrapartum deaths.

A 19-year-old G2P1 Hispanic female presented to the emergency room with spontaneous rupture of membranes at 33-6/7 weeks gestation. She had no prior medical history and had undergone routine prenatal care. Upon admission, fetal heart rate monitoring showed evidence of fetal distress, and a decision was made to deliver the fetus via Cesarean section (the decedent had undergone a Cesarean section for a prior delivery). During the C-section delivery with an epidural anesthetic, the patient suddenly became bradycardic and hypoxic at the point of fascial closure, following delivery of the fetus and placenta. Cardiopulmonary resuscitation efforts were unsuccessful, and she died in the operating room. The male fetus survived and had no complications.

At autopsy, she had an intact surgical site with no evidence of cardiac disease or pulmonary embolus related to deep venous thromboses. Microscopically, there were platelet and fibrin thrombi with admixed neutrophils filling the small pulmonary vasculature. Thorough sampling and special stains of the lungs failed to reveal squamous cells in the pulmonary vasculature, necessary for the diagnosis of amniotic fluid embolus. Examination of the placenta showed acute chorioamnionitis.

Even though the clinical features in this case pointed towards an amniotic fluid embolus (i.e., sudden intrapartum bradycardia and cardiopulmonary arrest), the diagnosis could not be made because squamous cells were not identified in the pulmonary vasculature. A review of the decedent's medical records indicates that intraoperatively her hemoglobin decreased from 9.0 to 5.2 to 4.5 gm/L. No source of hemorrhage was identified at autopsy; therefore, the decrease in hemoglobin and the pulmonary platelet and fibrin thrombi were likely related to disseminated intravascular coagulopathy (DIC). Instead of classifying the cause of death as "amniotic fluid embolism", the cause of death was classified as "intrapartum maternal demise with diffuse pulmonary fibrin and platelet thrombi complicating Cesarean section for fetal distress, with acute chorioamnionitis."

The clinical and hemodynamic manifestations of amniotic fluid embolism have been noted to be similar to those that are manifested in anaphylaxis and septic shock. The signs and symptoms include hypotension, fetal distress, cardiopulmonary arrest, coagulopathy, cyanosis, dyspnea, and seizures. The pathophysiological mechanism for the development of the amniotic fluid embolism begins with maternal intravascular exposure to fetal elements, when there is a breach in the barrier between amniotic fluid and maternal circulation. This in turn initiates an endogenous mediator response similar to an allergic reaction, with mast cell degranulation and activation of the complement pathway.

The diagnosis of amniotic fluid embolism has been traditionally made by identifying squamous cells in the pulmonary vasculature; however, fetal tissue or amniotic fluid components are not always found in the women who present with the clinical signs and symptoms of amniotic fluid embolism, as was the case in our autopsy. In light of the apparent pathophysiological mechanisms involved and because squamous cells may not always be identified in the pulmonary vasculature, the term "anaphylactoid syndrome of pregnancy" has been used to describe the syndrome of acute peripartum hypoxia,

hemodynamic collapse, and coagulopathy, which we believe this case represents.

The postmortem diagnosis of amniotic fluid embolism can be challenging to forensic pathologists. The gross findings are usually nonspecific and can include pulmonary edema and atelectasis, evidence of DIC, and pulmonary hyperinflation. Autopsy findings include fetal squamous cells in the pulmonary vasculature and masses of neutrophils and fibrin thrombi in the small pulmonary vessels. Special stains such as cytokeratin and mucin may be helpful. The autopsy should include a thorough sampling of the lungs, a proper evaluation of the uterine body looking for the possibility of wall tears as well as examination of the placenta. Thorough toxicology testing and a tryptase level are also important procedures in the evaluation of intrapartum deaths when an amniotic fluid embolism is suspected because the diagnosis is essentially one of exclusion, based on clinical presentation.

Amniotic Fluid Embolism, Anaphylactoid Syndrome of Pregnancy, Intrapartum Death

G110 Pheochromocytoma Causing Unexpected Death – Two Unusual Presentations

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After attending this presentation, attendees will be able to appreciate the postmortem pathology of pheochromocytomas and sudden death.

This presentation will impact the forensic science community by presenting the medicolegal significance and varied clinical presentation of adrenal and extraadrenal pheochromocytomas including sudden death, their histological features and the possible genetic implications of their diagnosis.

Pheochromocytomas are rare tumors of paraganglionic tissue. Paraganglionic tissue is distributed throughout the body and tumors may occur in multiple sites. Patients may present with severe headaches, nausea, excessive sweating, palpitations due to tachycardia and anxiety, tremors, pain in the lower chest and upper abdomen, and weight loss. These symptoms are due to the fact these tumors produce, store and secrete catecholamines (epinephrine, norepinephrine). Patients typically have hypertension, which may be intermittent. Clinical diagnosis is made by urinary and plasma catecholamine measurement, along with imaging. The tumors may present in the adrenal medulla and extra-adrenal sites. They may rarely be associated with sudden death, and catecholamine induced damage to the myocardium may be present, as the so called catecholamine cardiomyopathy.

Two cases of sudden death due to pheochromcytomas are presented. Both patients were 34-year-old males. In the first case, the male presented with abdominal pain. An ECG showed left bundle branch block and changes of an inferior myocardial infarction. He was variably hypertensive and hypotensive. He went into cardiac arrest while undergoing radiological investigation. At autopsy there was a suprarenal mass measuring 8.5 x 7.5 x 4.5 cm, with 700 mL of blood in the peritoneal cavity along with retroperitoneal hemorrhage. On histology, the tumor had the characteristic appearance of a pheochromocytoma. There were typical Zellballen. The tumor cells stained positively with neuroendocrine markers including chromogranin and synaptophysin. The supporting sustentacular cells showed some S100 positivity.

In the second case, the male had a witnessed collapse and died unexpectedly. He had been diagnosed as a non-insulin dependent diabetic five days previously. On the day of his death, he was described as well and his glucose level had been measured within the normal range. At autopsy a mass was found adjacent to the kidney but below the adrenal gland 3.5 cm in diameter. Histology showed the characteristic appearance of a pheochromocytoma.

Pheochromocytomas secrete catecholamines which cause hypertension. They also modify glucose metabolism, which accounts for the hyperglycemia seen in the second case. Diagnosis depends on histology and the characteristic immunohistochemical appearance. Malignancy cannot be reliably diagnosed by morphological features. These tumors may also be associated with genetic syndromes – such as multiple endocrine neoplasia (MEN) syndromes. Although traditionally known as the 10% tumor because 10 % are extraadenal and 10% malignant, a higher proportion of the cases, of the order of 25%, are malignant when associated with familial syndromes.

In the two cases, their clinical presentations alone may have resulted in their deaths being erroneously attributed to more common causes of sudden death, such as hypertensive or atherosclerotic cardiovascular disease. An appreciation of the clinical and pathological features of pheochromocytomas however properly diagnoses these cases. As such, surviving relatives can be informed and screened.

Pheochromocytoma, Sudden Death, Adrenal

G111 Digital UV/IR Photography for Tattoo Evaluation in Mummified Remains

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After attending this presentation, attendees will recognize an additional value of UV/IR imaging in the evaluation of mummified remains.

This presentation will impact the forensic community by providing an additional tool for postmortem identification.

The presence and location of tattoos can be an important component in the identification of remains in the extended postmortem period when remnants of skin persist. However, when there is significant mummification, elucidation of tattoos can be technically difficult due to skin discoloration and dehydration. Many methods have been proposed to increase the visibility of tattoos in the extended postmortem interval, including rehydration, hydrogen peroxide, and exposing subdural tissue. All have some, but limited applicability.

The use of ultraviolet and infrared photography has been of significant interest in forensic science in general and of cyclical published interest in forensic pathology and odontology. A large number of articles were published in the 1990s investigating the use of so-called "alternate light" methods, including narrow band illumination, fluorescence, and UV/IR photography for the evaluation of bite marks and trauma. There has been limited publication in the use of such methods for tattoo evaluation in the extended postmortem interval. One study found utility in evaluating fluorescence of ink using narrow band illumination. This study noted that infrared photographic evaluation, while slightly more useful than hydrogen peroxide, has traditionally been of limited utility because it "required photographic skills and was difficult and time consuming." Others have noted that the use of ultraviolet photography was difficult because it is impossible to see what is being photographed. With the use of film photography, the opportunity for quick feedback and fine-tuning of photographic parameters was not available. The photographs were, literally, taken blind.

In recent years, relatively inexpensive cameras sensitive to infrared and ultraviolet light have been marketed for forensic use. Many low-cost consumer digital cameras are sensitive to the infrared or ultraviolet spectrum, and incorporate blocking filters for standard use. An aftermarket has developed to market these cameras with the filters

removed. The availability of these relatively inexpensive cameras has spawned an active hobby market in artistic infrared and ultraviolet photography.

In this report, a commercial forensic camera sensitive in the UV/IR range was used to visualize a tattoo that was not perceptible in the visible spectrum.

The nude body of an adult female was found prone unburied in the woods. A missing person's report had been filed in a nearby city approximately two months earlier and police investigators suspected these were the missing person's remains. At autopsy, the body was largely skeletonized, with mummification of the skin of the back and upper extremities. Anthropological evaluation was consistent with the age, sex, and race of the missing person. Dental evaluation was consistent with the missing person, but was limited to do postmortem loss of teeth, which defied efforts at recovery. By history, the decedent was known to have a small tattoo of a heart on the back of her left hand, though the exact location was uncertain.

Examination of the left hand revealed marked mummification, but the skin of the dorsal surface of the hand was intact. Visual examination of the hand did not reveal any evidence of a tattoo. Attempts to increase visualization by rehydration and washing were unsuccessful. Hydrogen peroxide was not applied.

Under both UV and IR photography, a small heart-shaped tattoo was noted between the metacarpals of the thumb and index finger. The detail of the tattoo was visually similar in both spectra, though the UV provided a more subjectively "realistic" appearance of the texture of the skin.

This case demonstrates that at least with some inks, tattoos are clearly discernible using UV and IR photography. The almost immediate feedback provided by digital photography allowed evaluation of each image as taken to provide the optimum exposure.

The development of relatively inexpensive commercial digital UV/IR cameras allows the immediate evaluation and optimization of UV/IR photographs of postmortem tattoos. This, in turn, may make a previously rather esoteric method practical.

Ultraviolet, Infrared, Tattoo

G112 Undiagnosed, Untreated Acute Promyelocytic Leukemia Presenting as Suspicious Sudden Death

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Leukemia as a cause of sudden death is rare, because symptoms are usually present and treatment is initiated prior to death. After attending this presentation, attendees can expect to learn about a rare differential diagnosis of criminal death.

This presentation will impact the forensic science community by presenting a differential diagnosis of criminal death and reveals an aspect of the French medicolegal system which can be unknown to the American audience and in competence as it enlightens the importance of bone marrow removal during the autopsy.

Introduction: An autopsy case with acute promyelocytic leukemia is reported in which foul play had been initially suspected.

Case Report: A 40-year-old male who was found dead in his bedroom will be presented. He was working for the Brazilian Army and was in France for a training period. He had a two-month history of lower back pain. A complete blood count was normal one month before his death. At scene, the police noticed multiple bruises of markedly different colors on the body. A forensic autopsy was requested by the Chief Prosecutor because foul play was suspected. The external examination revealed multiple subcutaneous hemorrhages of different ages covering the whole body. The autopsy showed subarachnoid hemorrhage without any skull fracture. There was no other significant finding. Toxicology was negative. Histology revealed right-sided subarachnoid hemorrhage and a cerebellar hematoma. As foul play was initially suspected, the hyoid bone was removed. Histologic examination of the bone marrow showed no normal hematopoietic cells. Myeloperoxidase staining revealed the diagnosis of acute promyelocytic leukemia (APL). Death was attributed to acute intracranial hemorrhage due to APL. The manner of death was ruled natural.

Discussion: According to the literature, the most common tumors causing sudden unexpected death in adults include bronchogenic carcinoma, acute leukemia, gastric adenocarcinoma and adenocarcinoma of the urinary bladder. Death is usually attributed to a variety of mechanisms, including hemorrhage, thromboembolism and widespread dissemination. APL is characterized by the proliferation of abnormal promyelocytes and is classified as type M3 in the French-American-British (FAB) leukemia system. APL comprises approximately ten percent of the acute myeloblastic leukemias in adults. Because of the complicating disseminated intravascular coagulation and the likehood of threatening hemorrhage, APL is usually regarded as a medical emergency. This disease leads to a high rate of mortality, primarily from intracranial hemorrhage. There could be a tendency to overlook the diagnosis of this disease when a deceased presents multiple bruises that seem consistent with injuries. However, the French medicolegal system is different from the American system. In France, the decision to perform toxicology or histology after the autopsy is made the office of the prosecutor and not by the pathologist. Due to financial considerations, it is quite frequent that no complimentary analyzes are made, even if the pathologist thinks it is necessary to determine the cause of death. In our case, the circumstances of death and external examination at the autopsy did not raise the diagnosis of a malignant neoplasm in the hemopoeitic system. This type of case points out the importance of a thorough autopsy, including microscopic examination to protect innocent people from unwarranted prosecution. It is also important to retain bone marrow to enable the testing to be done and to confirm the diagnosis if required.

Forensic Pathology, Sudden Death, Acute Promyelocytic Leukemia

G113 Death of a Bodybuilder: A Case Report of Mixed Drug Overdose With Lethal Gamma-Hydroxybutyrate Level

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After attending this presentation, attendees will learn an approach to evaluation of a multi-drug overdose primarily due to gamma-hydroxybutyrate (GHB) with complex history and presentation; and, be able to recognize the symptoms and signs of GHB poisoning when combined with lower levels of multiple other drugs. Consideration of the changes in drug levels possible with decomposition; and be able to evaluate the role of confounding causes of death such as the possibility of heat-related death in an enclosed car in a parking lot in the sun.

This presentation will impact the forensic science community by assisting attendees to be able to recognize the signs and symptoms of gamma-hydroxybutyrate use, abuse, and overdose, particularly when exacerbated by the presence of multiple other drugs; compare to other

drug signs and symptoms when assessing a multi-drug overdose; and evaluate the confounding effect of perimortem heat exposure with onset of decomposition.

A 29-year-old male bodybuilder with a history of utilizing gamma-hydroxybutyrate (GHB or GBH) for its anabolic effect, was found dead in the passenger seat of a car in an airport short-term parking lot, at 2:00 p.m. during the month of May. The windows of the car were closed. Although it had been slightly more than seven hours since he was last seen alive, the decedent was in the early stages of decomposition.

The decedent had mentioned use of GHB to his employer as an event that occurred in the past. His father was also aware of his GHB abuse, but believed it to have ended. In April, a drug screening had not found any drugs in his system. He was known to have an intermittent problem with alcohol abuse and had recently signed up for rehab. He had sustained a significant fall not long before his death, for which he was treated and released; he had multiple healing injuries. He was also on regularly prescribed medications for a recent problem with sleep. These medications included zolpidem, alprazolam, and mixed amphetamine salts.

The week before his death, he hosted a friend from out of state, who was a physician. The night before death, which was also the last night of his friend's stay, the two of them went to a party which lasted for most of the night. In the early morning hours, they had an argument. The victim called another friend asking for intervention; this friend noted that he seemed somewhat groggy on the phone. The other friend was not able to provide intervention. A neighbor saw the victim's car depart in the early morning with two men in it, but could not identify them through the windows. It is possible that the friend who needed to go to the airport was driving the car, with the victim in the passenger's seat, where he was found dead more than seven hours later.

At autopsy, he was well developed and very muscular (5'8", 236 lbs; BMI = 35.9). The BMI classification into "obese" is likely incorrect as the body fat percentage was probably low, based on body habitus. The body showed evidence of early decomposition, with rigor passed, livor fixed in a pattern consistent with his position slumped forward in his seat, and extensive skin slip along the upper back. Small amounts of decomposition fluid in the body cavities were found on internal examination, and tissues were moderately autolyzed on histologic examination.

The only autopsy findings besides decomposition were healing injuries of the face, hands, toes, heels, and left flank, which were nonsignificant in death; and minor heart hypertrophy, which was probably physiologic (exercise-related), as he was known to do extensive exercising, and there were no hypertensive changes to the myocardium on histology. Of note, the gastric mucosa was free of small hemorrhages.

Toxicology provided the answer. There was present in his system more than enough GHB to be lethal. There were also small amounts of four other drugs, amphetamine (likely due to Adderall), citalopram (prescribed for depression), diphenhydramine (over-the-counter antihistamine, sometimes used as a sleep aid), and trazodone (another antidepressant). These four drugs likely contributed to death and likely contributed by making him sleepy, so that he did not exit the car nor telephone to seek help. Amphetamine likely made him more vulnerable to a cardiac arrhythmia in the setting of a lethal dose of GHB causing respiratory depression. Of note, no alcohol was present. The role of perimortem heat in accelerating his death could not be definitively determined by autopsy; this was a point of considerable significance to the family, who were of the opinion that the physician friend was culpable for allowing the groggy victim to remain in the car with the windows rolled up when it was time for him to catch his plane.

The time sequence of GHB intoxication, its effects in use, abuse, and overdose, and the likely mitigating or exacerbating effects of the other drugs present, are considered in relation to the findings in this case of fatal GHB overdose in a setting of multidrug use in a decedent who was otherwise probably healthier than the average person.

Gamma-Hydroxybutyrate, Perimortem Heat Exposure, Multi-Drug Overdose

G114 Hara-Kiri or Homicide?

Wendy M. Gunther, MD, Office of the Chief Medical Examiner, Tidewater District, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510-1046*

After attending this presentation, attendees will be able to recognize factors from scene investigation, history, and autopsy which may help in differentiating stab wound suicides from homicides.

This presentation will impact the forensic science community by reviewing an in-depth case presentation some of the factors that assist in differentiation of stab wound suicide from homicide.

The body of a 49-year-old white male was found collapsed face down on the carpet of his bedroom during the afternoon of a Saturday in April, about twenty hours after he had last been seen alive.

The front door was secure, but the back door to the residence was unlocked and propped ajar. The decedent had been seen mowing his back yard on the evening prior to death, and all his mowing equipment was still out in the back yard. He was found clad in gray shorts without shirt or shoes, appropriate for mowing. He was known to drink heavily when he mowed.

He was last seen alive by his girlfriend, with whom he had made arrangements to grill steaks on Saturday. She came to his house at the prearranged time, found the front door locked, knocked and called out for some time, but was unable to reach him; she did not think to check the back door. She left the scene, but continued to feel concern, and at last contacted police for a welfare check. Police found the body at shortly after 1600h; emergency medical services pronounced him dead on the scene at 1643h.

On initial examination, officers found a small fluctuant discolored mass protruding from the left lower side of his abdomen, and guessed that it might be a tumor eroding through the skin. There was a small amount of brown fluid on the carpet near the mass, but no blood. Based on this information and on history that the decedent carried the diagnosis of an unspecified aneurysm, while his twin had died prematurely at age thirty four of a myocardial infarct, the decedent's doctor initially agreed to sign the death certificate. It was not until a senior officer recognized the fluctuant mass as a loop of bowel protruding through a stab wound that patrol officers realized they should contact homicide detectives.

The house was immaculate. The decedent was a martial artist, and the first floor of the house contained a room dedicated to multiple displays of numerous Eastern swords and daggers. As far as police could ascertain, no swords were missing. There was no obvious blood staining or spatter, but there were too many swords in the room to ascertain on the day of death whether any had blood smears, or had been wiped.

There had been no 911 call nor was there any sign of a struggle. A beagle dog in the house seemed to be in no distress, and had not been heard barking. Cash and expensive watches were in place where they had been laid out with care equidistant and parallel on top of a dresser in the bedroom. The only item out of place was a box cutter, with a possible bloodstain on the blade, which was lying on the counter in the upstairs bathroom about eight feet from where the decedent was found collapsed. In the bedroom, about the same distance from him there was a tray table at the foot of the bed, on which was a tray with three sheathed knives laid out carefully equidistant and parallel. Investigation showed wiped blood smear on one of the sheathed blades.

At autopsy, the decedent was muscular and slightly obese at 65" and 183 lbs. There were no defense injuries on his arms or hands. The fingernails were very cyanotic, but short and even, without chips or tears. There were scabbed healing superficial abrasions on the backs of the 2nd and 3rd fingers, by the proximal interphalangeal joints. A number of linear scars were identified on the arms and hands. Scars on the backs of the hands appeared consistent with martial arts practice, but three transverse superficial linear scars across the wrist suggested self-incision, and there were overlapping linear scars on the anterior left upper arm which also suggested self-cutting. A 3½" linear scar on the outer aspect of the left upper arm was initially attributed to an assault he told family he sustained many years prior.

The only sign of injury was a complex stab wound overlain by incised wounds in the left lower quadrant. The abdominal wall showed internal characteristics of perforation by more than one blade. The wound, which was 1" long and about 6" deep, and therefore not consistent with the box cutter in the bathroom, perforated the abdominal aorta and ended its course in the anterior ligament of the lumbar spine; it caused death by internal bleeding. There was an extensive and bulging retroperitoneal hematoma, as well as 1400 cc of liquid blood and clots forming casts of the right and left colonic gutters. The blade passed very close but without injury to the loop of bowel which eviscerated through the stab wound. Evisceration had blocked the exit of blood through the wound and was responsible for the lack of blood on the carpet at the scene. Toxicology showed an ethanol level of 0.19% by weight by volume in blood, 0.23% in vitreous humor. Of note, no aneurysm of the cerebral, coronary, or aortic circulation was identified.

In the trash can in the bedroom was a letter to his girlfriend in his handwriting. The letter was not a suicide note. It appeared to be an angry letter of accusation. However, it had been crumpled and discarded without signing.

The decedent's complex history, involving decades of training in martial arts, samurai stories and films, alcoholism, divorce, current plans for remarriage, and the absence of support for his remote story of assault, caused a scenario to develop suggesting that he had attempted to commit hara-kiri as an honorable way out of an intolerable emotional situation. The story unraveled at last when the family reported on reading years of his journals, at which time a manner of death could be pronounced.
This complex history is presented in light of the autopsy findings and scene investigation to illustrate why this case of attempted hara-kiri was adjudged to be suicide rather than homicide.

Hara-Kiri, Stab Wound, Manner of Death

G115 Two Cases of Novel Influenza A (H1N1) Virus ("Swine Flu") Infection: Clinical Presentations, Autopsy Protocol With Findings, and Review of Literature

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After attending this presentation attendees will be familiar about the origins, spread, autopsy procedures, and findings in seven cases of H1N1 virus infection, that is currently designated a global pandemic.

This presentation will impact the forensic science community by organizing its preparation for a mass disaster situation involving a biological agent. The lessons learned from the way the nation and the world has responded will also be reviewed.

This novel infection, which has undergone a series of nomenclature changes (including new influenza virus, swine-like influenza virus, swine-origin influenza virus, and known colloquially as "swine flu") is now labeled a novel form of influenza. A virus resulting from a combination of genes derived from two types of swine influenza, one of which was in turn a "reassortment " of human, avian, and swine influenza A strains.

The initial spike of cases started in La Gloria, Mexico, generally regarded as the ground zero of this epidemic. The United States of America soon after became the epicenter of this rapidly spreading epidemic with a distinct pattern of disease incidence in relation to the usually seasonal variety of Influenza. On June 11, 2009, the WHO proclaimed the H1NI infection as a global pandemic, based on its spread in several continents, especially in the southern hemisphere. Now in early November, North America has become the epicenter of the disease. As of the of November 1, 2009, there have been more than 480 thousand laboratory confirmed cases of pandemic influenza worldwide and over six thousand deaths reported to the World Health Organization. The week of October 25 to 31 saw spike of at least eighteen flu related pediatric deaths, of which fifteen death were confirmed 2009 H1N1 and three were not sub-typed.

Described in htis presentation is the experience with cases evaluated in two counties in Central New York. The clinical history, hospital course and autopsy precautions and protocol followed, and diagnostic testing in cases seen by us are summarized in this Table # 1.

Table # 1.

Besides the variation in risk factors, the H1NI infection itself has raised many changes in business (loss of earning by the pig industry), changes in social mores, religious rituals and public behavior. It has also raised questions, including how one defines epidemic and pandemic, and to what extent preventive strategies should be allowed to disrupt normal life and economic activity. In New York State the Public Health Department had promulgated laws mandating all health care workers to receive the Seasonal and Novel Influenza vaccinations. Onondaga County expanded the requirement to include all medical examiner Personnel as well. These were later rescinded, and shortages of the vaccines became the dominant theme for conversation. Meanwhile there are reports that the virus has mutated and developed resistance to commonly used anti retroviral medications.

This presentation will also review the most recent publications, monitor and update the latest information about the spread of the infection as well as evaluate the public health response and lessons learned from the epidemic/pandemic. The main focus of this presentation will be to review the role of medical examiners/forensic pathologists monitoring sentinel events which adversely influencing public health.

Swine Flu, Bronchopneumonia, H1N1 Virus

G116 An Unusual Case of "Piggyback" Sandwiched Projectiles Caused by a Round-Nose Bullet Shot Through a Door

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The goal of this presentation is to reinforce with an unusual example, the concept of intermediate targets and secondary projectiles as they relate to gunshot injuries and in addition, to highlight the importance of correlating scene investigation with autopsy findings.

This presentation will impact the forensic science community by reinforcing the concept of secondary projectiles and highlighting the importance of correlating scene investigation with autopsy findings.

The concept of an intermediate target and secondary projectiles causing bodily injuries has been well documented in relation to gunshot wounds. An unusual case is presented in which a round-nose, copper jacketed .40 caliber projectile perforated a foam-filled metal door and carried two disc-like pieces of metal from the inner and outer lining of the door to the victim's body. Autopsy showed a distant type gunshot entry wound to the left front shoulder area and an adjacent superficial laceration, as well as a second small laceration of the left flank. The overlying clothing had corresponding defects from the bullet and fragments. On the adjacent skin and under the clothing, two metallic, essentially circular, concave pieces of thin metal were found. A round-nose, copper jacketed .40 caliber bullet had perforated the spinal cord and was retrieved from the spine. The nose of the bullet was slightly flattened. The two disc-like pieces of metal were very close in diameter to the bullet's diameter and fit nicely on top of each other on the flattened nose of the bullet, having the same, slightly out-of-round shape as the underlying bullet nose. The fragments also had a similar thickness as the metal surfaces on the door. Scene investigation and findings suggested that the man was shot through the door and the bullet carried the two metal discs "piggyback" on its flattened nose toward the victim, then the fragments perforated the clothing causing the small lacerations. Wounds caused by materials from intermediate targets have been well described, but we have found no case reports of piggyback sandwiched fragments carried on a round nose bullet such as we have described. By thoroughly analyzing the scene and the bullet, we were able to determine that the door fragments piggybacked on the bullet's nose to the decedent. Therefore, this case highlights the importance of correlating scene investigation with autopsy findings and shows the benefit of maintaining persistence when trying to explain discovered peculiarities.

Bullet Wounds, Intermediate Targets, Projectiles

G117 Newborn Kidnapping by Crude Cesarean Section

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The goal of this presentation is to illustrate an unusual case of fetal abduction via crude cesarean section.

This presentation will impact the forensic science community by illustrating the need for close collaboration between the forensic pathologist and the forensic laboratory when dealing with cases that involve kidnapping, drugging and restraining.

Introduction: The number of missing children reported each year in the United States remains astronomical. Between the years 1983 and 2008, 256 infant abductions occurred in the United States. The first documented case of a newborn kidnapping by cesarean section occurred in 1987. Currently, there are a total of eleven reported cases in which the fetus was abducted by a prenatal fetal snatcher between the years 1987 and 2008.

Materials and Methods: This case involves an 18-year-old African-American female who was 38 weeks pregnant. The victim became acquainted with the abductor, a 38 year old African-American female, while visiting their respective male partners at the jail. On July 15, 2008, the women saw each other again at the jail and engaged in conversation. The victim never returned to her home that evening. On the next day, the abductor presented to a local hospital claiming that she just gave birth in her apartment to a healthy baby boy.

Results: The scene of the crime is a third floor apartment in Wilkinsburg, PA. There was a foul order coming from the apartment. There were numerous flies around the windows. The decedent's body was located in an alcove off of the bedroom hidden by a mattress and head board. The body was that of a decomposing black female who was wrapped in a comforter. Upon inspection, it was noted that the hands were bound behind the back with duct tape and the ankles were bound together also with duct tape. The head was completely wrapped in duct tape with a plastic bag and duct tape totally occluding the airway. There was an incised wound of the abdominal area with clearly exposed intestine and uterus. The placenta was clearly visible.

Further inspection of the apartment revealed a roll of duct tape with a bloody fingerprint and a roll of plastic wrap. Loose pills were found on a shelf. All the above evidence was collected and submitted to the forensic laboratory.

The autopsy revealed a well developed, well nourished African-American female in a state of moderate decomposition. The body was identified via fingerprint comparison. The postmortem examination revealed a crude jagged edged incision of the lower pelvis and abdomen. There was exposure of a gravid uterus with a vertical incision over its anterior aspect. Loops of small intestine were exposed. A placenta was recovered from the comforter that covered the body. The distal edge of the umbilical cord revealed a dog-eared cut surface. Inspection of the cervix revealed that it was not dilated.

There were no other pathologic abnormalities or trauma identified during the autopsy.

Conclusions: The pills that were recovered from the scene were identified as Gabapentin. The decedent's blood along with a sample of the newborn baby's urine was found to contain elevated levels of Gabapentin. The abductor's fingerprints were recovered from the rolls of duct tape and plastic wrap. Investigation revealed that the abductor recently had a miscarriage and had recently faked another pregnancy going so far as to have a baby shower weeks before the abduction. The cause of death was certified as asphyxiation due to smothering by plastic bag and duct tape with contributing conditions of exsanguination due to partial evisceration of abdominal and pelvic contents and the presence of Gabapentin in the victim's blood.

Pregnancy, Kidnapping, Cesarean Section

G118 An Unusual Case of Accidental Poisoning: Fatal Methadone Inhalation

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After attending this presentation attendees will gain insight on a case of unusual accidental poisoning with methadone, occurring in a 38-year-old man who inhaled a white powder bought on the black market.

This presentation will impact the forensic science community by presenting the dangers from using "home-made" drug preparations. To date and to our knowledge, no case of accidental death following

methadone inhalation has been previously described up to the case herein presented.

Methadone hydrochloride (3-heptanone, 6-(dimethylamino)-4, 4-diphenyl-, hydrochloride) is a white, essentially odorless, bitter-tasting crystalline powder. It is very soluble in water.

It is a synthetic, long-lasting opioid with pharmacologic actions qualitatively similar to morphine and is active by oral and parenteral routes of administration. It is primarily used for relief of moderate to severe pain. It is also used in the detoxification and maintenance of patients who are dependent on opiates, particularly heroin. Recreationally, it is abused for its sedative and analgesic effects.

Methadone was synthesized by Ehrhart and Schaumann in Germany in 1941 in the Hoechst Laboratories and came into clinical use after the war. The use of methadone as a maintenance drug in heroin addicts began only in 1964, when Dr Vincent Dole and Dr. Marie Nyswander pioneered the use of a particular form of synthetic opiate for narcotic maintenance.

It is primarily a μ-receptor agonist and may mimic endogenous opioids and affect the release of other neurotransmitters (acetylcholine, norepinephrine, substance P and dopamine). This accounts for its analgesic and antitussive properties, respiratory depression, sedation, decrease in bowel motility, increase in biliary tone, hormone regulation and increase of prolactin and growth hormone release, miotic pupils, nausea, and hypotension.

As well as being an opioid receptor agonist, methadone acts as an antagonist at the N-methyl-D-aspartate (NMDA) receptor. The NMDA receptor system is a major excitatory central nervous system pathway involved in the neurobiology of pain. Methadone's ability to antagonize the NMDA receptor system may explain its superior analgesic behavior and why it can have effects in morphine resistant pain.

Unlike other opiates, methadone is primarily administered orally because of its good gastrointestinal absorption. It has high oral bioavailability and minimally lower rectal bioavailability. It is commercially available in liquid form. Most pharmacies, however, manufacture solutions, capsules or suppositories from less costly methadone powder.

Methadone hydrochloride powder is for oral administration only and is used in the preparation of a liquid by dissolving the powder in an appropriate vehicle. This preparation must not be injected.

The first fatality from methadone was recorded by Bieter and Hirsch (1948) in a 54-year-old man, who was given hypodermic injections of methadone (50 mg) in three doses over eight hours and who developed cyanosis and hypotension. They also recorded severe respiration depression in a 15-year-old boy who was given, by mistake, a 25 mg methadone hypodermic injection.

After inhaling methadone powder, he developed a cardiopulmonary arrest. Cardiac activity was restored only after prolonged resuscitative efforts. He was admitted to the local hospital and died after twenty-four hours of intensive care due to cardiac arrest.

An autopsy was performed at the University Center of Legal Medicine in Lausanne. At external examination there were only signs of medical treatment. Internal examination showed congestion of internal organs and cerebral and pulmonary edema. Histological examination showed moderate generalized congestion and hepatic steatosis.

Toxicological tests included blood ethanol levels and screening for common drugs and illegal substances by gas chromatography and mass spectrometry. This presentation will impact the forensic science community by showing the dangers of using "home-made" drug preparations. To date, case presentations of accidental death following methadone inhalation have not been previously described.

Conclusion: The cause of death was determined to be methadone intoxication, whose effects have been enhanced by the presence of ethanol.

Substance Abuse, Methadone, Intoxication

G119 Fatalities Occurring With Ingestion of Ibogaine

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After attending this presentation, attendees will understand ibogaine, its uses, and issues that may arise with the investigation of these deaths.

This presentation will impact the forensic pathology and toxicology communities by increasing knowledge of ibogaine's use, detection, and risk of death.

The psychoactive indole alkaloid ibogaine is the focus of an alternative medical subculture in which it is used most often for opioid detoxification, as well for individuals seeking psychotherapeutic insight or religious experience. Eighteen fatalities were reviewed that are reported to have occurred since 1990 in individuals within seventy six hours of taking ibogaine. These deaths occurred in numerous countries and we reviewed all available autopsy, toxicologic, and investigative reports.

There were fourteen males and four females with a mean age of 39 years (range 24-54) years. Fourteen individuals took ibogaine for the indication of acute opioid withdrawal and 3 individuals were non-addicts who used it for spiritual/psychological reasons. The circumstances were unknown in one decedent. Ibogaine was given as the HCl form in nine instances at doses ranging from 4.5 to 29 mg/kg, and as an alkaloid extract in four. The concentrations determined in ten decedents ranged from 0.24 to 6.6 mg/L. The time interval from the most recent ingestion of ibogaine until death ranged from 1.5 to 76 hours. In addition, commonly abused drugs (including benzodiazepines, cocaine, opiates, and methadone) were detected in eight of eleven decedents. Seven of the decedents had co-morbidities including: cirrhosis, hypertensive and atherosclerotic cardiovascular disease, and obesity. Among the two decedents in which no other drugs of abuse were detected in postmortem toxicology analysis, one had advanced heart disease and another had cirrhosis of the liver. Full toxicology and autopsy results were not available in seven and three decedents, respectively. Among these 18 decedents, the involved countries included the United States (5), Mexico (4), France (4), the Netherlands (2), Germany (1), the United Kingdom (1), and South Africa (1).

The uncontrolled settings in which ibogaine is given make the causes of these deaths difficult to evaluate, and little is known regarding toxic concentrations of ibogaine in humans. Contributing causes of some of these deaths appear to have involved drug use during treatment and preexisting cardiovascular disease. There appeared to be no clinical or postmortem evidence suggestive of a characteristic syndrome of neurotoxicity. Cardiac monitoring may be a more important safety issue in view of published observations of bradycardia in animals and a recent case report of QT prolongation in an alcohol dependent woman following the ingestion of alkaloid extract, as well the common use of pretreatment EKGs and cardiac exclusion criteria, and in some medical settings, implementation of cardiac monitoring during ibogaine treatment.

Ibogaine, Intoxication, Substance Abuse

G120 Acetaminophen Induced Death of a Fetus With Maternal Survival: An Unusual Case of a Suicide Attempt Resulting in Fetal Death

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After attending this presentation attendees will learn about an unusual case of a suicide attempt with unexpected complications to an unborn child.

This presentation will impact the forensic community by illustrating the risks of acetaminophen overdose on fetal survival.

Introduction: Suicide represents one of the most common causes of death in young women. Acetaminophen overdose represents one of the most common methods used to attempt suicide. Suicide rates among pregnant women are fortunately rare by comparison. However, poisoning deaths, both suicidal and unintentional are rising.

Material and Methods: The subject of this case is a 32-year-old caucasian woman who was pregnant with a healthy 35 week, 5 day gestation fetus. The subject has a history of depression and is prescribed Zoloft, although she was not compliant with her medications. She has no prior suicide attempts or ideations. She had a fight with her husband and exhibited increasing depressive symptoms. She stated to her husband that she had taken 'all her medicine', but she refused medical attention for approximately thirty six hours. Upon admission to the hospital, she was found to be in liver failure. She was treated with n-acetlycysteine. The next day, she started having uterine contractions. She was not able to clot her blood due to acetaminophen toxicity and liver failure, precluding a Cesarean section. Attempts to delay the delivery were unsuccessful. The fetus became increasingly bradycardic with labor progression and died shortly before spontaneous vaginal delivery (approximately four and one half days after the initial overdose event).

Results: The external and internal examination of the fetus was consistent with a gestational age of 36 weeks. There were no gross malformations, anomalies or evidence of external trauma to either the fetus or to the placenta. Likewise, metabolic screening was negative and postmortem tissue cultures were not helpful. Histologic sections of the fetal tissue were unremarkable with no signs of placental abnormalities or liver necrosis. Neuropathology of the brain revealed findings consistent with fetal distress and hypoxia. Postmortem toxicology on the fetal blood revealed an acetaminophen level of 8.55 mcg/ml.

Conclusion: The cause of death in the previously healthy fetus is attributed directly to the high levels of maternal acetaminophen. In an adult, an intake of 7000 mg or more is associated with death via liver failure in the absence of treatment. The maternal intake in this case is estimated to include 60 tablets of 500 mg each. Acetaminophen readily crosses the placental barrier to alter the function of the immature fetal liver which has only minimal abilities to safely metabolize the drug. The fetus is thus placed at greater comparative risk by acetaminophen than is the maternal source in cases of an acetaminophen overdose.

The mother ultimately survived, although she was placed on full liver support for coagulopathy. She is currently on the liver transplantation list. The fetus, despite survival to within minutes of delivery, died in utero secondary to fetal distress complicated by maternal acetaminophen toxicity.

Suicide, Acetaminophen Overdose, Fetal Complications

H1 Interpretation and Confirmation of Patterned Clothing Stains Observed on Both Tibiae

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After attending this presentation, attendees will observe how staining observed on skeletal remains was positively attributed to the victim's last known attire and how different patterns were linked to various parts of the garment.

This presentation will impact the forensic science community by providing an additional means of linking the description of an individual reported missing to unidentified skeletal remains. Investigators could potentially use this information as a means of ruling out individuals when attempting to make an identification.

Compared to the typical case received by a medical examiner, forensic anthropologists are at a considerable disadvantage when attempting to establish the identity of the human remains they receive. Usually there is very little soft tissue remaining. This eliminates the presence of identifying scars, marks and tattoos; makes it difficult to determine a subject's weight; and makes visual identification difficult without reconstruction. Dental records and radiographs can only be compared if you have a pool of potential victims to compare them with. Furthermore, skeletal remains are often discovered devoid of any contextual evidence, such as clothing or jewelry.

On a positive note, anthropologists can use skeletal measurements to determine height and several discrete skeletal features to determine sex. Several different skeletal features can help determine an individual's age at death, but the estimate typically includes +/- five years in each direction, if not more. Often, they are able to determine what type of build an individual had while based on the bone structure and degree of gracility or robusticity of the skeleton. Additionally, some features on the skull and some of the long bones may indicate what "race" an individual may have identified themselves as during life. Unfortunately, all of that information can still leave several possible "victims."

When a person is reported missing, it is standard to provide a description of the clothing the victim was last seen in. Therefore, associating skeletal remains with a missing individual can be easier if there is clothing accompanying those remains. Additionally, if the remains belong to an individual that was not reported missing, the type of clothing may provide an indication of the season or temperature at the time the individual died.

Analysis of remains in this case indicated a middle-aged white male with multiple gun shot wounds and several fractures, both peri-mortem and postmortem. Furthermore, staining patterns on the tibiae of the victim in this case indicated an object, possibly a material, with a grid-like pattern had lain against the bones for some time. The stains were light brown in color and showed two distinct patterns, a very small or tight-knit square pattern, and a larger square pattern higher up on the tibia. One author postulated that the larger square pattern looked like the waffle pattern of thermal underwear, while the smaller squares resembled the cuffs. As is typical in forensic anthropology cases, any clothing accompanying the remains had not been provided so the analysis would not be influenced or biased in any way. Once the analysis was finished and the report turned in, the authors reviewed the photos taken at the recovery scene. These photos showed insulated pants that had a thermal underwear-like lining in which the decedent's legs were enclosed at the time of recovery.

The exact method through which the staining occurred is unknown, but it is most likely due to differential exposure to the sun because of the varying thickness of the fabric. Observing such patterns in the future and associating them with certain clothing items could assist anthropologists and law enforcement agencies with identification.

Anthropology, Patterns, Stains

H2 A Preliminary Study of the Timing of Specific Characteristics of Copper and Iron Discoloration on Bone

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After attending this presentation, attendees will understand the early stages of copper and iron alloy corrosion and their transfer to bone.

This pilot study will impact the forensic science community by contributing to the understanding of the postmortem interval in forensic cases in which skeletal remains are recovered with associated metal objects.

Metal objects are often found in association with human skeletal remains in forensic contexts. Due to the presence of these objects, evaluation of the processes of metal discoloration on bone should be further explored. This preliminary qualitative analysis evaluates the timing and extent of stains on bone over a one year period from two general metal classes: copper and iron alloy. Specifically, this research evaluates the timing of discoloration, the reflection of the object form, the depth of cortical penetration, and the persistence of the stain through cleaning.

Five common metal object types, with different chemical compositions and forms, were affixed with non-metallic mesh on a sample of defleshed non-human (*Bos taurus*) bones. These objects included steel shot, steel utility knives, copper zippers, copper-plated shot, and copper-jacketed bullets. Bone samples were placed on the ground surface in secure enclosures that allowed for exposure to year-round environmental conditions in mid-Michigan. One bone sample from each metal category was then collected monthly and evaluated in a laboratory setting. Monthly climatic data were documented at each collection episode through the use of an on-site weather station.

Macroscopic changes related to metal staining on the bone surfaces were photographed and recorded by two observers. Microscopic changes related to the penetration of the metal discoloration into the cortical surface of the bone were documented using histological analysis. Samples exhibiting extensive staining were thin sectioned and observed microscopically to determine the diffusion of the stain into the cortical bone.

Discolorations were consistent with the corrosion of the specific metal type. Both metal classes exhibited evidence of corrosion within the first month of exposure, but only the corrosive product of the iron alloy objects stained the cortical surface of the bone. The iron alloy objects consistently produced deep-penetrating red-brown stains: the steel shot closely mirrored the shape of the corresponding metal object, while the utility knife did not. All of the iron stains persisted through the subsequent cleaning process. Conversely, the rate of stain for copper

objects was inconsistent. Although the teal-green corrosive product was visible superficially on both the metal object and the adhering soft tissue within the first few months of exposure, the copper stains rarely persisted through the subsequent cleaning process. When visible, the copper stains vaguely reflected the form of the corresponding object.

Metal staining on bone may provide forensic investigators with vital clues concerning secondary burials or primary burials where metal artifacts associated with human remains are transported away from the crime scene. Although this pilot study does not reflect the total breadth of crime scene recoveries, it does contribute to understanding the phenomenon of metal corrosion and its effect on bone in a controlled environment. With further studies, this research may help investigators interpret the postmortem interval when known metals are discovered in close proximity to skeletal remains.

Metal Corrosion, Human Osteology, Taphonomy

H3 Detecting Various Burial Scenarios in a Controlled Setting Using Ground-Penetrating Radar

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The goal of this presentation is to demonstrate the effectiveness of grave detection using ground-penetrating radar (GPR) at a controlled research site that incorporates multiple burial scenarios. Ground-penetrating radar can be a useful geophysical instrument used by forensic investigation teams in the search for buried bodies. After attending this presentation, attendees will gain a better understanding of the capabilities of ground-penetrating radar (GPR) to detect a variety of common grave scenarios that involve buried bodies.

This presentation will impact the forensic science community by providing guidelines to death investigation personnel on the benefits of the use of GPR when searching for buried bodies.

The field of forensic archaeology has proven vital for the improvement of forensic searches by conducting controlled research with various geophysical technologies. In particular, controlled research has determined that GPR is the best geophysical tool used to locate clandestine burials of homicide victims. One advantage of using GPR is that it provides the best resolution out of all geophysical instruments because real-time data is displayed on a monitor for immediate assessment in the field. The objective of this research project is to investigate the capability of GPR to detect a variety of grave scenarios utilizing buried pig carcasses. This presentation focuses on one aspect of a larger research project involving monitoring controlled graves for a two-and-a-half year period, and will focus solely on the first six months of data collection using a 500-MHz antenna.

The ground-penetrating radar unit chosen for this research was the [Mala RAMAC X3M] with a 500-MHz antenna. GPR grid data were processed using REFLEXW and GPR-SLICE computer programs, and were displayed using radargrams (the GPR transects collected over the two rows of graves), Z-slices (planview representations of the grid that can be displayed at different depths), and fence diagrams (data viewed simultaneously in multiple planes). A permanent grid measuring 11 m by 22 m containing six graves, each with a single pig carcass, and two control graves was set up in two rows. Data were collected in both a west to east direction and a north to south direction utilizing a transect interval spacing of 0.25 m. The six graves containing pig carcasses and the two control graves were devised to test a number of common forensic scenarios involving buried bodies. The eight scenarios consisted of a deep (1.0 m) blank control grave containing only disturbed backfill to determine the geophysical response of only the disturbed soil; a shallow (0.50 m) blank control grave consisting of only disturbed backfill to determine the geophysical response of only the disturbed soil; a deep grave containing only a pig carcass; a shallow grave containing only a pig carcass; a deep pig carcass wrapped in a vinyl tarpaulin; a deep pig carcass wrapped in a cotton blanket; a deep pig carcass with a layer of lime placed over the carcass; and a deep pig carcass with a layer of rocks placed over the carcass.

Initial results using the radargrams for months one to six showed that the graves containing items over the pig carcasses (rocks or lime) displayed the best resolution out of the six scenarios with pig carcasses. The grave containing a pig carcass wrapped in a tarpaulin displayed a greater resolution compared to the grave that contained a carcass wrapped in a cotton blanket as well as both graves that contained carcasses with nothing added to the graves. When viewing the shallow Z-slices, the disturbed backfill of all of the test graves is detected. Furthermore, the Z-slices demonstrated that each of the deep graves were easily discernable compared to the shallow graves. Finally, the fence diagrams showed that each of the deep graves containing a pig carcass were easily discernable, with the graves containing rocks and lime displaying the best resolution. Overall, the combination of radargrams, Z-slices and fence diagrams provided maximum resolution and delineation of the various grave scenarios.

Forensic Archaeology, Ground-Penetrating Radar, Controlled Graves

H4 Precision of Coordinate Landmark Data Acquired From the Os Coxa

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The goal of this presentation is to show that traditional and novel landmarks located on the human adult os coxa are repeatable and that researchers with at least moderate experience in landmark identification can locate varying types of landmarks on the human adult os coxa with minimal observer error.

This presentation will impact the forensic anthropological community by revealing new landmarks (as well as the use of traditional ones) located on the human adult os coxa that are repeatable and can be located with minimal observer error. These 36 landmarks provide a clear representation of the adult os coxa shape and some landmarks are located in regions that previously have not been metrically considered for sex determination. These landmarks can be used with a high percentage of accuracy in the assessment of sex.

In a recent sexing study using three-dimensional landmark coordinate data collected from 200 human adult os coxae, Bytheway and Ross (in print JOFS July 2010) found that sex and size have a significant effect on shape for both European Americans and African Americans. They achieved a sexing accuracy of 98% for both males and females of European Americans and 98% for African American females and 100% for African American males.

In this study, a total of 36 landmarks were chosen that would best capture the complete shape variation of the os coxa. Thirteen of the 36 landmarks are newly described landmarks identified by the first author. Landmarks were chosen because: (1) they are considered useful and significant in the literature; (2) they are repeatable; (3) they represent the object being studied; (4) they represent regions that are considered reliable for sexing the pelvis; and, (5) they represent regions that have not been metrically considered for sex determination but are addressed in this research. The landmarks fell into the general categories of *Traditional* or *Type 2*, *Constructed*, and *Extremal* or *Type 3* landmarks according to Lele and Richtsmeier (2001) and Bookstein's (1991)

landmark classifications. *Traditional* and *Extremal* landmarks are single points identified by biological description whereas *Constructed* landmarks are points identified once maximum values are established.

The purpose of the present study is to test the *precision* of consistently locating the 36 landmarks on a single form between the repeated measures of the same individual used in the morphometric sexing study. Nineteen individuals were randomly selected and each individual was digitized three times with a wait period of at least 30 minutes between digitizing sessions. The os coxa were "fixed" or not moved between digitizing sessions. A [Microscribe® 3D digitizer] was used to register the x, y, and z coordinates. Each os coxa was clamped into a vertically oriented vise and the 36 landmarks were digitized. Prior to digitizing the *Constructed* landmarks, each was measured with a sliding caliper to obtain maximum measurements. Once maximum value was obtained both points were marked with a pencil. Because the object was not moved between digitizing sessions, it is not necessary to bring each digitized object into the same coordinate system and the estimation of error along each axis can be calculated (Corner et al. 1992). Error was evaluated by calculating the standard deviation of each coordinate for the 36 landmarks across digitizing sessions and individuals. The maximum standard deviation, which is a measure of measurement error, for the X axis is 0.26mm with a mean of 0.180mm, 0.48mm for the Y axis with a mean of 0.240mm and 0.40mm for the Z axis with a mean of 0.260mm. These results show that for the 36 landmarks no one axis or direction is prone to error confirming consistency in locating the landmarks. Both authors were experienced in locating the landmarks, however, a less experienced observer would be expected to have less precision.

Precision, Coordinate Landmarks, Os Coxa

H5 The Utility of Cohen's Kappa for Testing Observer Error in Discrete Data and Alternatives

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After attending this presentation, attendees will learn to use caution in the application of Cohen's Kappa (1960) for assessing interobserver error for ordinal scoring and will learn of the utility in forensic anthropology of alternative methods that can be applied to data for error testing.

This presentation will have an impact on the forensic anthropology community by presenting methods that can be reliably used to test inter- and intra-observer error for discrete data, which is frequently used in sex and age estimation. Additionally, this study will encourage the use of appropriate tests of error for discrete data that can then be applied to make forensic anthropological studies *Daubert* compliant.

Compliance with the *Daubert* criteria requires the validation of all medico-legal methods through error testing. However, Ingvoldstad and Crowder (2009) have revealed a lack of consistency in the field for testing observer error in forensic anthropological research. While there is a clear trend to increase error testing in recent years, many studies fail to test both inter- and intra- observer error, or to use reliable methods for some specific data sets. Among the latter, testing inter- and intra-observer error in discrete data, such as the qualitative or ordinal data often employed to assess sex or age, poses a particular challenge. Cohen's Kappa (1960) is one of the most popular methods to test observer error in discrete data in disciplines such as clinical medicine and psychology, to name a few, yet its application within forensic anthropology has been limited.

The goal of this study is to examine the utility of Cohen's Kappa for assessing observer error and also to compare it with those of other alternative methods. This evaluation is based on the analysis of newly recorded data and the original datasets from Klales et al. (2009) and Vollner et al. (2009) to develop new methods for sex estimation from the human pelvis. A sample of 170 innominates of known, adult individuals from the Hamann-Todd Collection (HTH), housed at the Cleveland Museum of Natural History, was used for this study. Each of the Phenice (1960) traits was scored from the HTH material on separate occasions by two to four different individuals. Scores from one to five were assigned following the scale and corresponding illustrations and written descriptions in the previously mentioned studies. Different estimates of intra- and inter- observer error were obtained, as well as the percentages of correct classification for each specimen observed.

In the prior studies, sex estimation was based on linear discriminant function analysis and provided correct classification rates above 99%. However, Cohen's Kappa in these studies rendered low values: ventral arc 0.53, subpubic concavity 0.40, and medial aspect of the ischio-pubic ramus 0.43 (i.e., high inter-observer errors), therefore questioning the likelihood of replicating this high correct classification rates when the variables are scored by other researchers. Specifically, the low Kappa values did not seem to reflect differences in the end result, a highly accurate method of estimating sex; therefore, using this method of measuring reliability, specifically, inter-observer differences, may itself not be reliable for discrete data, because differences in scoring minimally affected classification accuracy. Unreliable methods cannot be valid and in this case, a low indication of reliability was contradicted by a high indication of validity. When evaluating reliability, one should not be discouraged by a "low" Kappa value, but must also look at other statistics and the practical consequences of inter-observer differences.

Results suggest that in spite of the low Cohen's Kappa figures originally obtained for these data sets, correct classification rates remain high and fairly constant independent of the observer. Cohen's Kappa was clearly outperformed by some of the alternative error estimation methods, which provided results more consistent with the observed correct classification rates. This suggests that Cohen's Kappa should be interpreted with caution, or even abandoned, when analyzing ordinal and other discrete data in forensic contexts.

Observer Error, Cohen's Kappa, Discrete Data

H6 Tags and Spurs: Morphological Features of Cranial Blunt Force Trauma Fractures

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After attending this presentation, the attendees will be aware of unique, morphological features observed through the examination of several forensic cases that may serve as diagnostic features of cranial blunt force traumas.

This presentation will impact the forensic community by introducing and discussing morphological features, "Tags" & "Spurs", which can be utilized to identify cranial fractures produced through blunt force traumas when complete crania or isolated cranial fragments are recovered and/or examined.

The ability to recognize, identify and interpret cranial fracture patterns is instrumental in the correct and accurate assessment of the type of trauma(s) which produced those fracture. Berryman and Symes (1998) provide a comprehensive discussion on recognizing gunshot and blunt cranial trauma through fracture interpretation, while Galloway (1999) provides a detailed discussion of blunt force fracture patterns and cranial morphology which influence their generation and propagation. Several fracture types and patterns have been documented that are frequently utilized to identify blunt force trauma (i.e., linear, depressed,

stellate, ring, Le Fort, contra-coup, internally beveled concentric, etc.), however through the course of examination of several forensic cases additional morphological features have been observed which may be of diagnostic importance for blunt force trauma recognition. Presented here will be two morphological features, "Tags" and "Spurs", and the probable mechanisms of their production.

Tags are small, hinge-fracture segments of the fracture margin, found on the inner or outer table of the cranium. After a linear, radiating and/or concentric fracture has divided a cranium into several pieces there is the potential for shearing, edge-to-edge movement of the fragments internally and externally through the application of force. This shearing movement along the fracture may not be smooth and even, and occasionally the fracture margins may snag creating hinge-fracture segments as force continues to be applied.

As previously noted, internally-beveled concentric fractures are associated with blunt force traumas, with the degree of beveling appearing slight to moderate. However, occasionally localized large bevels are produced along fracture margins creating what could be termed spurs. As force is applied to a cranium and a cranial fragment is created, the internal or external movement of the fragment may produce a relatively large spur or flake of the internal table attached to the margin of the fragment or adjacent fragment. These spurs are analogous to the "break-away" spurs frequently produced at the terminal aspect of saw cuts of long bones (Symes, Berryman & Smith, 1998).

Two forensic cases will be utilized to illustrate the "Tags" and "Spurs" discussed above. Case No. 1 involves a probable Caucasian, possible Hispanic female, 30-45 years of age, with multiple blunt force traumas of the left parietal, which possesses several distinctive "tags" along fracture margins and one fragment with a moderately large "spur." Case No. 2 involves an adult, probable Caucasian, possible Hispanic female with multiple blunt force traumas of the left parietal and frontal, which produced a fragment with very large "spur" and a small "spur" along a fracture margin. Each case clearly illustrates one of these unique fracture features of blunt force trauma.

Though there are several well know and documented fracture types and patterns that can be directly attributable to either blunt or gunshot wound traumas, two additional fracture types where noted during the course of examination of forensic cases involving blunt force trauma that have not been addressed in the forensic literature (at least to this researcher's knowledge). These fractures types, "Tags" and "Spurs," appear to be unique to blunt force trauma and may serve as additional diagnostic features in the identification of blunt force trauma in complete and/or more importantly fragmentary crania.

Blunt Force Trauma, Fracture, Tag & Spur

H7 Primary and Secondary Skeletal Blast Trauma

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After attending this presentation, attendees will understand some of the basic principles of explosives, blast trauma, skeletal injury mechanisms, and fracture patterns, and will learn the results of an experimental study on primary and secondary blast trauma, specifically skeletal fracture and dismemberment patterns resulting from various controlled explosive events.

This presentation will impact the forensic science community by assisting anthropologists in interpreting skeletal fracture patterns related to blast trauma.

Forensic anthropologists have become increasingly involved in criminal, humanitarian, and conflict-related investigations that involve human skeletal remains. Skeletal trauma interpretation is often an important aspect of these investigations. In recent wars and terror events, most injuries of the skeletal system have been caused by exploding ordnance. Within the anthropological literature, however, studies of skeletal trauma emphasize blunt, sharp and ballistic trauma, with little mention of skeletal trauma resulting from blasts. Explosive weapons are designed to be destructive through the sudden pressure change caused by the blast, or by spreading shrapnel which acts as small projectiles, both of which may result in skeletal fractures and dismemberment. In order to properly interpret skeletal fracture patterns resulting from blasts, it is important to understand the mechanisms of skeletal blast trauma, and to document known blast trauma patterns.

While there is an abundance of literature on blast trauma, particularly in medical and orthopedic journals, the focus of these studies is generally mortality and treatment of blast injuries. Moreover, most of these papers are case reviews, with very few controlled, empirical studies having been conducted. This project examines primary (resulting from blast wave) and secondary (resulting from disintegrated, penetrating fragments) blast trauma to bone in semi-controlled environments, and documents skeletal fracture and dismemberment patterns.

Pigs (*Sus scrofa*) procured from a local farmer were used as test specimens. Specimens were exposed to explosive events of varying explosive type (including C4, det cord, PETN, and pipe bombs), charge size (ranging from 0.5-10lbs of C4, up to 120 feet of det cord, and 1ft^2 of PETN), and distance (ranging from contact to several feet away). Specimen and test preparation were carried out in conjunction with and under the supervision of explosives experts. Following the explosive events, the remaining biological material was retrieved and transferred to the FBI Laboratory where the specimens were macerated in warm water, and reconstructed using Duco cement. Specimens were examined radiographically, visually, and microscopically. The extent and pattern of skeletal fracture and dismemberment was documented, along with any other pertinent observations.

Skeletal trauma from the blast events observed in this study tended to be extensive, presenting as complex, comminuted fractures with numerous small, displaced bone splinters and fragments. Traumatic amputation of the limbs and cranium was also observed. Skeletal injuries were concentrated in areas nearer the explosion, but there was generally no identifiable point of impact. Fracture patterns were more random in appearance than those typically associated with ballistic or blunt force injury events. Fractures tended to be more extensive on long bone shafts, though proximal and distal ends were also affected.

The patterns found appear to be uniquely associated with blast trauma, or at least differ enough in quality and extent to appear distinct from other types of well-documented skeletal trauma (such as ballistic, sharp force, and blunt force). These results may therefore assist forensic anthropologists and other forensic examiners in the interpretation of skeletal trauma by enabling them to differentiate between blast trauma and trauma resulting from some other cause. It is important, however; to consider the various factors affecting trauma and trauma variation including the bone type, injury location, and all available contextual information.

Forensic Anthropology, Blast Trauma, Skeletal Fractures

H8 Case Studies and Patterns of Postmortem Dismemberment

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The goal of this presentation is to present three case studies on postmortem dismemberment through the joint surfaces, and discuss the patterns of tool mark damage to the soft tissue and surrounding and/or underlying bone.

This presentation will impact the forensic science community by suggesting a protocol for processing and analyzing cases of dismemberment through the joint surfaces.

Two patterns of postmortem dismemberment are commonly discussed in the cutmark literature: one in which the bones of the limbs or torso are transected, and the other in which dismemberment is executed via disarticulation through the joint capsules. However, the latter method is observed at much lower frequencies. A survey of cases from the C.A. Pound Human Identification Laboratory identified 34 instances of postmortem dismemberment over the past 37 years. Of these, 27 (79%) occurred through the bone, while 7 (21%) were through the joint capsules. Recently; however, the Pound Lab has seen an increase in cases of postmortem dismemberment through the joints, with four such cases since August 2007.

The majority of the literature on cutmark analysis focuses primarily on the characteristics of marks made directly in the bone. As such, analysis and interpretation of dismemberment through the joint capsule is often difficult, as many of the cutmarks are often found in cartilage rather than in bone. Additionally, implements typically used to cut through the joints, such as knives or scalpels, have fewer diagnostic class characteristics than saws, making them more difficult to differentiate. With the involvement of the soft tissue, a different approach to the processing and analysis of the remains may aid in identifying characteristics of the tools used in the dismemberment event. The current study provides an overview on how to process and analyze dismemberments through the joints by presenting three case studies, each involving a slightly different approach.

The remains from Case 1 were preserved in formalin by the medical examiner prior to arrival at the lab in September 2008. Dismemberment occurred at the major limb joints and between two cervical vertebrae. Cutmarks were found in the articular cartilage or in the non-articular bone immediately adjacent to the joint surfaces, and had characteristics consistent with a straight-edged (non-serrated) blade. While some tissue was removed during analysis, preservation in formalin precluded a more detailed analysis of the underlying bone.

Case 2, in April 2009, provided an opportunity for exploring different methods of preserving cutmarks in cartilage. Some of the remains were submerged in formalin; other joint surfaces were covered with damp towels to prevent drying and permit eventual examination of the subchondral bone. A cross-cut saw was used to transect the lumbar spine; a knife was used to dismember the shoulder and hip joints. The knife cutmarks were highly variable in morphology, ranging from smooth, straight margins to very ragged, irregular margins. This variability may be an artifact of the remains' exposure to the differing preservation conditions, however the use of two different implements cannot be ruled out. Analysis of the underlying bone failed to provide any further distinguishing characteristics of the knife.

In June 2009, Case 3 arrived at the Pound Lab completely skeletonized. As the remains were fully fleshed at initial recovery, photos provided by the medical examiner's office were used to visually assess the articular cartilage of the major joints. This case displays both patterns of dismemberment, with the shoulders and knees disarticulated through the joint capsules and the proximal femora transected below the lesser trochanters with a hacking implement. The articular cartilage displayed incised defects, gouges and scrape marks, some of which corresponded with defects in the subchondral bone. The morphology of the cutmarks observed within and adjacent to the joint surfaces is consistent with the use of a finely serrated blade.

After examining these three different cases, it appears that the best approach is a two phase analysis starting with an in-depth examination of the soft tissue followed by an analysis of the underlying bone after processing. As the soft tissue must be kept hydrated prior to processing, a prolonged period of analysis can lead to differential preservation conditions that may alter the appearance of the cutmarks. If the analysis is conducted over an extended period of time, preservation of the remains in formalin may be ideal to better preserve the diagnostic features of the cutmarks. It is important to note; however, that this approach largely precludes an analysis of the underlying bone. Further research on knife marks in cartilage and other soft tissue is needed, as these types of cutmarks may contribute valuable information to tool mark analyses in dismemberment cases.

Dismemberment, Tool Mark Analysis, Soft Tissue

H9 A SEM-EDS Trace Elemental Analysis of Sharp Force Trauma on Bone

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The goal of this presentation is to apply the scanning electron microscope, with energy dispersive spectroscopy (SEM-EDS) to trace elemental analysis of sharp force trauma on bone.

This presentation will impact the forensic community by expanding the use of the SEM beyond that of cutmark analysis and to apply EDS to sharp-force injuries specifically. This study furthermore aims to provide another method for identifying tools used to inflict trauma.

The study of cutmarks on bone, as evidence of sharp forces, has a long history in anthropological studies. Forensic anthropologists have a particular interest when medico-legal questions are raised concerning the presence of cutmarks along with circumstances surrounding death. The unifying goal of these studies is to match diagnostic features of the tool with unique impressions left in the resulting cut.[1] It is crucial that forensic practitioners become familiar with recent technological innovations which could potentially meet these goals.

The scanning electron microscope (SEM) is a high-powered visualization tool typically applied to engineering, microbiological, and material sciences. Energy Dispersive Spectroscopy (EDS) is an additional technique that may be used concurrently with the SEM to identify the elemental composition of scanned materials by collecting the fluorescent X-rays generated in the SEM process. While SEM has been used extensively for cutmark analysis, few studies have applied EDS for the principles of forensic anthropology in published literature. EDS has determined the presence and chemical ratio of elements present in dental restorative resins,[2,3] and has additionally been used to authenticate or eliminate a possible set of human cremains.[4,5] In 2007 Berryman et al. identified several elements characteristic of gunshot residue on bones which had been impacted by gunshot trauma.[6] However, research has not yet applied SEM-EDS to additional forms of trauma on bone, particularly sharp force trauma.

Most contemporary metallic instruments are composed of steel or a similar alloy, which will rust upon exposure to aquatic environments. External layers of rust can easily be shed through contact, as well superficial metallic particles that deteriorate through the corrosion process. Sharp force trauma was preferentially selected for this analysis because the incision often resembles a trough, in which trace particles

are more likely to become imbedded and preserved in the bone matrix. Even when a sufficient amount of force is used, sharp instruments rarely obliterate or completely destroy point of contact.

Osteological material was provided by the University of Tennessee Zooarchaeological Laboratory. One *Bos taurus* limb (humerus, radius, ulna, and metapodials) was disarticulated and flesh was removed, leaving periosteum intact. Eight sharp tools of known metallic composition, with various shapes, sizes, and level of rust development, were selected to induce sharp force trauma to samples. Each tool was used to strike a single area of bone, leaving cut marks relatively perpendicular to the shaft. Samples were either fully processed by boiling and removing residual tissue, or minimally process by removing periosteum only. Samples were then dried, and vacuum-pumped for 72 hours prior to scanning. SEM was performed using a [Hitachi VP-SEM S-3400N microscope] and elemental analysis was performed using the [Oxford INCA Energy 200 Dispersive X-Ray Spectroscope.]

The SEM successfully imaged the cutmarks on bone at magnifications 200x – 500x. EDS found organic compounds (Ca, C, O, P, Na) in the control samples at generally expected ratios. Inorganic elements (Fe, Ni, Mn, Cr) were determined in samples cut with metallic hand-axes, and the highest amount of iron (Fe) and elevated oxygen (together creating corrosive rust compounds) were seen in the samples where a rusty instrument was used. The presence of inorganic elements was greatly reduced by the full processing method. Future research will include comparisons of various corroded tools to potentially individualize a source, and investigation of other metallic substances in addition to steel.

Results suggest that EDS may successfully be used to identify inorganic elements resulting from sharp force trauma. This methodology will lend to class-level identification, or negate alternative explanations for bone pathology. This work may potentially support other corroborating evidence when attempting to identify an instrument used in forensic contexts.

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Sharp Force Trauma, Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS)

H10 Long Bone Healing Following Trauma

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The goal of this presentation is to offer information on the timing of macroscopically observable osseous changes related to long bone healing for an historic skeletal sample and compare these observations to those previously reported for cranial fractures.

This presentation will impact the forensic community by contributing to the available research on fracture healing rates by providing a non-destructive method to assess fracture healing. The data presented here can be used to aid investigators in more accurately predicting time since injury in forensic settings.

The analysis of fractures in dry bone is of considerable medicolegal importance and can contribute significant information on the cause and timing of death. However, much remains to be learned about the timing of specific bony responses during the healing process. A previous study has already explored the timing of initial bony response to injury in regard to cranial fractures (Barbian and Sledzik 2008).[1] Using the same historic sample, this study further investigates the macroscopic timing and appearance of fracture healing in long bone specimens.

The Civil War skeletal collection at the National Museum of Health and Medicine, Washington, DC represents a collection with detailed case history reports that make it possible to compute the time elapsed from insult to recovery, amputation, or death. From this collection, a sample of humeri and femora specimens with gunshot wound fractures were selected for observation (n=262). Each specimen was macroscopically examined and scored for the presence or absence of any bony response. This presentation will report on the rates of four bony responses around the fracture area: osteoblastic response, osteoclastic response, line of demarcation, and sequestration. Osteoblastic response was defined as any bone building response including the deposition of subperiosteal new bone, rounding of the fracture margins, or the presence of areas of woven bone. Osteoclastic response was defined as areas of pitting, exposure of the diploë, or other bone resorptive response. A line of demarcation was seen as an "etched" line running adjacent to the fracture margins and appearing as a shallow depression. Sequestration was noted when a segment of bone was becoming necrosed.

A comparison of the findings from this study with the previous one reveals that the osteoclastic, osteoblastic, and line of demarcation responses show a similar pattern to that recorded for cranial fractures. Specifically for the clastic and blastic responses, there is a clear trend of increasing frequency in the weeks post-fracture with over 80% of the sample demonstrating a response by the sixth week post-fracture. For the line of demarcation, there is an increasing prevalence of this response through the fifth week post-fracture followed by a decrease in frequency in the sixth and subsequent weeks.

Different from the cranial fracture study is the onset and prevalence rates of the bony responses. The cranial fracture healing study found that the osteoclastic response can occur earlier than the osteoblastic response. While this finding is not supported by the long bone data, the frequency of osteoclastic response in long bones is slightly higher than that of the osteoblastic response through the second week post-fracture. The most notable finding from this study is the prevalence of all the bony responses during the first week post-fracture. In fact all four bony responses were scored as present during the first week post-fracture and over 41% of the first week post-fracture specimens displayed at least one osseous response. In comparison, the cranial fracture study found an initial latency period of approximately one to two weeks for each of the four osseous responses scored. Although it has been long recognized that cranial bone responds differently to fracture (Sevitt 1981),[2] the long bone rates of osseous response during the first week post-fracture still seem remarkable. The cranial healing study found that the earliest bony response occurred five days post-fracture. However, the long bone data suggest that some individuals are manifesting a bony response in less than five days. This occurs most frequently for the osteoclastic (n=33) and osteoblastic (n=32) responses although line of demarcation (n=3) and sequestration (n=3) are also represented. This appears to be in direct contradiction to our current understanding of the bone healing process.

While these results may seem surprising, it should be noted that at least some of the bony responses scored during the first five days post-

fracture do not appear to be consistent with the initial osseous response to trauma, but rather appear to be more consistent with longer term bony changes. This would appear to be the case with the observations of sequestration as well as the some of the osteoblastic responses which were associated with rounded fracture margins (n = 8) or the deposition of areas of woven bone (n=8). It, therefore, seems likely that some of the bony lesions scored represent pre-existing conditions unrelated to the bony fracture per se. It is known that the health of Civil War soldiers was compromised due to a number of factors including nutrition, sanitation, and infectious disease vectors (Bollet 2002),[3] and these factors may help to explain the observations reported here. In forensic contexts determining the timing of multiple fractures is often important, and the initial results of this study suggests that macroscopic bony responses on fractured long bones may reflect more than simply fracture healing.

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Long Bone Fracture, Fracture Healing, Gunshot Wounds

H11 Schmorl's Nodes in the Skeletal Remains of an American Military Population: Frequency, Formation, and Etiology

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After attending this presentation, attendees will understand the patterns of occurrence of a frequent pathological condition, the Schmorl's node, in a U.S. military population.

This presentation will impact the forensic science community by broadening our understanding of factors which may cause and influence the frequency of Schmorl's nodes.

This research considers multiple hypotheses regarding the etiology of Schmorl's nodes. Schmorl's nodes result from herniation of the *nucleus pulposus* of the intervertebral disc through the cartilaginous endplate and into the cancellous bone of the vertebral centrum. The author hypothesizes that the frequency of Schmorl's nodes in military populations will be higher than that seen in most non-military populations, since physical stressors, such as those experienced by those in military training and operations, may increase the incidence of this pathological condition. Schmorl's nodes might also be expected to appear more frequently in farming and athletic populations.

This research investigates the frequency of Schmorl's nodes in differing populations, with new data from a skeletal sample from the Central Identification Laboratory (CIL) at the Joint POW/MIA Accounting Command (JPAC) in Hawaii. The sample consists of U.S. servicemembers (the majority of whom are young Caucasoid males) who served during World War II, the Korean War, and the Vietnam War, with additional servicemembers from the Civil War and World War I. The remains derive from JPAC recoveries of battlefield burials, cemetery exhumations, and turnovers from foreign and domestic citizens and governments.

The current study consists of two samples, a broader study of instances of this pathological condition in CIL case reports and a more specific study examining intact skeletal remains. In the broader sample, 34 of 172 individuals (19.8%) had at least one vertebra affected by a Schmorl's node. This frequency has of course been depressed by instances of incomplete skeletal recovery and poor preservation. In this sample, the greatest concentration of Schmorl's nodes was seen in the lower thoracic region. In the smaller sample of nearly complete skeletons, 28 of 38 individuals (73.3%) had at least one Schmorl's node present. The greatest concentration of Schmorl's nodes was again seen in the lower thoracic region, with diminishing frequencies seen as the vertebrae get higher and lower in number from this point. Several Schmorl's nodes were also seen in the cervical vertebrae, a finding that has not often been reported.

In a comparison of other studies charting the occurrence of Schmorl's nodes, it was found that the frequency of these lesions can range from 8% to 79% of a population. A number of processes have been implicated in causing Schmorl's nodes, including trauma, the aging process, disease, intrinsic factors, and unknown causes. Of these processes, it is hypothesized that both rapid-loading events on the axial skeleton and repeated stress injuries due to hard physical labor over time are the predominant causes. Age does not appear to be a factor in the formation of these lesions, with similar frequencies found in young and old populations.

Schmorl's Node, Paleopathology, Trauma

H12 Protocol for Objective Evidentiary Photography in Forensic Anthropology

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After attending this presentation, attendees will understand the need for photographic procedural guidelines and protocols within the field of forensic and biological anthropology and will gain insight into proposed photography protocols that are straightforward and user-friendly to produce objective photographic documentation for a court of law.

This presentation will impact the forensic science community by demonstrating the importance of establishing professional standards for producing objective photographic documentation to visually substantiate scientific findings in a court of law.

This presentation will help attendees gain a better insight into the current limited availability of standardized photographic procedural guidelines and protocols within the field of forensic and biological anthropology and will demonstrate the importance to the forensic community of establishing professional standards for producing objective photographic documentation to visually substantiate scientific findings in a court of law by outlining specific, reproducible, user-friendly photographic procedural guidelines, and protocols.

Currently, there is no generally accepted protocol for the photographic evidentiary documentation of human remains analyzed by the forensic and biological anthropologist in the determination of a biological profile. A detailed analysis of existing photography procedural guidelines and protocols (PG&P) from a variety of forensic professions was conducted and elements of these protocols were synthesized, supplemented, and organized into straightforward and accessible procedural guidelines and protocols specific to the forensic and biological anthropologist that are applicable for the field or the laboratory. Procedural guidelines and a photography protocol for use in the documentation of a biological profile, as well as a digital image processing PG&P were also developed.

The proposed photography PG&P were used to produce digital images at the California State University, Chico Human Identification Laboratory (CSUC-HIL). Photographs were taken of the human skeletal remains of a single individual curated at the CSUC-HIL. [The following equipment was used: a Canon Digital Rebel, 35 mm camera, Canon EFS 18-55 mm normal lens and a Canon 50 mm Compact-Macro EF lens.] In this instance, the more common JPEG photographic format was used, although TIFF is recommended. A ScanDisk Flash 4 GB memory card was used to store all photographs.

Following the laboratory protocol, initial photographs of the human remains were taken with a 35 mm normal lens. All four corners, seals and the inside of the box containing the remains were photographed to ensure chain of custody. The human remains were photographed in anatomical position from head to foot and foot to head. The protocol recommends taking 100% orientation photographs using a 35 mm normal lens. This is achieved by photographing each skeletal element from all possible views to create a permanent visual record of all elements present.

Next, a 50 mm Compact-Macro EF lens was used to photograph all trauma, pathological conditions, and developmental anomalies. Using the 35 mm normal lens and the macro lens, photographs of all taphonomic changes present on all bones, the facial skeleton, maxillae and the mandible were taken. Photographs of the skull/cranium using a 35 mm normal lens were taken in the following order: Frankfurt plane, left and right lateral views, sagittal plane, occipital region, frontal plane, and basilar view. The photographs produce detailed visual and permanent documentation of fragile skull/cranial bones and of longs bones, flat bones and irregular bones.

The PG&P recommended for the photographic documentation of the biological profile incorporates elements of the laboratory procedural guidelines adapted to each skeletal element used in determining ancestry, sex, stature, age at death, and individuating characteristics.

The protocols worked well in the CSUC-HIL; however, the laboratory tables were low and could not be configured to reduce back strain and fatigue. Many photographs are needed to fully document human remains, thus it is important that the photography station facilitate the taking of many photographs. The protocols are straightforward and can be easily followed. Therefore, even if the Forensic anthropologist is not available to attend the recovery of the remains, detailed visual inventory and documentation of the human remains can be established for a court of law.

Forensic anthropologists are called upon to testify as expert witnesses in legal proceedings related to medico-legal death investigations and often use photographs of skeletal elements to document their findings regarding a biological profile. It is anticipated that the recommended photography procedural guidelines suggested here will be expanded and modified as the situation dictates, and as technology and the profession advance. The wide-spread and consistent application of these guidelines and protocols will, hopefully, lead to the speedy adoption of standardized photography procedural guidelines and protocols as part of the established methodologies in the profession.

Anthropology, Photography, Standards

H13 Postmortem Interval of Surface Remains During Spring in Southeast Texas

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After attending this presentation, attendees will learn the effect of environmental factors on decomposing human remains located on the ground surface in southeast Texas during the spring season. In the past, decomposition studies have been conducted mostly on pig carcasses in different types of climates. Southeast Texas has a subtropical humid climate which is quite different than climates in previous studies. The present study was conducted on a human cadaver in the spring season in a sun-exposed location at the Southeast Texas Applied Forensic Science Facility (STAFS), located in the Center for Biological Field Studies at Sam Houston State University, Huntsville, Texas.

This presentation will impact the forensic science community because the data collected from the surface remains will show the postmortem interval and body changes that occur while exposed outdoors during the spring season in southeast Texas. This data will be informative information that can be used in law enforcement investigations involving human decomposition in southeast Texas or other geographic areas with similar climates.

A previous study done in Saskatchewan, Canada on pig carcasses (Sharanowski et. al, 2008) measured the rate of decomposition and insect activity in the fall, spring, and summer in a shaded and sun-exposed location. There were three pig carcasses placed at each location and secured to the ground so that scavengers could not remove the carcasses. The pig carcasses were clothed in long sleeve shirts when placed for the observation period. The spring season in the Saskatchewan experiment (sun-exposed area) related most to the research done on the subject at the STAFS facility. The spring season time frame recorded for the Saskatchewan, Canada study was May 17, 2000 until June 18, 2000. The average temperature at the sun-exposed site was 17.8 degrees Celsius. The conclusion of the study conducted in Canada was that decomposition occurred at a much faster rate during the spring season with little insect activity.

Sam Houston State University recently began research at Southeast Texas Applied Forensic Science Facility (STAFS) to study decomposition and insect activity on various human cadavers under different environmental conditions. The test subject was an unclothed middle-aged male. He was placed on the ground surface in the outdoor facility, in an unobstructed, open area, in direct sunlight. The subject was placed during the spring from March 9, 2009 until May 29, 2009. The average temperature during the study time period was 19.22 degrees Celsius and the average rain fall was 0.0134 inches. Climate data was recorded at two hour intervals, twenty four hours per day over the three month period. Vigorous insect activity was seen throughout the study.

At the conclusion of the study some skeletal elements were exposed, but the majority of bone elements remained covered by desiccated tissue. Portions of the upper and lower limbs of the body, skull mandible, and cervical vertebrae had been moved from their original positions as a result of scavenger activity. A similar decomposition pattern was seen on the STAFS' subject as was recorded in the Canadian study with skin and soft tissue desiccated. The decomposition findings were not expected in the humid climate of Southeast Texas.

With heavy rain in mid-March the desiccating body tissue moistened, but once the rain ceased, it immediately dried and remained desiccated for the remainder of the study.

Decomposition, Surface Remains, Southeast Texas

H14 Common Household Rope and an Outdoor Hanging: An Investigation Sparked by a Skeletal Case Exhibiting Cervical Vertebra Entrapment

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After attending this presentation, attendees will appreciate the limitations imposed by the type of rope used in outdoor hanging contexts.

This presentation will impact the forensic science community by providing data on the limitations of the type of rope used in outdoor

hanging contexts, and insight into the clues important in determining whether skeletal remains decomposed on the surface or while being suspended.

Despite the fact that most suicidal hangings occur indoors, outdoor suicidal hangings are a relatively common occurrence (Komar et al., 1999; Spitz and Fisher, 2004). The purpose of this study was to recreate a skeletal forensic case involving an outdoor suicidal hanging that presented with a cervical vertebra entrapped in a cotton and belt makeshift noose (Berryman, 2008). In this type of case the presence of the entrapped cervical vertebra is thought to provide clear evidence of hanging as the cause of death (Ledford et al., 2009); however, it is unclear what conditions are required for this to occur. In the absence of a feature of this type, especially in anthropological cases where the bones and associated cultural items have been scattered, it would be difficult to attribute hanging as a cause of death as the pattern of skeletal deposition of a hanging individual is virtually unknown.

This preliminary investigation attempted to recreate a skeletal forensic case that presented with an entrapped cervical vertebra in an outdoor context. In order to do so, a 10-foot high wooden device was built to bear a maximum load of over 600 pounds with a pulley/crank system to ease the force required to lift an individual into the hanging position (1 to 2 feet above the ground surface). This study was designed to test whether a cotton rope, commonly used in indoor hanging contexts, can be used to recreate a "true hanging" where both feet are off the ground. Although a cotton rope was not used in the case that precipitated this research, it is thought to be an adequate substitute for the actual cotton material (rolled to form a cord approx. 3/8 inch in diameter) that appears to be the point of failure, having been broken or cut. This research was conducted at the Anthropological Research Facility at the University of Tennessee using cadavers from the Forensic Anthropology Center body donation program.

Results indicate that a cotton rope 3/8 inch in diameter is unable to sustain the full weight of a hanging, adult individual. In most circumstances the tensile strength of a particular rope is made available by manufacturers and can be used to assess whether an individual was fully suspended, or suggest a positional asphyxiation scenario, where feet remain on the ground. It is impossible to determine how a rope will respond to an outdoor hanging situation based solely on its tensile properties, especially in situations where common household items have been strung together to form makeshift asphyxiation devices. The cotton clothesline rope used in this study is common in indoor hanging scenarios, but it seems that it does not possess the tensile strength to withstand a fully suspended load.

As forensic practitioners—particularly in anthropological cases in an outdoor setting–the possibility of hanging as a potential cause of death is not considered without the presence of obvious features such as a noose. An understanding of the decomposition process and subsequent skeletal deposition in hanging cases is essential in order to differentiate between remains originally decomposing on the surface from those that decomposed while being suspended. Expanding our understanding of the decomposition process and subsequent skeletal deposition in situations other than an individual lying on the ground is necessary. Investigations of this nature may enable the discovery of other tell tale markers to differentiate situations where an individual decomposed on the surface as opposed to a hanging situation, and vice-versa. Identifying tell tale markers indicative of decomposition while suspended, and understanding the variables that the hanging condition presents (e.g., distance from the ground, positioning of the body in relation to the asphyxiation device, the type of noose used, and how these affect the decomposition process) may allow a more accurate evaluation of these types of cases.

Outdoor Hanging, Cause of Death, Forensic Anthropology

H15 Estimating Sex of the Human Skeleton Based on Metrics of the Sternum

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After attending this presentation, attendees will understand the call for utilization of the sternum as a viable estimate of sex in a recent forensic sample from North America and be introduced to the necessary measurements of the sternum, reasons preventing the taking of measurements, the process and reasoning behind the collection of data, and subsequent statistical analysis employed in this study.

This presentation will impact the forensic science community by showing that the sternum provides a viable estimate of sex in a recent forensic sample from North America and is a useful addition to the methods employed in human identification.

Estimating the sex of an adult skeleton is a critical facet in creating the biological profile of an individual. To date, there are different methods used on select elements of the skeleton to assess the sex of the individual. Studies performed on an Indian population (Jit et al 1980) indicate that analyzing the sternum may lead to an accurate estimation of sex. Therefore, the method is not population specific and may not prove useful on a recent forensic sample from North America, hence the motivation for this study.

Sternal measurements were collected from the William M. Bass Skeletal Collection located at The University of Tennessee, Knoxville. This is a collection of recent forensic skeletons with known age at death, ancestry, and sex. The metric definitions provided by Schwartz (2007) and Bass (1987) were followed so that others attempting to replicate this research will be able to reliably measure the sternum. The measurements include length of the manubrium, length of the body, sternebra 1 width, and sternebra 3 width. A digital sliding caliper was utilized to take these measurements. Time was designated at the beginning of the second and third days to employ the test-retest method in order to calculate the intra-observer error rate and ensure reliability of these measurements.

In this study, comparisons of the proportion of the length of the manubrium to the length of the body of the sternum were performed to determine if there are measureable differences between males and females. Based on the work of Dahiphale et al. (2002), it is hypothesized that the body of the sternum in an American population will be greater than twice the length of the manubrium in male samples, but that in female samples, the length of the manubrium will be greater than half the length of the body. This is referred to as Hyrtl's Law. In addition, comparisons of these measurements between individuals identified as American Black and White were analyzed to determine whether or not this method could be used on both population groups.

The study contained 412 sterna (289 males, 123 females; 377 White: 35 Black). The data was entered into the Statistical Analysis Software (SAS) computer program, version 9.1.2. A discriminate function analysis (DFA), using all variables, produced an overall cross-validation classification rate of 84.12% for sex estimation. The cross-validation classification rates for males and females were 80.00% and 88.24%, respectively. The applicability will be discussed of utilizing the sternum as a method of sex estimation and propose specialists in the field adopt it as a supplementary method for use in human identification.

Forensic Anthropology, Sex Estimation, Sternum

H16 Microscopic Markers of Trauma in Decomposed Bone and Skin

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The goal of this presentation is to detect the vitality of soft tissue and bone lesions in an advanced state of decomposition using a monoclonal anti-human Glycophorine A antibody in order to evaluate the presence and distribution of blood cells.

This presentation will impact the forensic science community by showing an attempt at detecting a vital reaction in decomposed skin and bone in order to distinguish between antemortem and postmortem lesions in difficult situations.

The diagnosis of the vitality of a wound, or rather the identification of a vital reaction that enables one to differentiate an intravital wound from a postmortem wound, is a crucial issue in forensic pathology and more so in forensic anthropology. In fresh skin the macroscopic examination of hemorrhage infiltration can be sufficient to reveal the vitality of the wound but in many other cases histological and histochemical analyses are required. Bone injuries may follow similar "laws" as concerns the evolution of the macroscopic and histological picture.

The scope of this study was to detect the vitality of soft tissue and bone lesions in an advanced state of decomposition using a monoclonal anti-human Glycophorine A antibody in order to evaluate the presence and distribution of blood cells.

Six samples of bone fractures and two samples of skin wounds were taken from cadavers with a known time of survival between trauma and death, and then submitted to a simulated decomposition procedure. Negative controls were also included. The samples were left to decompose for 30 days in air and in water and analized at a time interval of 3-6-15 and 30 days. The bones were decalcified in a specific solution consisting of water, HCl, and Formic acid. Bone samples were stained with HE, Perls', PTAH, Weigert technique and PAS. Skin samples were stained with HE, Trichrome stain. Both bone and skin samples were stained with immunohistochemical technique. Skin and bone samples from four real cases of blunt and gunshot trauma were also included in the study.

Results showed, in the bone samples, red blood cell residues on the fractured margins and within Haversian canals may contribute to the diagnosis of a vital reaction. In the skin samples, red blood cells were visible until the 6th day in air and granular deposits of glycophorin reactive material after six days in air and in all samples in water. The general microscopic structure of bone was assessed in order to verify traumatic alterations in osteons.

In conclusion, this study may begin to shed some light on the issue of detecting a vital reaction in decomposed skin and bone in order to distinguish between antemortem and postmortem lesions in difficult situations.

Bone Fracture, haemorrhagic Infiltration, Glycophorine

H17 Can We Estimate Stature From the Scapula? A Test Considering Sex and Ancestry

Rachel M. Burke, MA, 10024 Northeast 120th Sreet #D3, Kirkland, WA*

After attending this presentation, attendees will better understand why multiple techniques for estimating stature are important, what measurements of the scapula are potentially useful for estimating stature, and how to use different regression formula to estimate stature based on scapular measurements.

This presentation will impact the forensic science community by providing a new method for estimating stature based on measurements of the scapula in order to create a more thorough biological profile.

The biological profile is one of the most important things that forensic anthropologists accomplish in their work. This includes the determination of age, race, sex, and stature. These four components of the biological profile aid in the identification of an individual in the forensic context. Since the beginnings of the field of physical anthropology, osteologists and anatomists have studied human remains in order to provide new and innovative ways of building the biological profile.

Two published studies have attempted to estimate stature from measurements of the scapula. Campobasso et al. (1998) found that certain measurements of the scapula were highly accurate in estimating the stature of males and females from an Italian population. Shulin and Fangwu (1982) concluded that other measurements of the skeleton were more useful in estimating stature than the maximum scapular breadth for a Chinese population.

The current research expands upon both of these previous studies using an American population collected from the Hamann-Todd Osteological Collection at the Cleveland Museum of Natural History. In so doing, this researcher hypothesized that there was a significant relationship between one or more measurements of the scapula and living stature. Additionally, significant measurements were submitted for multiple regression analysis in order to create regression formulae useful in estimating stature.

After taking eleven measurements of the scapula, these variables were regressed against the stature measurements (N=223) provided in the Hamann-Todd Human Collection Database. The results show that several variables including the length of the scapular spine, the maximum acromion-coracoid distance, the length of the axial border, the length of the coracoid, and the maximum scapular breadth significantly contribute to stature. Additionally, race also significantly contributes to stature. Regression formulae were calculated for populations when race is both known and unknown. After applying each of these formulae to a smaller test sample, results show that, unlike the findings of Campobasso et al. (1998), stature could be predicted for all individuals with an accuracy of 27%, for blacks with an accuracy of 50%, and for whites with an accuracy of 36%.

Stature, Scapula, Biological Profile

H18 A Pilot Study on Nuclear DNA Recovery From Charred White-Tailed Deer (*Odocoileus virginianus*) Bone Tissue

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After attending this presentation, attendees will understand recovery of compromised DNA from charred bone remains from three commonly used incendiary liquids.

This presentation will impcat the forensic science community by identifying if certain bones yield more DNA than others, especially after being burnt, although this study uses white-tail deer as an animal mode. Criminals often attempt to hide proof of the crime by burning evidence. Both wildlife and human homicide investigators will benefit from the results charred bone DNA analysis can give to their respective forensic inquiry.

The proposed study utilizes White-tail deer (*Odocoileus virginianus)* as an animal model to study the effects of different accelerants on long bones. The sample location (i.e., tibia, femur, and/or patella) was also compared to determine the best area from which to extract DNA. The population for the proposed study is legs from white-tail deer recovered from road kill. Samples were obtained in conjunction with the Pennsylvania Game Commission from Pennsylvania roadways. Time of death was estimated using ocular fluid reflectivity based on an established index used by wildlife officers. One of the legs was reserved as a control from each specimen. The remaining three legs were incinerated with gasoline, kerosene, or lighter fluid respectively. These accelerants are considered to be the most commonly used to conceal criminal behavior by investigators. This study will comprise a total of ten deer, with an associated sample size of 40 appendages, using three bone fragments from each appendage.

Appendages were soaked in a heated solution of water and sodium carbonate to ease removal of the soft tissue surrounding the bone. After elimination of all adhering tissue, each bone fragment was pulverized in a sterile coffee grinder. DNA from the subsequent bone powder was extracted using the standard silica ancient DNA protocol (Paablo and Moss). Each sample was genotyped using a custom designed STR multiplex. Multiplexing utilized primers previously designed by Anderson et al (2002) for white-tail deer populations. The modified multiplexes consisted of eleven STR primers separated into two PCR panels determined by base pair (bps) size and fluorescent label color. The white-tailed deer STR panel utilized two primer mix cocktails, which were run through an EdgeBio filter cartridge. These cartridges are essential when working with in-house multiplexes as they remove any unincorporated fluorescent labels. Stacking of salts, which is a common problem associated with non-commercial multiplexes, is also diminished via the filter cartridge. The samples were then run on an ABI 3100 Avant genetic analyzer. Allele sizes were binned and exported to a computer spreadsheet. Complete and partial genetic profiles were identified and scored for each appendage bone fragment.

Although this study uses white-tail deer as an animal model, it impacts the forensic community by identifying if certain bones yield more DNA than others, especially after being burnt. Criminals often attempt to hide proof of the crime by burning evidence. Both wildlife and human homicide investigators will benefit from the results charred bone DNA analysis can give to their respective forensic inquiry. This study purports to demonstrate that nuclear DNA can be extracted from remains containing extremely degraded DNA and previously only typed for mitochondrial DNA sequencing. It also outlines the development of a microsatellite multiplex, which will be used as part of Duquesne University's service learning component. In this capacity, future students can assist Pennsylvania game commission officers on white-tail deer poaching cases, incorporating collection and documentation techniques learned in another two semester long course, Criminal Investigations.

Charred Bone, DNA, Accelerants

H19 Rolling Bones: A Field "System" for the Recovery and Transportation of Fragile Skeletal Evidence

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After attending this presentation, attendees will be better able to preserve, recover, document, and transport fragile skeletal remains and other evidence encountered in field situations.

This presentation will impact the forensic community by demonstrating how an inexpensive, easily available material (aluminum foil) can be used as the basis for a "system" to protect the integrity of fragile evidence.

Skeletal remains are encountered. Usually, local and other law enforcement recover them and bring them to the nearest coroner or medical examiner – maybe even to the nearest forensic anthropologist. How often do they arrive jumbled in a body bag, paper bag or a box, where the bones rattle around, break themselves up and in general destroy the direct evidence that bones provide? How to preserve the integrity of fragile, even fragmentary, skeletal remains? How to document the relationship of bones and fragments to each other and to other material evidence in or on the ground? How to safely recover fragmented and fragile material evidence other than bone?

In 1976, the Sauls excavated their first ancient Maya skeletons (Cuello site in northern Belize).[1] They encountered poor bone preservation due to the destructive actions of plant root penetration, burrowing critters, and alternating rainy and dry seasons. Skeletal remains were fragile, fragmentary and incomplete.

During the late 1970s and early 1980s, they received and analyzed shipments of additional burials from Cuello that were excavated by the project in their absence. The chemical impregnation techniques in use at the time were not easily reversed, damaged the bone, and potentially interfered with molecular analysis. The traditional wrapping of remains with toilet tissue, often while wet with preservative, made things even worse. Traditional field diagrams were based on the assumption (often wrong) that the excavators had identified each fragmentary, bone or bone fragment and its orientation in situ.

This research was motivated to develop a different approach when next in the field at Cuello. The technique was further refined during several excavation seasons at various sites in the Maya area, and subsequently applied it to forensic work. This procedure involves the use of aluminum foil for both retained alignment of fragmentary bones during removal from the grave, and packaging of the bone for transport. During removal the foil becomes the package, maintaining the relationships of bone fragments and protecting them from further breakage. A technique of "rolling out" and lifting fragile, fragmented bone (or other evidence) using foil was also developed, further maintaining integrity and preserving information.

A number and orientation end-mark can be written on individual foil packages with a felt-tip marker, corresponding to the number and

end-mark recorded on the "rough working" burial plan. When the packages are appropriately labeled and field mapped in situ, the orientation of each bone (and therefore the body) in the grave can be more easily determined in the laboratory. In essence, the bones can be "put back the way they were in the ground", revealing finer nuances of body position and other relationships. This "rough working burial plan is the one that goes with the bones to aid in analysis". "A more carefully drawn official" burial plan is also produced for reports.

This very simple and inexpensive system for preservation, recovery, documentation, and transport of skeletal (especially fragmentary skeletal) remains has been field tested in both archaeologic and forensic situations for more than 30 years. Useful with postcranial bones, skulls also lifted and packaged in foil retain their teeth, cranial fragments are held in position, and fragile facial bones are protected.

This training and this technique have paid off. Remains recovered by individuals who have taken our course are coming to us in much better condition. Skulls wrapped in foil have all the teeth they were found with and facial bones are not broken en route. Other bones are not breaking each other up inside paper or plastic bags. Important relationships are maintained within the packages. More information (evidence) can be obtained.

Those who have taken the OPOTA course are often assisted by other investigators in recoveries, and now some of these other individuals have begun to carry foil with them in their kits.

Reference:

[1] Saul, JM, Saul, FP, Thompson, LM. *Recovery and Documentation of Skeletal Remains: A Brief Field Guide,* Programme for Belize Archaeological Project Field Guide Series 1, Occasional Papers, Number 7, Mesoamerican Archaeological Research Laboratory, The University of Texas at Austin, Austin; 2007.

Skeletal Recovery, Skeletal Preservation, Skeletal Transport

H20 The Effects of Fire Suppression Techniques on Burned Bone

Briana K. Curtin, BA, 1901 Elaine Drive, St. Joseph, MO 64505*

After attending this presentation, attendees will understand the causes and types of secondary fractures produced on burned pig (Sus scrofa) bones by two distinct fire suppression techniques: (1) water from a portable fire engine with a pressurized hose; and (2) hand-held compressed air/chemical portable fire extinguishers.

This presentation will impact the forensic community by presenting the differences of fracture patterns produced by natural burn, natural cooling, handling, pressurized water, and hand-held compressed dry chemical portable fire extinguishers. Results from this study will allow forensic anthropology practitioners to better discriminate between fractures caused by heat exposure and those caused by fire suppression techniques. In particular, this research will clarify the description and identification of fracture patterns resulting from the two most common suppression techniques employed at fire scenes.

Pope and Smith (2004) discuss five typical fire scene events that damage bone: (1) falling debris; (2) heat embrittlement; (3) types of fire extinguishments; (4) manual handling of the burned remains; and, 5) transport of the burned remains. This research will focus upon fire extinguishment methods. It will be shown that burned remains extinguished by pressurized water or portable fire extinguishers produce differences in secondary trauma fragmentation and fractures compared to burned remains allowed to cool naturally (i.e., no fire suppression technique employed).

This study examines the results from experimentally burning four intact fleshed pig carcasses for four hours on mattresses. Test one involves burning the fleshed remains of one whole pig with no method of fire suppression employed, with the remains allowed to cool naturally. Test two involves physical removal of the burned remains from the fire and allowed to cool, which simulates conditions where firefighters hastily remove remains from the fire scene. Test three examines the effects of using pressurized water extinguishment from a fire engine. Test four examines the postmortem condition of burned remains that were extinguished using a hand-held compressed air/chemical portable fire extinguisher.

Several variables are held constant for each of the four tests: size of the fire and amount and type of fuel, size of the pig, temporal exposure of the body, and condition of the bone (DeHaan 2002). In addition to these variables, the duration of the fire will be held constant for tests two through four, which will be allowed to burn for four hours, the approximate time it will take for the majority of appendicular bones to be defleshed and fractured from heat (de Gruchy and Rogers 2002).

Comparisons between the burned bones from each of the four tests (natural cooling, cooling and manual removal from the fire, pressurized water, and hand-held compressed dry chemical portable fire extinguisher) will be outlined. Examination of secondary post-fire fractures caused by the different types of suppression techniques will be performed through both macroscopic and microscopic comparative analyses, with variables including bone fracture type and size, fragmentation degree, length, width, and external/internal color scored for each bone. Type of trauma, distinguished between heat-related fractures caused by fire, post-fire fractures caused by handling/external pressure due to fire suppression and post-fire fractures caused by handling and transport alone will be demonstrated. This ability to distinguish between heat-related, post-fire extinguishment, and post-fire handling fractures is important to forensic anthropologists who are confronted with burned bones, and this research will allow practitioners a better understanding of the mechanisms of bone fracture caused by fire suppression techniques.

Burned Bone, Fire Suppression, Secondary Fractures

H21 Burned Beyond Recognition: Can the Biological Profile Be Estimated From Unprocessed Human Cremated Remains?

Teresa G. Nugent, BA, Texas State University, 601 University Drive, ELA 232, San Marcos, TX 78666*

After attending this presentation, attendees will understand the potential for determination of biological profile from bones that are believed to be "burned beyond recognition" based on macroscopic observations of unprocessed, cremated human skeletal remains.

This presentation will impact the forensic community by providing investigators with an indication of the skeletal elements that most frequently survive high temperature fires of lengthy duration and the patterning of preservation of the bony elements that are typically used to estimate the biological profile.

The biological profile of unidentified human skeletal remains is an integral part of forensic investigations and analyses. Cremation makes establishing a biological profile difficult due to the thermal destruction and associated fragmentation of bone. However, Stewart (1979:67)[1] emphasized that a "good number of skeletal parts often survive the firing with characteristic features intact enough to be recognizable as human." Because there are a limited number of publications that corroborate Stewart's observations (Bass 1984; Bass and Jantz 2004; Bohnert 1998; Brickley 2007; Eckert et al 1988; Murat 1998; Warren and Schultz 2002),[2] this study evaluates the potential for estimation of the biological profile based on macroscopic observations of unprocessed cremated human skeletal remains from contemporary commercial cremations. This presentation will impact the forensic community by providing investigators with an indication of the skeletal elements that most frequently survive high temperature fires of lengthy duration and the

patterning of preservation of the bony elements that are typically used to estimate the biological profile.

Data for this study were gathered from blind macroscopic analyses of 18 individuals from the collection of documented human cremains from the University of Tennessee's William M. Bass skeletal collection. These individuals were cremated using standard crematory procedures at temperatures between 1600-1700°F (870-926°C) for similar duration and were not mechanically pulverized. Use of these cremains allowed for an in depth examination of burned bone without debris such as building materials, soil, melted glass, and plastic that often confound the recovery of human remains at fatal fire scenes. Specific skeletal elements (pelvic, cranial, mandibular, vertebral, and certain long bone epiphyses) were selected as the focus of this study due to their standard use in estimating the biological profile. Because of the fragmentary nature of the sample, elements were not laid out in anatomical position, instead each element was reconstructed to the extent that preservation allowed and examined on its own. Each set of cremains was inventoried using the fragmentary remains inventory procedure described in Ubelaker and Buikstra's Standards for Data Collection of Human Skeletal Remains (1994). Once an element was identified and sided, the completeness was determined and scored as 1 = > 75% present (or "complete"), 2 = 25%-75% present (or "partial"), and 3 = < 25% present (or "poor"). Paired elements were scored separately. In addition, degenerative changes, skeletal age markers, and pathology were recorded. Data reported here include: (1) the frequency of which skeletal elements relating to the biological profile most often survived cremation; (2) whether there was consistency in preservation of particular elements from one cremain to the next; and, (3) whether preserved elements included features that could be used to estimate age and sex.

Results showed that the bones of the cranial vault preserved in over 90% of the individuals in the sample. Cranial preservation frequencies were 94.4% for parietals, 91.6% for frontal, 91.6% for occipital, and 91.6% for temporals. Of the postcranial elements, only the proximal femur had a preservation frequency above 90%. Postcranial preservation frequencies were 94.4% for proximal femora, 88.8% for proximal humeri, 86.1% for ischia, and 82.8% for acetabulae. Age and sex indicators from the pelvis and cranium were less frequent, but observable. The following indicators of sex were observed from the pelvis: ventral arc (8.3%), subpubic concavity (2.7%), ischiopubic ramus ridge (8.3%), greater sciatic notch (16.6%), and preauricular sulcus (13.8%). The following indicators of age were observable from the pubic bone: auricular surface (52.7%) and pubic symphysis (27.7%). The following indicators of sex were observable from the cranium: nuchal area (27.7%), mastoid processes (22.2%), supraorbital margins (38.8%), and glabellar region (5.5%).

The results from this study clearly support earlier work done on estimation of the biological profile using human cremains. From this presentation, attendees will take away a greater understanding of the potential for determination of biological profile from bones that are believed to be "burned beyond recognition."

References:

1 Stewart, T.D. 1979. Essentials of Forensic Anthropology.

2 Springfield: Charles C. Thomas.

Cremains, Biological Profile, Burned Remains

H22 Effects of Heat-Modification on Sharp Force Trauma in Charred Remains

Daisy D.M. Vincent, MA, 29 rue des Poudrieres, Neuchatel, 2000, SWITZERLAND*

The goal of this presentation is to evaluate the significance of heat-modification on sharp force trauma found in charred remains.

This presentation will impact the forensic community by demonstrating that the influence of heat on sharp force trauma found in charred remains is minimal and that the forensic analysis may be carried out with accuracy.

Postmortem criminal burning holds a prominent place in attempts to delay the identification of the victim and the cause of death. Previous experiments have focused on the microstructure of the bone, qualitative changes such as color, shrinkage and warping, and to a lesser extent, trauma in relation to fire modification. Due to the reaction of bone microstructure to fire, it is expected that trauma would be affected as well, which may have an effect on the accuracy of its analysis.

This experiment explores qualitative and quantitative differences between sharp force trauma found on heated bone and on normal bone. The first part of this project focuses on the qualitative effects of heat and fire modification on sharp force trauma. Variability of color shades, as well as the shape of the edges and extremities were documented. The quantitative analysis includes measurements of the defects and of their related morphological features. Depth at each extremity, width of the internal extremity, width at the border of the rib and size of the bone raising at border were recorded. A count of associated fractures and a measurement of the angle of penetration were also included in the quantitative analysis.

Forty-eight fresh domestic pig carcasses were stabbed four times in the left ribs with a utility kitchen knife mounted on a guillotine to obtain stabs of similar orientation and force. The carcasses were stabbed perpendicularly to the ribs. Half the sample (24) was subsequently charred using Propane UN1978 blowtorches. They were superficially charred on their entire side and exposed to flames directed into the trauma sites for 10 to 20 minutes. The process was stopped when the epidermis flaked off and the trauma sites had opened into oval-shaped, gaping wounds with deeper charring on the neighboring soft tissues. The interface temperature of the blowtorches varied between 985 and 1070 degrees Celsius. The carcasses were monitored during decomposition at the TRACES facility in northwest England, and the ribs were collected at various stages of decomposition. After maceration, the trauma sites were analyzed both macroscopically and microscopically. Microscopic analysis included light microscopy qualitative observations and scanning electron microscope measurements. The final sample contained 50 control cut marks and 92 experimental cut marks.

A detrended correspondence analysis and an analysis of similarity (ANOSIM) were used to interpret the qualitative data. The ANOSIM, using the Bray-Curtis dissimilarity coefficient, showed that there is no significant difference between the groups based upon location, morphology and color ($R=0.01372$, $p=0.28394$).

A multivariate analysis of variance (MANOVA) and a principle components analysis were used to analyze the quantitative data and identify the significant variables. The multivariate analysis of variance showed that there is no significant difference between the groups. (Pillai=0.27526, $F_{8,57}=1.16417$, $p=0.33656$). A principle components analysis identified two variables explaining 99% of the variance between the cuts marks: width of the defect at the border of the rib and size of the raising at border.

The results of this experiment show that in charred remains, heat does not seem to affect the shape, size and characteristics of the trauma defects. This discovery is significant as it indicates that tool mark analysis and sharp force trauma analysis can be carried out with the same level of accuracy than on normal bone. It is however expected that a modification of the trauma features may be observed at higher degrees of temperature and longer exposure to heat and fire. More data needs to be collected to evaluate at which stage heat modification may start to significantly affect sharp force trauma features and the accuracy of forensic analyses.

Sharp Force Trauma, Charred Remains, Scanning Electron Microscope

H23 Teaching Forensic Field Methods to Anthropology Students: The University of West Florida Model

A. Joanne Curtin, PhD, University of West Florida, Department of Anthropology, 11000 University Parkway, Pensacola, FL 32514*

After attending this presentation, attendees will understand the scope of forensic anthropological field training offered at University of West Florida.

The purpose of this presentation is to describe the field methods course currently offered at University of West Florida, and to open a dialogue with other institutions offering similar courses, with the ultimate goal of improving the training of undergraduate and graduate students in forensic anthropology.

Continuing education courses ("short courses") in the documentation and recovery of human skeletal remains are offered for law enforcement personnel at numerous institutions across the United States. Academic courses devoted to training anthropology students in forensic field methods are fewer in number, and more variable in their content. The purpose of this presentation is to describe the field methods course currently offered at the University of West Florida (UWF), and to open a dialogue with other institutions offering similar courses, with the ultimate goal of improving the training of undergraduate and graduate students in forensic anthropology.

Since 2008 UWF has offered a dedicated forensic field school whose goal is to train graduate students and senior undergraduates in the skills required to handle forensic field recoveries. These situations require solid project management skills. Each forensic case is unique, so responders must be able to assess each scene, make an informed decision as to whether skeletal elements are human or not, devise an efficient strategy for locating, recording and recovering remains, work collaboratively as team members with other anthropology students, and with professionals from other fields (forensic investigators from the medical examiner's office, crime scene specialists from law enforcement, dog handlers, etc.). The data collected must be accurate and meet contemporary evidence standards. Finally, responders must be able to communicate the results of their investigations clearly and unambiguously.

At UWF, students receive training in technical skills such as compass use, line search, establishment of grids, setting up/running an optical survey instrument, excavation, measurement, and field photography, and broader project management skills (ability to assess needs, determine efficient solutions, delegate tasks, contribute constructively to team dynamic, and communicate effectively). Students first receive classroom instruction in relevant field techniques, and then are required to apply their knowledge and skills initially in a series of "mock" forensic scenes including both surface scattered remains and clandestine burials, and later in a real cemetery excavation. Finally, each student is required to write two case reports, one describing the recovery of surface remains, and one for buried remains. Once they have successfully completed the course, students may assist in actual forensic case work, under the supervision of faculty members.

Forensic Field School, Survey Methods, Excavation Techniques

H24 Fatal Fire Modeling: Replicating Environmental and Human Factors Associated With the Recovery and Analysis of Burned Human Remains

Elayne J. Pope, PhD, Anthropology Department, University of West Florida, Anthropology Building 13, 11000 University Parkway, Pensacola, FL 32514*

The goal of this presentation is to present replicative modeling of structural and vehicular fires provides forensic scientists with the opportunity to identify specific variables that are directly correlated with the production of burn patterns, which serves to improve the overall accuracy and reliability of our analysis of burned human remains.

This presentation will impact the forensic science community by showing that just as each fire scene is unique, so are the burn patterns produced on the body, which directly result from being exposed to different types of environmental conditions during and after the fire.

A year ago, a report by the National Academy of Sciences called for higher standards and increased accuracy of scientific research in the forensic sciences. Experimental replication of known and realistic conditions is but one of several solutions that forensic anthropologists can use to address these concerns. Traditionally, our investigation of burned human remains begins in a laboratory setting, which is far removed from the *in situ* context of the taphonomic changes that originally produced the skeletal burn patterns used in our analysis. This presentation will show that just as each fire scene is unique, so are the burn patterns produced on the body, which directly result from being exposed to different types of environmental conditions during and after the fire. Replicative modeling of structural and vehicular fires provides forensic scientists with the opportunity to identify specific variables that are directly correlated with the production of burn patterns, which serves to improve the overall accuracy and reliability of our analysis of burned human remains.

A total of eight donated human cadavers were burned different environments that replicated actual forensic casework using two vehicles, four furnished burn cells (structures), a travel trailer, a dumpster, and a light craft airplane that had crashed into a building. Though these seem like random scenarios, many of these environments produced patterned similarities, as well as differences, depending on the types of combustible fuels, objects in contact with the body, duration, and methods of extinguishment. All of the experiments went to flashover (where all contents ignite), and burned for a duration of 15-30+ minutes.

Combustibles and Points of Contact*:* Initially during the fire, certain surfaces of the body remained protected from heat, since they were in direct contact with other objects (floor/furniture/fabrics/seats). However, these points of contact gradually changed as the furnishings burned away and from limb flexion into the pugilistic posture, which exposed more surfaces of the body directly to heat. Bodies that remained elevated from the floor on exposed mattress springs, seating frames (household and vehicular) had more uniform heat-related damage to soft tissues and bone than those that remained directly in contact with a flat surface (metal bench/floor/stove/trunk) during the fire.

Fallen Debris: During the fire, especially after flashover, various types of debris collapsed onto and around the body, more so for structural fires than vehicular. This process created two different taphonomic artifacts of fragmentation and protection. Collapse of fire debris increased fragmentation of brittle burned bone from impacts to the body and/or from the body shifting position as supportive materials

burned away. Debris also provided more areas of protection from direct flame and dehydrated the remaining soft tissues. For example, the aircraft crash fire burned for 20 minutes with temperatures over 2000° F that destroyed the body of the plane and part of the building, yet the human body remained well protected from being buried in fire debris, leaving only the face, hands, and knees exposed.

Human Factors: Scenes were realistically extinguished by firefighters with pressurized water, then searched and excavated by fire and death investigators, who had no prior knowledge of the original conditions. Each of these activities contributed to the further breakdown and alteration of burned human remains. This inherent problem was minimized with extensive photographic documentation of the original *in situ* context of the victim and the entire field investigative process.

Results from these documented structural and vehicular fires will be presented to illustrate the how each kind of fire environment produces different types of burn patterns and should be considered when analyzing burned human remains, along with postmortem changes from human factors during recovery.

Fatal Fire Investigation, Burned Human Remains, Taphonomy

H25 Differentiating Peri- and Postmortem Fractures in Burned Postcranial Remains

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The goal of this presentation is to examine how preexisting skeletal trauma alters the normal heat-related changes of the soft and skeletal tissues, causes limb deformation, and produces characteristic burn patterns in the bone that are discernable from normal heat-related fractures.

This presentation will impact the forensic science community by demonstrating how there are identifiable characteristics of peri-mortem trauma in poscranial remains that alter the normal burn patterns for each limb and leave permanent evidence of injury after the fire.

The classic characteristics of peri-mortem and postmortem fractures are relatively easy to determine in skeletonized long bones, however this distinction becomes more difficult to assess in burned human remains. When bone is exposed to heat, it undergoes systematic biochemical and structural changes from pyrolysis that can result in charring, calcination, heat-related fractures, and fragmentation, all of which makes it very brittle during and after the fire. This presentation examines how preexisting skeletal trauma alters the normal heat-related changes of the soft and skeletal tissues, causes limb deformation, and produces characteristic burn patterns in the bone.

Blunt force trauma was intentionally produced in long bones of 10 limbs prior to burning and documented for their post-fire condition as they would appear at an actual scene, followed by laboratory analysis. The characteristics of preexisting trauma was evaluated for the type of wound (closed or open), contextual soft and skeletal anatomy for the upper and lower limbs, degree of limb deformation (*in situ* and after recovery), heat-related color changes, and morphology of the fracture margins. These were then compared to characteristics of normal postmortem heat-related and post-fire handling fractures that are commonly produced during and after the fire.

Peri-mortem Skeletal Trauma Characteristics: It takes a considerable amount of external force to produce fractures in living and green bone, especially while being protected within soft tissues. Long bones of the appendicular skeleton have been shown to fracture predictably based on variable of area and amount of force, cortical and trabecular thicknesses, injury types, and other biomechanical factors (Galloway 1999). This study found that additional factors contribute to the heat-related changes of peri-mortem trauma in burned postcranial remains. One of the biggest influences was the anatomical arrangement of muscle and soft tissues around the bone itself.

Muscle Protection: Muscle is dense and fibrous, and heat exposure causes it to gradually shrink and retract, regardless if the bone is intact or not. It was observed that in thicker musculature of the thigh that the broken margins pulled over one another in the charred muscle. In contrast, limbs that had differential amounts of soft tissue, such as the lower leg, the fractured ends of the anterior tibia protruded into the fire environment as the thicker musculature of the calf continued to shrink and opened the broken areas open like a hinge. Both conditions caused marked limb deformation that is observable after the fire.

Open or Closed Wounds: The soft tissue wound around the fractured bone also influences the heat-related changes of limb deformation and condition of the fractured margins. Open wounds (compromised layers of soft tissue) exposed the fractured margins the earliest and longest to the fire, thus producing abnormal burn patterns and heat-related changes to the bone. Closed wounds did not always expose the fractured ends to the fire, since they remained protected and overlapped within charred muscle, but still shows marked limb deformation.

Limb Anatomy: The upper arm and leg both have a singular bone, which are more uniformly protected by musculature. In contrast, the lower arm and legs have two bones with irregular distributions of musculature around each bone, particularly the lower leg. One of the variables tested was to examine the differences of breaking one or both bones within the same distal limb. Fractures to both bones resulted in marked limb distortion, while fractures to a single bone resulted in partial limb deformation. Neither condition affected the pugilistic position of distal joints below the traumatized sites.

Fracture Morphology: Fractured margins from peri-mortem trauma exhibited one or several identifiable characteristics of (1) fractures in or extending into unburned bone; (2) stark color differences divided by a fracture; (3) pieces of fractured bone present in charred musculature; and/or, (4) deformation/erosion of the fracture margin and sometimes color differences (in charred and calcined bone).

Postmortem Heat-related Characteristics: Heat-related fractures in bone result from direct exposure and the depletion of organic components during the process of pyrolysis, thus causing the external surfaces of cortical bone to shrink and split. At this point, minimal force applied to burned bone can result in fracturing and fragmentation during and after the fire. These and other postmortem fracture characteristics of burned human remains will be presented.

Peri-mortem Skeletal Trauma, Fractured Long Bones, Burned Bone

H26 Towards a Standardization of Burnt Bone Analysis: The Use of Micro-Computed Tomography and 3-Dimensional Imaging to Assess Morphological Change

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After attending this presentation attendees will learn of the issues surrounding analysis of burnt bone from a forensic anthropological basis,

and methods which may be applied using advanced 3D imaging techniques in order to standardize and obviate some of these issues.

This presentation will impact the forensic science community by presenting a novel standardization method for the quantitative analysis of burnt bone, and raise significant issues with the methodology expounded by the current and historical literature.

An understanding of the heat induced alterations to bone is a necessary prerequisite for the subsequent identification of burned human remains. Fire, or any form of combustion, has the capability to alter, damage, or destroy evidence that is vital to the identification process. However, since bone undergoes extensive alterations when exposed to heat, the accuracy of standard identification methods will therefore be detrimentally affected. In spite of this, there is still a great deal not fully understood regarding the transformative processes that heat causes to bone and the most appropriate method for study. This is in part due to the large variation in experimental models used by investigators. Different temperature intervals, recorded measurements, and statistical analysis have lead to confusion in the literature regarding the typical mechanism and expression of heat alteration. Although there is a growing corpus now available to facilitate more accurate interpretation and analyses of burned bone, these studies are largely based on qualitative features and are, at best, misleading. Without quantitative measurements, there is no way to account accurately for the heat induced alterations that bone experiences, or modify current anthropological techniques. Recording quantitative measurements can therefore help to standardise burnt bone analysis, improve current analytical methods and, in the process, meet the imperative need to develop more accurate identification techniques for burned human remains.

The primary goal of this research was to quantify morphological and morphometrical differences between pre-burn and post-burn skeletal specimens (before and after burning comparison) using advanced micro-imaging and three-dimensional volumetric techniques. The experimental investigation was conducted on a data set of porcine skeletal elements burned between 300°C and 1200°C. Differences between the use of embalmed and unembalmed specimens were also investigated. The material was scanned before and after burning using Micro-Computed Tomography and 3D surface laser scanning. The resulting pre- and post-burn CT and surface scans were analyzed using volumetric reconstruction software in order that a comprehensive qualitative and metrical assessment could be carried out between the pre and post-burn homologues. Numerical data, which could be statistically analysed for the quantification of heat-induced alterations, was obtained by generating volumes of interest (VOI). Interpolation and resampling was applied to the resulting VOI. This allowed us to investigate and quantify the percentage change in standard histomorphological skeletal characteristics between the pre- and post-burn states. The cortical thickness of each specimen was also measured in order to calculate average volume change. Changes in surface shape, morphology, and distortions were quantified using Geomagic best-fit contour alignments.

The study found recognizable quantifiable morphological change between the pre- and post-burn homologues, some of which run counter to established expectations of thermal alteration from published sources. In particular, although an increase in trabecular thickness and subsequent decrease in trabecular separation was expected (due to the well-documented loss of carbonates during inversion and fusion) this trend was not achieved during this investigation. The results show a decrease in trabecular thickness at 600°C and 900°C, and although recorded to initiate at 500°C, both features showed a marked change at temperature as low as 300°C. These deviations from the normal trend can all be explained by the high presence of bone marrow in the rib sections; this reflects the process of "normal" anatomical burning whereby tissues contain their full complement of inorganic and organic components (including marrow and fat), highlighting the need to establish element specific models for each anatomical region.

Burnt Bone, Computed Tomography, Forensic Anthropology

H27 Mama Mia! Murder and Disposal of a Corpse in a Pizza Oven

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The goal of this presentation is to provide the attendee with a case example involving the dismemberment and burning of the remains of an adult male in a commercial pizza oven. As a result of the remains being burnt to a near carbonized state, determination of personal identification and cause of death were found to be somewhat problematic. As a result of the condition of the remains, forensic anthropologists were consulted so as to assist not only in the identification but to make to determinations as to the temperatures required to render the remains in their burnt state. Forensic anthropological methodology, utilized in this case will be presented to the attendee to demonstrate its importance in the investigation of fire death and disposal of human remains by fire.

This presentation will impact the forensic science community by greatly assisting the attendee with forensic anthropological concepts and techniques which can be applied to a variety of cases involving the burning of human remains.

In cases involving homicide, the body of the victim is often burned as a means of hiding the crime and eradicating features of personal identification. Various methods of disposing of a corpse by burning have been reported, including burning of the deceased in a house, car, fireplace, or in a fire pit or fire barrel. The degree of body cremation is dependent on a number of factors ranging from the type of heat source, temperature, time, and position of the body within the heat source. This case involves a unique case of body cremation in which the deceased was cut up into several portions and placed on aluminum pizza trays in a 600 degree fahrenheight commercial pizza oven. In August of 1993 in the city of Surrey British Columbia, a fire was reported at the "pizza king" a local pizzeria. Local fire fighters responded to the scene and quickly extinguished the fire which was observed roaring from the large pizza oven in the back of the restaurant. Inspection of the oven to determine the cause of the fire, revealed the badly burnt skeletal remains of a human body. Police were summoned to the ghastly scene only to discover additional evidence of a brutal murder. A search at the rear of the restaurant led to the recovery of a large plastic trash bag containing clothing items of the deceased which were stained with blood. A total of four large pizza pans were recovered from the oven, each holding multiple burnt skeletal elements. Additional burnt human remains located on the floor of the oven were also recovered.

Examination of the remains at the coroner's facility revealed that the body had been cut into the following segments: head, arms plus upper thorax to the bottom of the rib cage, remaining thorax, spine and pelvic girdle, the left leg, and right leg. Anthropological analysis of the remains found them to represent that of a senior adult male. Identification of the deceased was later established via odontological comparisons as that of a recent immigrant from India. The antemortem height and weight of the deceased was reported to be approximately 65 inches and 130 pounds respectively. The temperature conditions in the pizza oven not only reduced the copse to cremains, but were great enough to produce partial melting of the heavy aluminum pizza trays. One of the key questions concerning the investigation of the murder was the time and temperature required to reduce the human remains to their present burnt state. Data utilized to interpret the cremation of the remains included information on the construction and operation of the gas fueled oven, maximum obtainable temperature, and coloration and density changes observed in the cremains. The cremation findings will be presented along with other details regarding the murder investigation.

Cremains, Forensic Anthropology, Homicide

H28 XRD and FTIR: A Diagnostic Tool to Determine Whether or Not a DNA Profile Can Be Successfully Generated From Heat Treated Bone Prior to DNA Extraction

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After attending this presentation, attendees will understand the effects that temperature has on the material and physical properties of bone and their subsequent correlation with DNA amplification and typing.

This presentation will impact the forensic science community by demonstrating that XRD and FTIR can be used to predict whether or not a DNA profile can be obtained from heat treated bone, prior to DNA extraction.

Deoxyribonucleic Acid (DNA) from skeletal tissue can be invaluable, as it is often the only available source of information for individual identification. Bone is considered a tri-phase composite, made up from collagen (protein), hydroxyapatite (mineral) and water. Unlike soft tissue, osteocyte cells, which are the source of DNA in bone, can be protected from external environmental factors by the protein-mineral matrix. However, when skeletal tissue is exposed to extreme conditions, including high temperature or long periods of submersion in water, the potential for generating a useful 'DNA profile' can be adversely affected. Although heating has been shown to cause damage to DNA through oxidation and hydrolysis, there has been very little detailed research into the amplification of DNA from bone compromised by heat. Studies have often lacked appropriate controls or were based on case studies where accurate environmental parameters, such as temperature and/or the exposure period were unknown.

To date, DNA-based identification from badly decomposed remains has often been reliant on the use of mitochondrial DNA (mtDNA), which exists within cells in much higher abundance than nuclear DNA (nDNA). However, mtDNA is only inherited through the maternal line. This reduces the usefulness of identifications made using mtDNA, as matrilineal relatives cannot be distinguished from one another. nDNA profiling of such samples would greatly improve the specificity of identification.

By comparison to soft tissue, the protocols for extracting DNA from bone are often time-consuming and laborious, usually requiring a demineralization step prior to extraction, which can take a number of days. In the case of skeletal tissue that has been compromised by environmental insults, even more time can be 'wasted' as not all the samples extracted will successfully produce a useable DNA profile. In individual cases, time may not be a critical issue. However, in cases where hundreds or thousands of samples are processed, such as in the World Trade Centre attacks (2001) where 13,000 samples were processed, a large amount of time and money was wasted on unsuccessful profiles.

The goal of this project is to develop a diagnostic tool that can reliably predict the likelihood of successfully obtaining a useable DNA profile from a compromised skeletal tissue sample. Mechanical properties, such as hardness and elastic modulus and material properties, such as collagen content and mineral content, of bone that has been compromised through heat treatment, will be correlated with the results of nDNA profiling.

Using *Bos taurus* as an animal model, sections of femora were heat treated, using a muffle furnace, at 50 °C intervals to 600 °C for periods of one and two hours. Post treatment, Vicker's hardness was recorded, and the Crystallinity Index (CI) of samples' mineral content measured using X-ray diffraction (XRD) and Fourier Transform Infrared imaging Spectroscopy (FTIR). These properties were then correlated with the presence of detectable nDNA as determined by the PCR amplification of 100, 300 and 500 base pair fragments and STR based DNA profiling.

The results of this study show that the characteristics of bone change when heat-treated. XRD and FTIR findings showed that the crystallinity of hydroxyapatite increased with temperature, while Vicker's hardness was seen to increase until 200 °C then suddenly decrease before a rapid increase at 300 °C. The ability to amplify DNA and hence obtain a DNA profile genotyping was lost above 200 °C. Using logistic regression both FTIR and XRD were shown to produce a CI value that could be used to successfully predict whether or not a DNA profile could be obtained.

The ultimate goal of this study is to produce a diagnostic tool that can be performed quickly and cheaply, in order to determine whether subsequent DNA profiling is a viable/cost effective option for identification purposes. Such a tool would not only save time and money, but would increase the overall success rate of DNA profiling.

Predicting DNA, HeatTreated Bone, Temperature

H29 Taphonomic Patterns: Can Brush Fires Mimic the Natural Decomposition of Heavy Muscle Markers on Bone?

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After attending this presentation, attendees will understand that brush fires are capable of creating discoloration patterns similar to those which occur on human bones from the natural progression of decomposition. This will be evaluated using three stages of decomposition: fresh, advanced decomposition, and skeletonization.

This presentation will impact the forensic community by introducing ground breaking heat related skeletal trauma research that has not previously been evaluated. Although heat related skeletal trauma has been studied in house, crematorium, and car environments, it has rarely, been studied in outdoor environments and never examined in a maritime environment. This research will impact the forensic community by helping discern the stage of decomposition for burned human remains that were exposed to a brush fire. It will also contribute to the breadth of information available on the identification of heat related skeletal trauma and the interpretation of morphological color characterizations.

Brush fires in Nova Scotia typically occur from April to June. Rare, but still occurring, is that humans fall victim to brush fire injuries. These injuries may result in an individual's demise or mask their unique deposition, if deceased in an outdoor environment before exposure to a brush fire. This study evaluates: (1) whether or not brush fires create unique burn patterns at specific stages of decomposition; and, (2) whether the discoloration patterns on bone, from burning, mimic naturally decomposing muscle tissue on skeletal remains. Therefore, caution must be adopted in the interpretation of taphonomic processes in outdoor environments that are frequented by brush fires.

This project was conducted during the summer months, of June to September 2009, to isolate one Maritime season. Eight 50 kg pigs were used as the experimental specimen due to their similarity in weight ranges, percentages of fat content, and body hair texture to human cadavers. The pigs were placed into four paired groups for evaluation: (1) control, non-burned pigs; (2) fresh, burned pig; (3) advanced decomposition, burned pigs; and (4) skeletonization, burned pigs. Each pig was secured and protected under a custom-made cage throughout the decomposition process. However, when the pigs were exposed to the simulated brush fires, the cages were removed for a brief period of time. To quantitatively determine the decomposition stages of the pigs, they were scored using Megyesi et al.'s (2005) method that was broken into three different anatomical areas. The control pair was allowed to proceed from fresh to skeletonization in an undisturbed manner, and once the optimum characteristics were observed in the other three groups

(fresh, advanced, and skeletonized) their cages were removed and they were exposed to simulated brush fires. The pigs were visited on a daily basis, at the same time, to keep decomposition data and photo documentation consistent. The local weather station was also consulted on a daily basis so that data pertaining to the minimum and maximum temperature and relative humidity, total precipitation, and wind speed was collected.

Once all four paired groupings reached the dry stage of skeletonization they were dry macerated to remove any remaining flesh that remained on the bone surfaces. This was to avoid disturbing or removing any discoloration patterns on the surface of the bone that may be otherwise damaged due to exposure to water or chemical treatment. Once prepared, the cleaned bones were observed for burn pattern analysis and characterized using a Munsell Color Chart for standardization of colors. Bones exposed to the simulated brush fires were compared to the taphonomic discolorations that occurred in the naturally decomposing, control, paired grouping. As well, surveyors (a forensic anthropologist and a forensic pathologist) then scored the discoloration patterns on a selection of various bones, anonymously, as either coming from a burned or natural decomposed pig.

Burn analysis revealed: (1) no significant burn pattern on skeletal remains that have been exposed to fire while at various stages of the decomposition: but, (2) that brush fires can mimic the natural decomposition patterning of heavy muscle markers on bone.

Brush Fires, Taphonomy, Decomposition

H30 Differential Decomposition Patterns in Charred Versus Un-Charred Remains

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The goal of this presentation is to provide attendees with a method for both recognizing differential decomposition patterns indicative of fire modification and estimating the postmortem interval in charred remains.

This presentation will impact the forensic science community by providing awareness concerning the process of decomposition in fire modified remains, and allowing for more accurate postmortem interval estimation in charred remains. The pattern of decomposition in fire modified remains will be discussed in order to provide a greater understanding of the taphonomy of burning and subsequent decomposition.

In recent years there has been a renewed interest in fire modification of human remains, focus has primarily centred on early soft tissue changes during a fire and the effect of fire modification on bone. There is a paucity of literature on the subsequent decomposition of fire modified remains. This study established a scale by which investigators may determine the postmortem interval (PMI) from the appearance of charred remains, using visual markers of decomposition. The scale is based on accumulated-degree days (ADD) for standardization and applicability across disparate geographic and environmental regions. Additionally, the unique pattern of decomposition in charred remains is proposed as a means by which investigators may distinguish areas exposed to the most intense levels of burning from those which sustained less intense fire damage.

For the purposes of this study, a total of forty eight pig carcasses (*Sus scrofa*) were designated to either a control group (N=24) or an experimental burn group (N=24). Experimental pigs were charred for approximately ten minutes using a propane blowtorch (at sustained temperatures between 985-1070 ºC) to Crow-Glassman Scale (CGS) levels 1 (for the head, neck and limbs) and 2 (for the torso) (Glassman and Crow, 1996). These levels have been associated with the term *charred* for the purposes of this study, as opposed to *burned*, which suggests more extensive muscle tissue damage. Decomposition was assessed visually every 50 ADD for all carcasses, with weights and pH samples taken in subgroups (N=3) every 100 ADD for both charred and uncharred carcasses.

A Charred Body Scale (CBS) for decomposition, paralleling that of Megyesi *et al*. (2005), was created and visual observations utilized to score charred carcasses at 50 ADD intervals. Carcasses in the control group were scored using the Megyesi *et al*. (2005) scoring system at the same ADD interval. The total body scores (TBS) for the control group and the total charred body scores (TCBS) for the experimental group were statistically analyzed to determine whether a significant difference existed in the rate of decomposition between the two groups.

Preliminary results indicate that there is a slight but significant difference ($p<.001$) between the decomposition scores of charred and uncharred remains, due to charred remains passing through early stages of decomposition at a faster rate than uncharred remains. Field observations suggest that subsequent statistical analysis of the decomposition rate between the two treatments with regard to specific body regions (head and neck, torso or limbs) may uncover more pertinent trends.

Additionally, it has been shown that the *pattern* of decomposition was altered by the charring process. Regions of the body which received the most extensive fire damage decomposed prior to less burned areas. Thus for the purposes of this study, the torso (which was burned to CGS level 2) of the experimental group reached bone exposure long before either the head and neck or the limbs. In contrast, the head and neck region of the uncharred carcasses decomposed rapidly, whereas the skin and skeletal structures of the torso remained intact through the close of the experiment at 747 ADD.

Due to the altered body scores and pattern of decomposition in charred remains, traditional methods of estimating PMI are less than ideal in cases of fire modification. It is suggested that the Charred Body Scoring system be utilized as a more accurate and pertinent means of determining PMI in charred remains. In addition to this, understanding the differential pattern of decomposition in charred remains can aid investigators in reconstructing the events surrounding a body's exposure to fire, as areas of most extensive fire damage decompose at a markedly faster rate than those with lesser charring.

Charred Remains, Postmortem Interval, Accumulated Degree Days

H31 Rethinking Bone Trauma: A New Biomechanical Continuum Based Approach

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After attending this presentation, attendees will have an improved understanding of the biomechanics of bone trauma and gain exposure to a new biomechanically based way of analyzing bone trauma.

This presentation will impact the forensic community by proposing a shift in the way that forensic practitioners think and examine skeletal trauma.

Anthropologists are now commonly tasked with integrating trauma analysis into the biological profile of age, ancestry, sex, stature, and pathology. Past approaches have focused primarily on which category (i.e., blunt, sharp, ballistic) is present. Anthropologists often run into trouble when there are characteristics of multiple types of trauma, i.e., an incised wound (indicator of sharp trauma) with a radiating fracture (indicator of blunt trauma). The categorical mindset sets the stage for errors when the analysis is focused around identifying a weapon, rather than looking at basic biomechanics of the injury.

The alternative mode of thinking views trauma as a continuum rather than discrete categories. The fracture patterns are influenced by three primary extrinsic variables of force, surface area of impacting interface, and acceleration/deceleration. This new way of thinking was tested through a series of experimental studies and injury data analyses on over 500 specimens. The studies include fracture patterns in the skull,

thorax/upper body trauma, human phalanges, an lower limb fractures. The results show the importance of the variables ("engineering inputs"); force, surface area, and acceleration/deceleration, on the fracture patterns ("anatomical outputs") of the human body.

Force: The human body is subjected to a variety of forces in everyday activities; however, injury occurs when these forces exceed the tolerance levels for the tissues of the body. The amount of force influences the severity of fracture. In the cranial base, the impact force determined extent of fracturing. In forensic anthropology, clues to the amount of force may be seen in the extent of the fractures. In the vault, fracture patterns with numerous radiating and concentric fractures may be indicative of higher force than a single linear fracture. However, anthropologists must keep in mind that it is not always a one to one comparison. The intrinsic properties of the bone (such as geometry, location, quality of bone) come into play and can explain differences in fracture patterns caused by equal force.

Surface Area of Impacting Interface: The variable of surface area between the impacting object and the bone is crucial in fracture analysis. This variable explains the differences between blunt and sharp trauma. An impact to the skull of 12 lbs, but a large surface area may cause a typical blunt trauma fracture pattern with a point of impact, radiating, and concentric fractures. However, an impact to the skull with an identical force of 12 lbs, but a very small surface area (i.e., the edge of a knife or axe) will create an incising type wound with straight margins. While the force remains the same, a change to the surface area of the impact interface alters the pounds per square inch (psi) influencing the bone. As frequently and aptly noted, sharp trauma is simply a beating with a sharp object (Symes et al 1989, Symes et al 2002). The variable that dictates the difference between a sharp trauma wound and a blunt trauma wound is simply surface area. It is possible to have sharp trauma wounds that also contain characteristics of blunt trauma. In testing, this variable played an important role in understanding the mechanics of impacts to the thorax.

Acceleration/Deceleration: The variables of acceleration or deceleration are important for understanding how a change in velocity over time can influence how bone responds to trauma. Since bone is a viscoelastic material, it has different mechanical properties dependant on the rate of loading (acceleration/deceleration). Anthropologists are accustom to looking for plastic deformation to indicate blunt trauma, and an absence of deformation to indicate ballistic trauma. These differences are created by the differences in acceleration/deceleration rates between the two. Instead of viewing these categories as independent, they can be visualized as a continuum; influenced by how the deceleration of the impacting object influences the fracture mechanics of the bone. When conceptualized in this manner, it is easy to understand how a bullet can create plastic deformation and "blunt trauma" when it has slowed down (i.e., reached terminal velocity) to an acceleration/deceleration rate consistent with blunt trauma.

In conclusion, there is a need for a "rethinking" in regards to trauma, with a shift in focus from a categorical weapons based approach to a biomechanically based continuum.

Fracture Biomechanics, Bone Trauma, Blunt Trauma

H32 A Forensic Pathology Tool to Predict Pediatric Skull Fracture Patterns – Part 2: Fracture Quantification and Further Investigations on Infant Cranial Bone Fracture Properties

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The goal of this presentation is to inform attendees about further research on fracture propagation caused by impulsive loading of the parietal bone in a developing porcine (pig, Sus scrofa) model.

This presentation will impact the forensic community by describing directions and patterns of fracture propagation in the developing porcine model and demonstrate the GIS image-analysis method to quantify fracture patterns.

Pediatric deaths involving head injury with associated cranial fractures represent one of the greatest challenges to forensic professionals. The ability of the forensic investigator to establish the circumstances of death in these cases is severely hampered by the lack of skull fracture standards for infants and young children. In many of these situations the most likely cause of trauma is interpreted by examining the overall patterns of bone fracture and comparing them to descriptions of the incident, however these analyses are both qualitative and anecdotal, leaving the final interpretation up to a best guess by the experienced professional. This research aims to understand the basic principles behind infant cranial fractures in the porcine model which may then be used to guide later human research.

Previously findings were reported that identified multiple fracture initiation sites on the porcine cranium away from the impact site, and also demonstrated that a compliant interface caused relatively more fracture damage to the developing porcine cranium than did a rigid interface at equal energy levels (Fenton *et al.* 2009). The phenomenon of remote fracture initiation in the infant porcine specimen has also been documented using high-speed video. This next phase of research deals with fracture propagation at higher input energy levels. The generated porcine fracture patterns from both the previous low energy (initiation) and new high energy (propagation) impacts have been quantified using a GIS image-analysis model. In addition, fracture propagation and the relationship between input energy and fracture length has been explored through these higher energy impacts.

In order to examine higher energy fracture propagation, a gravity accelerated mass (GAM) drop-tower was employed. Only rigid impacts have been conducted to date. To produce more input energy for the impacts, the drop height of the mass was doubled. Based on a sample size of 34 porcine specimens aged under 28 days, the preliminary data of total damage to the cranium (both bony fracture and diastatic fractures) followed similar patterns as the previous rigid impacts but with four times more measured damage than documented in our earlier studies.

In an attempt to quantify these porcine fracture patterns, a GIS model was employed using an image-analysis approach, as previously described by Marean *et al.* (2001). Using this method, each fracture

configuration was traced onto an individual outline of the porcine cranium. The GIS model then superimposes each cranial outline and sums the overlying fractures, generating an overall fracture pattern. Results indicate that more fracture damage occurred in the younger aged specimens, particularly more diastatic fractures. The fracture patterns for each corresponding age class were similar to the previous initiation impact fracture patterns. Interestingly, the higher energy impacts generated more fracture co-occurrence between specimens. This suggests that with more input energy, the tendency for repeated fracture configurations increases.

The location of fracture initiation has been in question due to conflicting viewpoints in the literature. Recently, Kroman (2007) documented fracture initiation beginning at the impact site for adult human cadaveric specimens. From gross observation of the current infant porcine model, fracture initiation appeared to occur at remote sites and radiate back toward the site of impact. Fracture initiation and propagation was then recorded using high-speed video on six drop-tower impacts to infant porcine crania of differing ages. Each impact was recorded at a speed of 8,000 frames per second with a resolution of 512x128 pixels. Results indicate that fracture initiation occurred at the surrounding bone-suture boundary and propagated back towards the point of impact. It is, however, currently unclear if this translates to infant human crania.

The opinions, findings, and conclusions or recommendations expressed in this presentation are those of the authors and do not necessarily reflect the views of the Department of Justice.

Child Abuse, Fracture Patterns, Bone Biomechanics

H33 Objective Interpretation of the Striation Pattern Observed in Experimentally Cut Costal Cartilage

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The goal of this presentation is to introduce a quantitative method developed for the analysis of tool mark impression evidence in cut costal cartilage. The method is designed in consideration of the federal guidelines for admissibility of forensic evidence.

This presentation will impact the forensic community by presenting a method that transitions a traditionally subjective analytical test to an objective test, an approach that can be translated to other areas of visual analysis, i.e., ballistic and fiber analysis.

Published literature on tool mark impression examination demonstrates the generally accepted theory that class and individual characteristics of a weapon's cutting edge are recorded in the cut surfaces of cartilage and bone and can be identified using microscopic analysis. Several studies have correlated variation in striation pattern observed in the cut surface to the cutting edge design and wear defects of a tool, while others have gone so far as to conclude the striation pattern is unique to the tool. Despite the general acceptance, limitations of the current methodology are lack of quantitative analysis, failure to measure error rate, and minimal independent testing.

Federal guidelines regarding admissibility of forensic evidence have become more rigorous in recent years and as a result tool mark impression evidence has been found inadmissible on multiple occasions. A recent conviction was overturned by the Supreme Court of Florida because of what was determined to be the invalid admission of expert testimony regarding tool mark impression analysis. The expert witness identified a particular knife as a murder weapon based on a technique of microscopic analysis of the markings left by the knife in a piece of cut cartilage. The expert for the defense testified that the methodology used was not generally accepted as reliable and did not therefore satisfy the federal guidelines. The Florida Supreme Court ruled that while the knife itself was admissible, the interpretation of the cut marks provided by the witness was inadmissible. The Court found that no scientific precedent existed to support the opinion that a specific knife can be identified from marks made on cartilage (Ramirez I, 542 So.2d at 354-55).[1]

The inadmissibility of cut mark impression evidence is a threat to the successful adjudication of countless violent crimes. In 2008, Harris County Medical Examiner's Office Forensic Anthropology Division received forty cut mark cases for tool mark impression evidence analysis and six suspect weapons for direct comparison. Given the limitations of the current methodology and need for admissible analysis, a quantitative method to analyze cut mark impression evidence in costal cartilage is developed. The goal of the project is to quantitatively discern between striation patterns made with knives of different cutting edge design.

Experimental incised wounds were made in pig (*Sus scrofa)* costal cartilage using a serrated, non-serrated, and micro-serrated kitchen knife. Thirty incised wounds were made with each knife. Each cut surface was cast with [Mikrosil Casting Material.] Each cast was photographed using a digital camera attached to a stereomicroscope. The images were imported into [Adobe Photoshop CS Extended software.] Using the Ruler function of the Photoshop program, the distances between the striations were measured. Presence of striations, regularity of the striation pattern and presence of primary and secondary striation patterns were documented. Presence and absence of striation and distances between striations were statistically evaluated using [SPSS 16.0 Basic software.]

A pilot study was conducted using ten cut marks. Four analysts (three practicing forensic anthropologists and one doctorate level anthropology intern) independently analyzed the ten cut marks (twenty cut surfaces). The results of the pilot study showed 100% agreement among the analysts for striation recognition and 85% agreement in regularity of the pattern (std. error 0.124). No correlation between the presence of serrations in the knife's cutting edge and regularity of striation patterns was found ($r = -0.05$). In light of the very small sample, sampling error cannot be excluded as a possible cause.

The pilot study shows striation patterns are easily recognized within cut costal cartilage surfaces. Evaluation of the correlation between the cutting edge design and striation pattern, observer error, and repeatability will be possible following the examination of the complete sample of cut marks.

Reference:

[1] *Ramirez v. State of Florida* 2001 WL 1628609, 27 Fla. L. Weekly S 18 Supreme Court of Florida, Dec. 20

Forensic Anthropology, Tool Marks, Impression Evidence Analysis

H34 The Contextual Nature of "Excessive Force": Alcohol-Induced Osteopenia, Fracture Prevalence, and Healing Rates Among In-Custody and Homicide Deaths From the Harris County Medical Examiner's Office

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After attending this presentation, attendees will better understand the mechanism by which alcohol affects bones, and what those effects are. In addition, they will understand the impact of alcohol-induced bone disease on fracture incidence rates in a medico-legal setting.

This presentation will impact the forensic science community by reviewing the consequence of chronic ethanolism on bone health, and non-destructive techniques by which bone quality can be assessed.

The effect of chronic ethanolism on the skeleton is well documented in the medical literature. Although the exact mechanism is unknown, excessive amounts of alcohol appear to inhibit the bone building capabilities of osteoblasts, leading to a noticeable decrease in bone density and a concomitant decrease in the mechanical strength of bone. Published rates of alcohol induced bone disease among chronic ethanol users vary from 25-100%, depending upon the type and size of the study. Comorbidity factors such as liver disease, smoking and malnutrition exacerbate this loss in bone capability, but are not uniformly present. This decrease in bone density and altered mechanical properties, including reduced load capabilities, increases fracture prevalence among chronic ethanol users, especially those diagnosed with clinical grade osteopenia and osteoporosis. The inhibition of osteoblast activity will also affect the healing rates of the fractured bones in the form of delayed union and non-unions. Chronic ethanol users with bone fractures may require increased time for healing, altering the rate at which the characteristic markers such as sub-periosteal bone deposition and callus formation will appear.

Four cases of in-custody or unlawful death examined by the Harris County Medical Examiner's Office in Houston, Texas are presented as examples of increased fracture incidence rates due to osteopenia among alcoholic individuals. These four cases consist of three men and one woman, all 50 years of age or older, with a known history of long-term excessive alcohol consumption. Each individual suffered multiple fractures, and the cause and manner of death is classified as blunt force trauma and homicide for each case. In addition, one of the individuals suffered fractures several weeks before death occurred, allowing some degree of healing to take place.

Using radiographs and physical examination, the ribs from these four individuals are compared with individuals whose bone quality appears in the normal range (control group). The control group includes three individuals (2 males and 1 female, all 50 years of age or older) who have no known history of alcohol abuse. The weight, cortical bone quality, and trabecular bone density was assessed in each rib. Ribs were selected due to their availability and propensity to fracture in cases of interpersonal violence.

The difference in weight, cortical quality, and trabecular density was remarkable between the chronic ethanol users and the control group. The ribs taken from the ethanol group are lighter in weight and have an almost translucent quality to them. The trabecular bone located in the rib head and neck area is notably decreased in the ethanol group when compared to the control group. In the case of the individual with antemortem fractures, the degree of bone repair visible on the ribs was also less than is expected from the reported interval between injury and death.

The results of the study show that there is a qualitative difference between the bone strength of individuals with a history of chronic ethanolism, and individuals lacking such a history. The standard police procedures for controlling individuals who are resisting arrest or proving a danger to themselves and others may therefore, in ethanol abusers, cause a greater number of fractures and can lead to the death of the individual. This has prompted a reexamination of the concept of "excessive force" for individuals with known histories of alcohol abuse. In cases such as these, a proper evaluation by a physical anthropologist of the bone quality of the decedent will prove invaluable in determining whether or not excessive force was used to cause the injuries that may have led to the death of the individual, or if the injury was related to severely compromised bone quality. Bone quality and history of drinking should also be considered if the timing of antemortem fractures is of importance in a case involving a known alcoholic.

Alcoholism, Osteopenia, Fracture Incidence

H35 Patterns of Trauma on the Skeletal Remains of U.S. Soldiers in the Battle of East Chosin, North Korea

James T. Pokines, PhD, Kelly L. Burke, MSc, and Josephine M. Paolello, MS, JPAC/CIL, 310 Worchester Avenue, Building 45, Hickam AFB, HI 96853*

After attending this presentation, attendees will examine a specific pattern of peri-mortem/early postmortem trauma detected on the skeletal remains of U.S. soldiers lost in the Battle of East Chosin, Democratic Peoples' Republic of [North] Korea (D.P.R.K.). Multiple hypotheses regarding the possible sources of the majority of this trauma will be presented and examined.

This presentation will impact the forensic science community by broadening the understanding of battlefield trauma derived during the Korean War, as it documents a pattern of apparent deliberate skeletal alteration of remains after death by non-U.S. forces.

Attendees will examine a specific pattern of peri-mortem/early postmortem trauma detected on the skeletal remains of U.S. soldiers lost in the Battle of East Chosin, Democratic Peoples' Republic of [North] Korea (D.P.R.K.). Multiple hypotheses regarding the possible sources of the majority of this trauma will be presented and examined. This research broadens our understanding of battlefield trauma derived during the Korean War, as it documents a pattern of apparent deliberate skeletal alteration of remains after death by non-U.S. forces.

The mission of the Joint POW/MIA Accounting Command, Central Identification Laboratory (JPAC-CIL) is to recover and identify the remains of U.S. servicemembers lost in recent conflicts, including the Korean War (1950-1953). Over 8,000 U.S. servicemembers are currently missing/unrecovered from this conflict. One of the largest battles occurred around the Chosin Reservoir. This large reservoir was the location of a U.S./Republic of [South] Korea (R.O.K.) advance far into North Korea at the end of November 1950. The night of November 27 saw the beginning of a massive attack by divisions of the Chinese People's Army, which over subsequent days led to over 3,000 U.S. and R.O.K. casualties as their forces were pushed back in disarray south of the reservoir and subsequently toward the current border with South Korea. The rapid withdrawal and loss of unit cohesion caused the majority of the dead to be left behind, either buried by U.S./R.O.K. forces or left for enemy forces. The severe winter cold and heavy snow further reduced opportunities for burial of these remains.

Multiple recovery missions from 2001 until 2005 have excavated battlefield sites in the East Chosin Reservoir area and recovered skeletal remains and associated artifacts identified as U.S./R.O.K. in origin from primary and secondary burials. Bone preservation in most cases is sufficient to allow detailed analysis of skeletal trauma. Peri-mortem trauma, largely in the form of gunshot wounds, is common among the remains recovered from the chosin area and other locations in North Korea. An additional pattern of trauma has been identified: sawing or massive blunt force trauma to humeri, usually with the portion of the arm distal to the trauma still associated with the remains. The indications of sawing trauma include clear kerf formation, straight cuts, and residual striations. Blunt force trauma could have been caused by multiple implement types, with unknown duress applied to soft tissue to allow limb removal. These remains likely were in a frozen state when altered, with access to remains at the base of open burial features restricted and alteration possible only to those remains near the top.

Of a sample of n = 26 left humeri, 12 (46.2%) exhibited this trauma pattern (three sawing/probable sawing, and nine massive blunt force). Of a sample of n = 24 right humeri, five (20.8%) exhibited this trauma pattern (three sawing/probable sawing and two massive blunt force). In addition, definite sawing trauma was detected on one femur and one nasal region, and similar blunt force trauma also occurred on three left and two right lower arm portions (radius or ulna). This pattern of differential peri-mortem arm trauma is mirrored in the larger sample of all U.S. remains recovered from North Korean battlefields or received by unilateral turnover, where a marked underrepresentation of lower arm portions (i.e., distal to the proximal humerus) has been detected previously.

The origin of this trauma is most consistent with the deliberate cutting or other dismemberment of these remains by enemy forces, with the possible aim of trophy acquisition or other systematic defacement of U.S./R.O.K. remains. Rejected hypotheses include coincidental peri-mortem battlefield trauma, the removal of extended frozen limbs to expedite burial in small burial features, differential skeletal preservation of these elements, and battlefield amputations by U.S./R.O.K. medical staff. This trauma could have occurred immediately after the withdrawal of U.S./R.O.K. forces or months later, given the frozen state of these remains.

Battlefield Trauma, Korean War, Chosin Reservoir

H36 Peri-Mortem Skeletal Trauma in U.S. Korean War Soldiers: An Epidemiological and Historical Study of Prisoner-of-War and Battlefield Casualties

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The goal of this presentation is to review patterns of peri-mortem trauma documented on the skeletal remains of U.S. soldiers lost during the Korean War. Attendees will gain a greater awareness of the importance of documented historical context in the interpretation of war-related skeletal trauma.

This presentation will impact the forensic science community by increasing the understanding of war-related trauma in a historical context and documents patterns of skeletal trauma occurring under disparate circumstances of death.

In a follow-up to our 2008 presentation (Baker and Christensen 2008), data on peri-mortem trauma was collected from more than 200 skeletons of U.S. casualties of the Korean War that were analyzed between 1996 and 2009. While the CIL does not conduct analyses of peri-mortem trauma in order to determine cause or manner of death, we have a unique chance to examine peri-mortem traumata in light of historically documented circumstances of death. In some cases, we may be able to gain insight into battlefield behavior.

War casualties can generally be divided between battlefield fatalities and deaths that occurred elsewhere. For this study, battlefield casualties and Prisoners of War (POW) form the primary groups of interest. Remains came from three different sources: remains recovered from alleged battlefields during Joint Recovery Operations (JROs) conducted in the Democratic People's Republic of Korea from 1996 to 2005, remains returned to the U.S. after the war by the Chinese government which were subsequently buried as Unknowns and later exhumed by the CIL for identification, and remains turned over to the U.S. by North Korean authorities between 1990 and 1994 from known POW cemeteries, as well as 2002 and 2004. The Killed-in-Action (KIA) sample included more than 130 individuals, while the purported POW sample comprised more than 50 individuals. Trauma patterns were compared between groups as well as to historical data, which was taken from reports of KIAs, those who were Wounded in Action (WIA), and those who subsequently Died of Wounds (DOW).

Early in this study, it was noted that POWs had less peri-mortem trauma than KIAs. With a larger sample of POWs now available, that anecdotal observation has been confirmed. Peri-mortem trauma rarely occurred in POWs and was limited to three instances of cranial trauma and a single incidence of peri-mortem trauma to the femur. In one case, a POW was shot in the back of the head, and in the case of the femoral injury, the individual in question is known to have been killed in a strafing incident. This suggests that most of these men may have died of causes unrelated to trauma sustained in direct combat and provides support for the historical notion that most POWs died of disease, malnutrition, or exposure.

Statistical analysis of trauma frequency revealed some interesting patterns. Disparities in trauma to the face, vault, and tibia between the two groups were significant at the $p < 0.10$ level, while trauma to the femur was significant at the $p < 0.05$ level. Humeral injuries in the two groups were significant at the $p < 0.001$ level. While calculation of the overall trauma rate assumes that the probability of trauma to all regions of the body is equal and is therefore not necessarily an accurate representation of reality, it does provide a sense of the magnitude of difference in susceptibility to peri-mortem skeletal injury between the two groups. The overall trauma rate, calculated as the number of elements with trauma versus the total number of elements present for examination, was significant at the $p < 0.0001$ level.

During the 2008 research, it was discovered that a number of individuals experienced peri-mortem trauma to the humerus, including sharp trauma. A number of other individuals were missing either an entire arm or one or both humeri, despite the presence of distal arm elements. In this study, nearly one-third of the KIAs were classified as having missing arm elements (either with or without associated peri-mortem trauma in that region of the body). As noted above, the peri-mortem trauma rate in the KIAs was significantly higher than that seen in the POWs. In combination, these traits suggest that some remains were tampered with postmortem.

POW, KIA, Fractures

H37 Preliminary Studies of the Isolation of Drugs From Bone and Bone Marrow: A Broadened Role for the Forensic Anthropologist

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The goal of this presentation is to introduce attendees to a new analytical technique, Accelerated Solvent Extraction (ASE), and its potential to provide evidence of drugs and drug metabolites in bone and/or bone marrow.

This presentation will impact the forensic community by detailing a new analytical technique which provides a presumptive line-of-evidence towards determining the identity of a decedent based on drug or medication history by detecting certain classes of lipophilic drugs in decomposed or skeletonized remains.

Toxicologists continue to develop methods for the detection of drugs and drug metabolites in various biological matrices other than blood and urine, including oral fluid, hair, and more recently, bone. The use of bone specimens for toxicological examination provides forensic anthropologists with an opportunity to collaborate with toxicologists in further developing techniques for detection of drugs and drug metabolites. A limited number of studies have been conducted; the majority utilize solvent extraction of analytes from bone specimens. However, these studies typically examine the whole bone and do not isolate the lipid portion of the bone only. This issue may be significant since many drugs are lipophilic and are more likely to be distributed to the lipid portion of bone and bone marrow. The typical method of soaking cut bone in methanol has not been thoroughly evaluated with regards to reproducibility or recovery. The current pilot study employs Accelerated Solvent Extraction (ASE) to separate the lipid portion from the non-lipid portion of the specimen, which reduces the potential for contamination and the volume of solvent required to perform the test. ASE is a reproducible, easily calibrated, and robust method, allowing for increased accuracy and reliability. ASE also requires only a few minutes, rather than twenty four hours, to complete the isolation process.

This is a preliminary study of the isolation of drugs and drug metabolites from the lipid fraction of bone specimens obtained from rats administered drugs for various durations. The non-lipid portion of the bone remaining after ASE was also tested to determine the completeness of the extraction. The extractions performed by ASE were compared to extractions performed following a twenty four hour methanol soak.

Amitriptyline, a tricyclic antidepressant, was detected in the lipid fraction of whole bone specimens following single-dose administration; however, single-dose methylenedioxymethamphetamine (MDMA, Ecstasy) and repeated-dose cocaine were not detected. The lipophilicity of the drugs and/or experimental design may account for the lack of detection of these analytes. No drugs were detected in the non-lipid portion of the ASE extract, suggesting that ASE performed a thorough extraction of the lipids, and therefore, the drugs.

Both methods resulted in the detection of amitriptyline, and the ASE technique yielded evidence that the extraction was complete. Additionally, ASE can allow for calibration and potential correlation of drug administered and concentrations found. Overall, the results of the study are promising, lending support to ASE as an analytical technique for the isolation of drugs and drug metabolites in bone. Future work must be conducted to elucidate the effectiveness of this method.

The assessment of drug use through the analysis of bone for drugs and drug metabolites is an important tool in the investigation of skeletonized and decomposed cases, providing presumptive evidence of the decedent's identity by correlation of the analytical findings with purported drug history. The results may also provide evidence supporting the cause and manner of death, particularly in cases involving drug use and misuse.

Forensic Anthroplogy, Accelerated Solvent Extraction, Bone Toxicology

H38 The Effects of Varying pH on Bone in Aquatic Environments

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After attending this presentation, attendees will learn the results of an experiment investigating the effects of varying pH solutions on bone segments submerged for a one-year period. Attendees will also learn some of the capabilities of the FBI's Underwater Search and Evidence Response Team.

This presentation will impact the forensic science community by providing empirical data on postmortem aquatic changes which may be extremely useful in forensic contexts for both improving time since death estimates, and also for providing better information to underwater recovery experts thereby potentially increasing the quantity and quality of remains recovery.

In the summer of 2007, the FBI Laboratory's Forensic Anthropology Program received an inquiry from a member of the FBI's Underwater Search and Evidence Response Team (USERT) regarding the possible condition of missing human remains. The USERT assists in water-based searches for evidence, and divers are specially trained to locate and recover items of evidence that are believed to be underwater. The USERT also utilizes the most advanced underwater technology to assist in its searches, including side-scan sonar, sector scan sonar, and remotely operated vehicles (ROVs). While the USERT has been involved in several high-profile dive operations, the majority of USERT operations involve searches for handguns, knives, bodies, vehicles and similar items. The USERT also is capable of conducting hull and pier searches in support of counter-terrorism and counter-intelligence operations. FBI USERT also may be contacted for assistance in state and local police matters when there is a need for underwater evidence recovery.

The question posed by the USERT diver in this case was: How well preserved would you expect a body to be after twenty years in a slightly acidic lake? Divers were curious whether, because of the acidity of the water, there would be enough of a skeleton remaining to warrant an underwater search. A review of the literature revealed that little is known about the decomposition of remains in aquatic environments of varying pH, and even less is known about the specific effects of these environments on bone. Documentation of postmortem changes in aquatic environments has been scant and consists primarily of general overviews, a few empirical studies, and case reports. Other reports emphasize the formation and preservation of adipocere, algae formation, invertebrate colonization, or fluvial transport, but little research has been done specifically on bone preservation in various aquatic environments. This discovery prompted the following pilot study.

Bovine remains were obtained from a meat processing facility, and cut into approximately 3-5cm thick cylindrical discs using a table saw. Solutions were prepared to represent aquatic environments of pH1, pH4, pH7, pH10 and pH14 using nitric acid and sodium hydroxide. The specimens were placed into glass beakers and the solutions were added until the bones were completely submerged. The specimens were periodically removed from their solutions and photographed. After one year, the specimens were removed from the solutions, rinsed, photographed, and examined visually and microscopically.

The pH7 and pH10 solutions had little effect on the bone, but all other solutions affected the bone to some degree. Extreme pH levels significantly affected the integrity and physical appearance of the bone, completely dissolving it in six days in the case of pH1, and degrading it considerably over one year in the case of pH14. Good to excellent preservation was observed in the solutions of pH4, pH7 and pH10, with the pH10 solution showing somewhat better preservation than the pH4 solution. Given that the range for pH of water in the U.S. is around pH4.3-pH10, one would therefore expect the pH of the water to have little effect on bone preservation (at least over a period of one year or less). More information on the effects of pH levels on fully-fleshed remains would be needed to improve estimates of time since death, but the results observed here may be useful in making statements regarding time since skeletonization.

Empirical data on postmortem aquatic changes may be extremely useful in forensic contexts for both improving time since death estimates, and also for providing better information to underwater recovery experts thereby potentially increasing the quantity and quality of remains recovery. While this study was rather small-scale and included pH extremes unlikely to be encountered in forensic contexts, it serves as one of the first controlled studies of its kind. It is hoped that results will

prompt larger empirical studies to be conducted including the use of, for example, larger biological specimens, less extreme pH levels, and varying temperature and salinity.

Water pH, Bone Preservation, USERT

H39 Taphonomic Processes Involved With the Decomposition of Human Remains Within the Puget Sound

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After attending this presentation, attendees will understand the affect of factors (e.g., age, height, sex, position when recovered, amount of clothing at recovery, animal activities involving the remains, Postmortem Submergence Interval, and Accumulated Degree Days) on the decomposition of remains within the Puget Sound, Washington State, USA. Attendees will also have an understanding of Total Aquatic Decomposition Scores and Accumulated Degree Days and their utility in death investigation.

This research provides equations for the calculation of the Postmortem Submergence Interval and Accumulated Degree Days from the Total Aquatic Decomposition Scores of remains recovered from the Puget Sound. This information is important for death investigators/law enforcement personnel as an aid to the identification of individuals missing in the interval predicted by the equation. The presentation will impact the forensic anthropology community by adding to knowledge of taphonomic processes within aquatic environments (specifically the Puget Sound) and contributing to any further studies on aquatic or marine decomposition.

This research provides equations for the calculation of the Postmortem Submergence Interval and Accumulated Degree Days from the Total Aquatic Decomposition Scores of remains recovered from the Puget Sound. This information is important for death investigators/law enforcement personnel as an aid to the identification of individuals missing in the interval predicted by the equation. The findings presented also impact the forensic anthropology community by adding to knowledge of taphonomic processes within aquatic environments (specifically the Puget Sound) and contributing to any further studies on aquatic or marine decomposition.

Factors affecting the decomposition of human remains have been a topic of interest to Forensic Anthropology since its inception. However, only recently have the taphonomic processes involved with aquatic decomposition become foci in forensic research. Several studies have been done on fluvial systems but research on marine systems is relatively scant as recovery of remains from the open ocean can be problematic due to factors such as depth, weather, currents, etc. The Puget Sound is a large (~135x76 km), mostly enclosed body of saltwater that facilitates the recovery of a considerable number of remains. The aim of this project was to collect and analyze data on the taphonomic processes involved with decomposition within the Puget Sound.

Data from four of the eleven county coroner/medical examiners offices surrounding the Puget Sound, including Kitsap (N=5), Mason (N=3), San Juan (N=8), and Pierce (N=6) counties, were analyzed statistically for taphonomic processes which could affect the decomposition of human remains within the Puget Sound. Forty-four cases were originally examined; however, after the removal of cases from the sample due to extensive adipocere formation (N=3) and Accumulated Degree Days scores of less than ten (N=19), twenty two cases remained. Adipocere cases were removed as adipocere formation tends to retard decomposition. All cases were given Total Aquatic Decomposition Scores (TADS) and Accumulated Degree Days for the time of their submergence, from entry to recovery. The TADS are the sum of three Aquatic Decomposition Scores given based on the decompositional stage of an area of the body, these include Facial Aquatic Decomposition Score, Body Aquatic Decomposition Score, and Limb Aquatic Decomposition Score. The Accumulated Degree Days is the sum of the temperature (˚C) of the water each day (or as near the day as possible given obtainable data) that the remains were submerged.

Both Accumulated Degree Days ($p= 1.177x10^{-10}$) and Postmortem Submergence Interval ($p=2.026x10^{-7}$) were found to have an affect on Total Aquatic Decomposition Score using linear regression models. Equations for determining Postmortem Submergence Interval and Accumulated Degree Days from the Total Aquatic Decomposition Scores of human remains recovered in the Puget Sound were created. The equation for establishing Postmortem Submergence Interval is: $\log_{10}PMSI=((TADS+1.751)/5.649)$ +/- 3.047 and the equation for establishing Accumulated Degree Days is $\log_{10}ADD=((TADS+5.6607)/ 7.4294)$ +/- 2.107. The results of this study were compared to similar studies done on fluvial systems in the United Kingdom (Heaton, et al., in press). No significant difference ($p>0.01$) was found between the decomposition rates within rivers in the United Kingdom and those seen within the Puget Sound when the data were subjected to an analysis of covariance (ANCOVA) test with Accumulated Degree Days as a control.

Marine Decomposition, Postmortem Interval, Puget Sound

H40 Microbial Marine Decomposition: Marine Bacteria as an Indicator of Postmortem Submersion Interval

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After attending this presentation, attendees will gain a greater understanding of the involvement of marine bacteria important to the process of decomposition of bodies and/or body parts in marine environments, specifically a temperate New Zealand coastal environment. This presentation will provide marine bacterial succession data from pig (*Sus Scrofa L.*) heads submerged in this coastal region during autumn, winter, and summer and will demonstrate how such data may be used by forensic investigators to aid in submersion interval estimation.

This presentation will impact the forensic community by increasing forensic knowledge on the role of extrinsic microbes in the postmortem decomposition process, while introducing the concept of marine bacterial colonization and succession on bodies recovered from marine coastal contexts as a novel, and potentially valuable, tool with which to estimate the length of time of submergence and the postmortem submersion interval (PMSI) of a corpse or individual body part.

Much is now understood regarding the involvement of microorganisms in taphonomic processes on remains in terrestrial settings, however very little is known about the role of bacteria and pattern of degradation of animal remains in aquatic environments. Because heterotrophic bacteria are ubiquitous in aquatic ecosystems and are ecologically important for the recycling of specific nutrients in the oceans, it is hypothesised that extrinsic bacterial action will mediate the progressive decomposition of remains immersed in the sea and that the actions of successive bacterial species may act as indicators as to the

period of submersion. This is important for forensic professionals in coastal locations as bodies recovered from the sea form a significant portion of cases for PMSI determination.

This study used adult domestic pig (*S. scrofa L.*) carcasses as models for human remains. Pig heads were placed in cages surrounded by mesh so as to exclude larger scavengers and gain the longest submersion period possible for bacterial colonisation. Cages were submerged in the Otago Harbour in water 3-5 m deep in March (autumn), July and August (winter) 2007 and January (summer) 2009. Bacterial samples were taken by swabbing the carcasses at two to four day intervals until skeletonisation. Total bacterial community DNA was extracted from the swabs and colonising marine bacteria identified by sequencing their 16S rDNA genes. On sampling days, observations of gross decomposition changes and the presence of any small marine scavengers in or on the cage were also noted. During the course of the experiments, environmental data such as seawater temperature were monitored daily.

Marine bacteria rapidly colonised the submerged remains and did so in a successional manner. Marked differences were observed in the structure of microbial communities identified on the pig remains during the different seasons, thus showing a seasonal succession pattern, for which a significant difference in water temperature is likely to have been a contributing factor. Several bacterial species were present for much of the duration of the experiments while others only colonised after specific submersion intervals.

Determining the length of time a body has been immersed in an aquatic environment is a crucial factor that must be determined in any death investigation. The dynamic shifts in marine microbial community composition over a submersion period, as seen in this study in the form of relatively early or late colonisers, may be useful as submersion indicators. The data generated now forms the basis for development of a novel indicator of PMSI in the sea and, with further study, may prove useful for PMSI estimation of bodies and/or body parts recovered from coastal marine waters in the Otago region and beyond in cases where a specific PMSI is in doubt.

Marine Decomposition, Postmortem Submersion Interval, Bacteria

H41 A Study of the Differences Between Fresh Water and Salt Water Decomposition: Establishing Time Since Death or Time Since Submergence

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After attending this presentation, attendees will understand the need for more research to in order to understand decomposition in aqueous environments.

This presentation will impact the forensic science community by providing a better way to establish time since death or time since submergence in underwater death investigations.

Forensic investigators frequently become involved with cases in which decomposing human remains are recovered from aqueous environments. One important task for these investigators is to establish time since death or time since submergence. This estimation is useful to law enforcement so they can narrow their search of possible victims in order to confirm the decedent's identity. Time since death has been shown through previous research to be a tricky timeline to establish. Many environmental factors must be taken into consideration when establishing time since death and cases in which decedents have been submerged in water only serve to make this estimation more complicated. In addition to the usual suspects of ambient temperature, humidity, local insect activity and overall environment, the other factors that an aqueous environment introduce must be taken into account. These include, but are not limited to water temperature, water salinity, and micro and macro-organisms that already live in the environment that the decedent has been submerged in. To date, there have only been a small number of research projects conducted that detail the process of decomposition in aqueous environments. As a result of this, time since death determination in aqueous environments remains a tricky timeline to establish.

This project is an experimental study conducted to: (1) document the differences in the overall process of decomposition between bodies that have been submerged in freshwater and saltwater environments; and, (2) test whether time since death or submergence can be accurately estimated using previous research conducted by Seet.[1] Fetal pigs were used as a replacement for human remains because of the similarities in muscle and tissue structure. Ambient air temperature, water temperature, the pig's internal temperature, and pH were documented daily. Gross postmortem changes that occur throughout the process of decomposition as well as insect activity were also noted and documented with photographs. Bloating, purges, skin slippage, discoloration, maggot activity, fly, and beetle activity was documented in a present/absent context. The pigs were placed in buckets and kept in adequately vented cages. The cages were meant to keep out larger vertebrate scavengers while still allowing access to the invertebrate scavengers that play an active role in the process of decomposition. The freshwater was collected on site from a stagnant cranberry bog and the saltwater was collected from an urban beach in the city of Boston, MA. This research was conducted twice in two distinct seasons of spring and summer in New England.

Preliminary results from this research indicate that the environment of saltwater versus freshwater does effect the process of decomposition. Decomposition was documented as occurring faster in the freshwater than in the saltwater. Results have indicated that the saltwater hindered the decomposition process by deterring insect activity. These results also indicate the importance of the role of forensic entomologists in time since death research. Other data collected from this project will be correlated with Seet[1] to test the results of the estimation of time since submergence based on gross morphological changes. Results from that research indicate that time since submergence can be established by using variables such as the presence or absence of purge and marbling.

Reference:

[1] Seet, BL. Estimating the Postmortem Interval in Freshwater Environments. Unpublished Masters Thesis, University of Tennessee, Knoxville, TN. 2005.

Forensic Anthropology, Aqueous Environments, Decomposition

H42 Decomposition Patterns in Indoor Environments: A Comparative Analysis of Rodriguez and Bass's Stages

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The objectives of this study are to explore the patterns and timing of the effects of decomposition and to identify factors that may or may not play a prominent role in the decay of bodies within enclosed environments, by comparing these data to the stages created by Bass (1997) and Rodriguez and Bass (1983).

This presentation will impact the forensic community by presenting data related to decay within an environment that has been largely unexplored. The patterns identified accentuate the need for generating

comparative samples and engaging in collaborative research to create refined standards for estimating the postmortem interval within sheltered environments. This investigation retrospectively reviewed 69 cases to identify the presence and sequence of taphonomic effects of individuals who died within enclosed environments. The frequency of indoor decomposition and the patterns identified, such as the minimal role of necrophagy and sunlight on enclosed remains, underlines the need to generate comparative samples and generate context-specific standards for estimating the postmortem interval.

Where do people die alone when they remain undiscovered for extended periods of time? The forensic literature implies that most cases involving decomposed remains occur in outdoor contexts, yet a review of 2003-2008 Nebraskan autopsy records demonstrates that most people dying alone are within their homes. Of 87 forensic cases reviewed, 69 died within enclosed environments. For enclosed locations, men (n=49) and women (n=20) were represented (ranging in age from 2 months to 90 years). Unsurprisingly, police are most often the ones to discover the remains (20.3%). Estimation of the postmortem interval (PMI) is critical to reconstructing the events surrounding a person's demise and this is an area in which forensic anthropologists are increasingly playing a leading role.

Rates of decay are context-specific and little attention has been paid to decomposition patterns within enclosed environments. This research aims to achieve a better understanding of decay rates by exploring contributing factors and the applicability of Bass' stages to indoor decomposition cases.

There is a plethora of experimental research devoted to quantifying the rate of human decay for PMI estimation. Specifically, Bass (1997) and Rodriguez and Bass (1983) have created decomposition stages that are widely used within medicolegal investigations, but are based on decomposition in the outdoor environments. The value of retrospective studies in combination to experimental research is that the large number of variables that affect decompositional rates may be explored.

Rodriguez and Bass's work encapsulates the process of decomposition into four phases: fresh (first day), bloated (first week), decay (first month) and dry (first year), each of which is associated with specific taphonomic effects. In this study, investigators rated the stage of decay that best fits the description of the remains, resulting in 50.7% (n=35) fresh, 36.2% (n=25) bloated, and 13.0% (n=9) advanced. The dry phase was not represented in this sample. Preliminary results show that with the passage of time, the likelihood of remaining undiscovered within an enclosed environment decreases.

For fresh cases, the mean PMI was 1.4 days (range=1.0-7.5 days) and fell within the "first day" period 88.2% of the time. For bloated, the mean PMI was 5.0 days (range=1-17 days) and occurred within the first day to first week interval 73.9% of the time. For "advanced", the mean PMI was 16.6 days (range=2-66 days) and correctly transpired within the first week to first month range 55.6% of the time. This demonstrates the problematic increase in variability of decay rates with extended PMIs.

Investigators also documented the individual effects located on the remains and examined the frequency of necrophagy and climate on the rate of decay. Within the bloated stage, bloating of the abdomen was documented at a frequency of 91.7%; however, bloating was still present within 62.5% of the "advanced" cases, when putrefactive gases have supposedly been released. Skin slippage, a feature that is not expected to occur until the bloated phase, was also documented in 20% of the fresh cases. Partial mummification was identified in 17.4% of the bloated cases. Skeletonization was only found within one advanced case.

Bass' stages heavily emphasize the actions of insects in soft tissue removal, and there is debate within the field as to whether insects directly contribute to indoor decay. Only seven cases of fly colonization were documented in this sample: 11.1% within the bloated stage and 71.4% within the advanced stage. No cases of beetle colonization were identified in the indoor records, which is consistent with the literature for enclosed spaces. The only documented case of carnivorous activity was found within the first week and "bloated" range. lt from the lack of necrophagous activity within enclosed settings.

As an approximation of climate, seasons of deposition were analyzed with an odds ratio, showing that a decedent is 1.5 times more likely to undergo decomposition before discovery in the spring and summer than in the fall and winter. This indicates that while the bodies were in artificial environments, temperature does factor into their rate of decay. The frequency of indoor decomposition and the minimal role of necrophagy on enclosed remains underline the need to generate comparative retrospective samples and context-specific standards for PMI estimation in indoor environments.

Postmortem Interval, Forensic Taphonomy/Decomposition, Indoor Environments

H43 Differential Decomposition of Non-Traumatized, Blunt Force, and Sharp Force-Traumatized Buried Pig Carcasses

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After attending this presentation, attendees will have a greater understanding of the effect of peri-mortem trauma on decay of buried remains. The study will specifically address the research question: Does the presence of peri-mortem blunt force or sharp force trauma accelerate postmortem decay of buried remains?

This presentation will impact the forensic community by comparing the differential effects of laboratory-induced blunt force and sharp force trauma on postmortem decay rates of stillborn pigs. These data will aid investigators' understanding of differential decay of traumatized versus non-traumatized remains and may aid in the determination of postmortem interval for such remains.

Forensic anthropologists have suggested that human remains manifesting peri-mortem trauma decay at a faster rate than non-traumatized remains (Mann et al. 1990).[1] Irregular or premature decomposition may occur due to injury which exposes underlying tissue to decomposition agents and insects (Rodriguez 1997).[2] In this pilot study, stages of decomposition are examined for non-traumatized buried newborn pig carcasses compared to carcasses subjected to blunt and sharp force trauma. We hypothesize that pigs with peri-mortem trauma, particularly that which involves exposure of underlying tissue (sharp force trauma), will decay more rapidly than non-traumatized or only minimally traumatized (blunt force) remains.

Nine stillborn pigs (*Sus scrofa)* were obtained for this experiment. Each pig was numbered and its initial weight, maximum length, and width recorded. Pigs 1, 4, and 7 were not subjected to trauma. Pigs 2, 5, and 8 were subjected to blunt force trauma, administered by placing a pig on a metal force plate and impacting the right head and shoulder with a concrete cylinder projectile, dropped through a 50 cm long PVC pipe. The left side of the head and shoulder were impacted by the same projectile dropped through a 108 cm long PVC pipe. A similar procedure was used on Pigs 3, 6, and 9 to simulate sharp force trauma but the projectile used was a sharpened iron wood-splitting wedge. Vertical vector force was recorded by the force plate and, along with impact time, was analyzed by [Logger Pro 3.2 software] to calculate the impulse, or change in momentum of the projectile after striking the carcass. As expected, impulse measurements were higher for projectiles dropped from the 108 cm pipe, since gravitational potential energy is directly proportional to height. Impulse was measured in Newtons/second.

Pigs were then buried at a decay facility in the Spring season in uniform depths of 40 cm in two rows of pits placed at 2 meter intervals. An iButton in each pig's mouth recorded temperature at four-hour intervals. Soil color and texture were described and soil samples

collected for determination of pH and soil chemistry (using X-ray fluorescence). Non-traumatized pigs and pigs with blunt and sharp force trauma were alternately buried in individual pits by their number.

The research plan involved exhuming Pigs 1 – 3 after one month, recording their stages of decay and reburying them. After three months, Pigs 1 – 6 were disinterred and described, then reinterred. After three additional months, all nine pigs were disinterred and their pit characteristics and decay rates described and compared. This staged exhumation and reburial was enacted to assess and control for the effects of burial disturbance on decomposition as a potential bias in this investigation.

At one month exhumation, Pigs 1 – 3 had lost over 35% of their body weight. Stage of decomposition was assigned following Galloway (1997).[3] Pig 1 (non-traumatized) manifested the least decomposition (early Phase II) compared to Pigs 2 and 3. Pig 3 (sharp force trauma) showed a slightly higher rate of decomposition compared to Pig 2 (mid-late Phase II).

At the three month exhumation of Pigs 1 – 6, all six pigs manifested skeletonization with only a few portions of hair and tissue associated with bone. Acidic soil, higher summer temperatures, increased insect activity, and higher overall rainfall with retention of moisture in clay soils likely accelerated decay in all pigs.

Results of this pilot experiment demonstrated differences in decay rates between non-traumatized and traumatized buried remains. Although sample sizes were small, pigs subjected to sharp force trauma manifested greater decay compared to other (blunt force-traumatized and non-traumatized) pigs. Factors which may be responsible for this differential decay are discussed and include internal (e.g., accelerated microbial activity) as well as external (increased accessibility to the physical and biological environment) influences. In future, experiments with larger sample sizes and more frequent monitoring through disinterment may enhance detection of variability in decay rates of traumatized and non-traumatized remains.

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2. Rodriguez WC. Decomposition of buried and submerged bodies. In Haglund WA and Sorg MH, editors. Forensic taphonomy: the postmortem fate of human remains. Boca Raton: CRC Press, 1997;459-468.
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Postmortem Decay, Peri-mortem Trauma, Postmortem Interval

H44 Application of Geopedology to Forensic Anthropology: Can Vivianite Be a Marker of Burial in Soil? – Three Case Reports

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The goal of this presentation is to illustrate the potential use of geopedologic analyses in determining the prior burial of human remains in cases of remains coming from an unknown context and which may have been previously buried and then exhumed.

This presentation will impact the forensic science community by showing how the presence of vivianite inside the bone structure of buried bodies may be considered a marker of a previous burial, even if soil residues are no longer recognizable on the remains.

Three cases were studied: the first case concerns the finding of a skeletonized corpse of an old woman wrapped in a blanket, who was buried by her daughter in the house garden seven years before; the second case concerns a corpse buried in a 80 cm deep grave in a wooded area 20 years before, following the indications provided by organized crime; the third case is that of a skeletonized human cranium found within a building site.

Sections of samples of bone from the three cases underwent petrographic microscopy and composition microanalyses by scanning electron microscopy (SEM-EDS), in order to verify the presence of vivianite crystallization in bones. Vivianite is an iron hydrated phosphate ($Fe_3(PO_4)2{\cdot}8(H_2O)$) and a reducing agent, rich in organic material, usually observed in anoxic environments. In these conditions the ferrous ions (Fe^{2+}) in the soil combine with phosphorous from the surrounding environment, as seen in archaeological contexts (for example, in ancient latrines). In cases of buried corpses, the soil is a source of ferrous ions and bone provides phosphorous; the decomposition processes create the necessary reducing conditions. Therefore, the presence of vivianite within the bone structure may indicate that the corpse was previously under soil even if the skeletonized remains are found in a different environmental context.

In all three cases analysis by petrographic microscopy showed blue-green-violet shades in different bone districts, which indicate the presence of vivianite. Microanalyses by SEM-EDS confirmed that the chemical composition of this material is concordant with vivianite, although further analyses need to be performed.

In addition, in the third case the SEM-EDS highlighted an inclusion of geopedologic material inside the diploe. This detail stresses the potential of microtrace analysis in verifying whether the skeleton has been in soil. In addition, geopedologic microtraces may allow one to compare the mineralogical residues with soil samples from the possible area of burial.

This study showed the presence of vivianite inside the bone structure of buried bodies, which may be considered a marker of a previous burial, even if soil residues are no longer recognizable on the remains.

Further analyses are needed, however, in order to improve the knowledge of this field of geopedology.

Forensic Anthropology, Geopedology, Burial

H45 Biometric Assessment of the Accuracy of a Large Sample of Three-Dimensional Computerized Facial Approximations

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The goal of this presentation is to assess whether three-dimensional computerized facial approximations generated by ReFace are biometrically similar to three-dimensional models of their corresponding known faces. This study is the first of its kind to evaluate such a large number of facial approximations (n = 288).

This presentation will impact the forensic science community by providing the first large-scale evaluation of the accuracy of three-

dimensional computerized facial approximations using objective biometric techniques. The establishment of biometric similarities between computerized facial approximations and known faces has implications for the application of computerized methods to solving unidentified decedent cases.

ReFace is a computerized facial approximation program which generates faces for unidentified decedents using a large reference database currently populated by head CT scans of American males and females of African-, Asian-, and European-descent. An unknown skull is imported into the system as a 3D model, either as a CT scan or surface scan, and registered to the reference skulls within the user-specified sex/ancestry demographic in order to calculate a statistically likely face. Any known biological information, such as age, height, or weight can also be used to influence the final approximation. To date, evaluations of the accuracy of ReFace approximations have been carried out by human recognition studies using face pool selections and resemblance ratings and by computer recognition studies.

In this study, the [ReFace] reference database, consisting of three-dimensional bone and skin models, was used as the test sample in a leave-one-out validation in which one head at a time was excluded from the system and treated as an unknown. For each individual, average approximations were generated with only sex and ancestry specified and with no modifications for age, height, or weight. Because the reference faces within each demographic are topologically equivalent, landmarks of interest could be placed on one canonical face from which x-, y-, and z-coordinates could be generated for the corresponding landmarks on each known face and each approximation within a particular demographic. For this study, 34 anthropometric and constructed landmarks were chosen to evaluate the accuracy of the three-dimensional configurations of the most influential and centrally located facial features: the eyes, nose, and mouth. Landmarks along the perimeter of the face were avoided because they vary considerably with weight, and landmarks along the brow ridges were also avoided because they are essentially determined by the shape of the underlying supraorbital ridges. Three-dimensional coordinates were used to calculate all interlandmark distances (n = 561) for each known and approximated face. Euclidean distances were calculated for each pairwise combination of faces, and for each approximation, the rank of its corresponding known face according to the Euclidean distance was evaluated.

When each demographic was evaluated separately, the rank 1 recognition rate, or the percentage of known faces with the smallest Euclidean distance to its approximation, ranged from 6.25% for African-descent males (n = 48) and females to 23.40% (n = 48) for Asian-descent males (n = 47). The average rank of the known face ranged from 8.33 for European-descent females (n = 49) to 14.19 for African-descent females (n = 48). Average ranks of the known faces for all demographics were significantly higher than that expected by chance. In order to further assess the strength of association, each approximation was compared to all known faces (n = 288). The average rank of the known face when considering all individuals was 20.94 and the median rank was 7, meaning that for 50% of the approximations, the known face ranked somewhere in the top 7. The rank 1 recognition rate for the overall evaluation was 16.67%.

The results of this study indicate that facial approximations generated by ReFace are biometrically similar to their corresponding known faces even when compared against a large face pool. Higher ranks than those obtained in this study may be obtained by including more landmarks, especially around the eyes. This study also suggests that the soft tissue structure of the face is highly influenced by the morphology of the underlying craniofacial skeleton and can be estimated fairly accurately by a statistically-oriented computerized facial approximation program, such as ReFace.

Facial Approximation, Facial Recognition, Human Identification

H46 Results From a Survey on Computerized Facial Approximation

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The goal of this presentation is to provide the forensic identification community with feedback about opinions toward computerized facial approximation (CFA) programs and to promote an interdisciplinary discussion on the potential of CFA as a tool for solving unidentified decedent cases.

This presentation will impact the forensic science community by presenting the varied opinions of identification specialists toward computerized facial approximation and the unidentified backlog.

Recent advances in computer animation and three-dimensional imaging have stimulated developments in computerized facial approximation. Some programs are already being used for casework, while many others are still under development. Several advantages offered by CFA are: (1) shorter generation times as compared to traditional methods; (2) the possibility for non-artists to generate approximations, allowing agencies to do so with their own personnel on their own schedule; (3) the reduced handling of fragile remains, and with some programs the elimination of the need to de-flesh remains; and, (4) the digital archiving of unidentified cases for future analyses. The primary disadvantage is the need to digitize an unidentified skull using equipment that most forensic identification agencies do not possess. Despite this disadvantage, many agencies are seeking tools such as CFA in order to utilize as many resources as possible to re-evaluate and publicize cold cases. Given these recent efforts and the inevitable increase in the use of CFA programs, this survey was designed to investigate previously unaddressed issues regarding the facial approximation needs of the identification community.

Email invitations were sent in the summer of 2008 to 764 forensic identification specialists in the U.S. asking them to participate in a web-based survey on CFA. The survey consisted of 29 multiple-choice questions concerning the use of facial approximation, interest in CFA, program features, and the unidentified backlog. An open comment box was provided at the end of the survey for additional comments about survey content. Eighty-six anonymous responses from medical examiners/coroners, forensic anthropologists, forensic artists, law enforcement officers, and other identification specialists were collected and evaluated.

According to this survey, sixty six percent of respondents are interested in using a CFA program at their agency, while only 50% are currently producing approximations in the traditional methods. Only 39.5% of respondents would be able to obtain a three-dimensional scan of an unidentified skull in order to use a CFA program. Fifty-one percent think CFA programs will play a significant role in reducing the backlog of unidentified decedent cases in the United States. Seventy-two percent answered that if a thoroughly tested CFA package were made available to their agency for no charge, their agency would use this system as its primary method of generating facial approximations for unidentified decedent cases. When asked to choose from among three types of CFA programs which one they thought would produce the most accurate images, fifty-five percent selected a program which calculates a facial approximation based on a large reference database of faces, thirty-five percent selected a virtual clay program based on traditional facial tissue depth markers and tables, and ten percent selected a program which allows you to paste three-dimensional eyes, noses, and mouths onto a skull (n = 83). When asked to select the primary reasons for the high number of unidentified decedent cases in the United States, seventy-

eight percent selected no way to cross-reference unidentified cases with missing persons, seventy-one percent selected no centralized system to publicize approximations/images, and sixty-nine percent selected no centralized resources/guidelines for processing and analysis of unidentified cases (n = 72).

The results of this survey indicate that a large proportion of the forensic identification community is interested in using CFA programs. While opinions about types of programs and features varied considerably, most individuals preferred a mathematically-oriented program that can address the ancestral diversity of unidentified decedents in the United States, including Hispanics. Regarding the unidentified backlog, survey respondents consistently emphasized the need for inter-agency cooperation The results of this survey will hopefully provide valuable information to individuals involved in the development of CFA programs and help promote a cross-disciplinary dialogue about facial approximation and how it can be used to help address the backlog of unidentified decendents in the United States.

Facial Approximation, Human Identification, Survey

H47 Integrative Measurement Protocol Incorporating Morphometric and Behavioral Research Tools From Forensic Anthropology, Human Biology, and Primatology

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After attending this presentation, attendees will become familiar with a new integrative measurement protocol designed to promote an understanding of the relationship between soft and hard tissue anatomy and scale, will have access to video and written measurement definitions, and will be familiar with how these protocols can enhance forensic anthropological work.

This presentation will impact the forensic and biological anthropology communities by introducing a new integrative protocol that will enhance research designs for questions addressing human morphology and identification.

In recognition of the interdisciplinary nature of the forensic sciences, and particularly of the subfield forensic anthropology, the Bones and Behavior Working Group presents a set of protocols for linking behavioral, biological, and skeletal databases. The goal of this protocol is to promote greater synthesis across biological anthropology and to facilitate estimates of living parameters from skeletal remains of forensic interest. The practice of forensic anthropology involves research into human skeletal, but also behavioral, variation across and within populations, requiring an understanding of human and nonhuman primate evolution. Similarly, other human biologists, primatologists, and evolutionary morphologists seek to understand the evolution of human adaptation. Yet despite the interdependence within an individual organism of physiology, behavior, and skeletal biology, each subfield of biological anthropology works in relative isolation. Although each subfield might address similar "umbrella questions" regarding adaptation and growth, which would be enhanced by, for example, the ability to estimate body weight or size from skeletal remains, these scientists generally do so without integration of protocols across subareas.

A small group of scientists with expertise in each of the target subareas, particularly drawing from the fields of primatology, human biology, skeletal biology, and forensic anthropology, met to generate a set of interdisciplinary protocols. This set of protocols promotes the integration of data collection from living and skeletal specimens in order to enhance knowledge of biological variation and ultimately our ability to estimate aspects of living anatomy from an individual's skeletal remains. Questions involving proximal life history variables or stressors will be more accessible, which is of particular interest to forensic anthropologists investigating human identification. The group culled a set of core measures from across the subdisciplines, measures that address issues of universal concern and that could be made maximally comparable. The resulting protocol is designed to provide a small core of standard measures that can be easily added to lengthier and more specific protocols generated to address targeted research questions. The protocol includes "nonskeletal" measures such as body weight and overall size (e.g., stature, sitting height) and "proxies for key skeletal measures" (e.g., body segment measurements, cranial circumferences), with definitions that can be approximated on both living and skeletal samples.

To facilitate dissemination of the protocol and to obtain feedback for its refinement, this presentation demonstrates the protocol and examples of how it has been used in cross-disciplinary research and how it will benefit work in forensic anthropology. The presentation includes instructional videos of collection methods and tools, a sample database for entering protocol measurements, sample resources for acquiring research tools, and sample results of pilot research projects. Measures and proxies are demonstrated with written instructions, photographs, videos, and diagrams; users are assumed to have familiarity with skeletal landmarks and skeletal measurement technique. Pilot research projects include evaluation of how well skeletal proxies correlate with measures taken on living subjects, and consider the relationship between frame size (as measured from knee dimensions) and body weight. The group's website, which can be viewed at www.bonesandbehavior.org, provides protocols and videos for free download, along with ancillary data protocols targeting more specific questions (e.g., dental anatomy, blood spot collection), archives of methods papers, and references to sources that provide equipment and additional background information.

Morphometry, Protocol, Interdisciplinary

H48 Evaluation of Bilateral Differences in Histomorphometry From the Anterior Cortex of the Femur of Korean Adults

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After attending this presentation, attendees will learn about the importance of bilateral differences in femur histomorphometry when it comes to applying to the practical forensic fields. The usefulness of age-predicting equations previously documented for Korean adults will be discussed.

This presentation will impact the forensic science community by verifying the usefulness of the microscopic age estimation method based on a sample of Korean adults and will provide the rationale for taking femoral specimens without distinction of sides. This study will be of greatest interest to forensic anthropologists in many countries, as well as Korea.

The femur has an advantage in that it is often found in forensic context and can be used to provide basic skeletal materials for histomorphometric analysis. From this aspect, the microscopic age estimation equations from the right femur in Korean adults were reported in 2009.[1] However, a particular bone, such as right femur, to use for the histomorphometric analysis is not always found in the practical forensic fields. The purpose of this study is to evaluate the bilateral differences in histomorphometry from the anterior cortex of the femur of Korean adults. The right and left bone specimens of anterior femoral midshaft were removed from 21 Korean cadavers (14 males and seven females) in wedge form that one of the saw cuts was kept perpendicular to the long axis of the shaft. The age range for the sample is 46 to 94 years with a mean and standard deviation of 67.5 and 13.2 years, respectively. After cutting off the thick sections of 1-mm from each wedged femoral fragments using a diamond wheel, the thin sections (less than 100 um thick) were prepared for histological analysis by manual grinding method. Five subperiosteal areas of each thin section were analyzed microscopically by indicating points (the most anterior point and points 10° and 20° to the left and right) on the glass cover slip of the bone slide. The number of intact osteon (Pi), number of fragmentary osteon (Pf), osteon population density (OPD), and average size of intact osteon (OA) were measured using an [Olympus BX-51] light microscope with simple polarizing attachment and image analysis solutions at a magnification of ´100. The Paired samples T-test was performed to verify the differences between right and left histomorphometry and regression analysis was performed to test the accuracy of age-predicting equations previously documented by Han et al.[1] for Korean adults. As the results, Pi, Pf, and OPD, except for OA, showed no significant differences in paired samples T-test between right and left sides (P = 0.245, 0.901, 0.214, and 0.002, respectively). Even though further testing on the femur histomorphometry is required and planned to evaluate more samples, the results of this study suggest minimal effect on bilateral differences of femur histomorphometry measured in Korean adults, thereby providing the reliability of taking femoral specimens without distinction of sides for histological age estimation techniques at the practical forensic fields. The results of the accuracy of age-predicting equations previously documented by Han et al.[1] for Korean adults using forensic specimens requested at National Institute of Scientific Investigation, Korea will be presented.

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Age, Histomorphometry, Femur

H49 Forensic Anthropological Consideration of Quantification Techniques of Individuals From Excavated Human Remains in Case of Burial Place at Daehak-Ro, Korea

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After attending this presentation, attendees will learn about the procedures and forensic anthropologic considerations used to estimate the number of buried individuals in a commingled burial site.

This presentation will impact the forensic science community by showing how anthropologic findings and methods helpful for estimation of the number of buried individuals can be enhanced by using with molecular (DNA) analysis.

The minimum number of individuals (MNI) and the grand minimum total (GMT) have been the traditional parameters of quantifying individuals. However, these methods have limitations in quantifying the commingled osteological assemblages for two reasons: (1) Both traditional methods just estimate the number of individuals represented by the assemblage recovered; and, (2) the accuracy of estimation is determined by the number of skeletal elements to be completely recovered. The Lincoln Index (LI) and the most likely number of individuals (MLNI) were recently introduced as the methods of estimating the number of individuals throughout the excavated human remains. These recent methods can estimate the number of individuals by considering the bones unobserved, because the equation of estimation accounts for the number of skeletal elements on each side and the number of bones in each pair. Therefore, the LI and the MLNI have benefits to estimate the number of individuals in any types of commingled field.

On November 27, 2008, 170 scattered human remains were recovered in a cave after the removal of buildings located at Daehak-Ro in Seoul. The femur was most commonly found and the number of left and right femora was 13 and 17, retrospectively. Nine pairs of femurora were matched through forensic anthropological analyses and the molecular works targeting DNA. The MNI was calculated as 17 (the maximum number in both sides) and the GMT was calculated as 21 (accounts for the number of paired bones). Finally, the MNI and the GMT were calculated as 18 and 22, respectively, after adding some skeletal remains that might be from one infant.

The scattered remains at the site indicated a secondary interment by the presence of commingled skeletons and absence of bones. For this reason, the LI or the MLNI was regarded as suitable methods to quantify the individuals in the current study. The LI was 25 and the MLNI was 24. The DNA analysis detected 26 types of mtDNA from the skeletal sample that was available for the molecular experiment. In two cases,

several bones with same mtDNA types were identified to be from the different individuals. As a result, 28 individuals were finally confirmed to be present at the site.

The LI or the MLNI are conclusively the more valuable methods for quantification of commingled field than the MNI or the GMT, as indicated by verification using molecular analysis. However, significant error in determining the number of individuals present may result when only DNA analysis is used.

Number of Individuals, Commingled Field, Daehak-Ro

H50 Stature Estimation: Are There Any Advantages to Using Principal Component Analysis?

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After attending this presentation, attendees will develop a basic comprehension of principal component analysis (PCA) and methods used in stature estimation. Some disadvantages that exist in current stature estimation methods and how the current method remedies this situation will be discussed. Attendees will also learn whether PCA is advantageous to increase the precision of stature estimates. They will also learn whether using a greater number of osteometric measurements in a summation method used in Fordisc will result in more precise stature estimates.

This presentatrion will impact the forensic science community by presenting a new method with which stature estimation equations may be created. It will discuss methods with which the most precise stature estimates may be obtained and how this would improve a biological profile and narrow down the list of missing persons in identification efforts.

Stature estimation is an important component of the biological profile in forensic cases. Many methods for estimating stature have been published with various levels of accuracy and precision. Although many stature estimation methods are reasonably accurate, more precise methods would improve identification efforts by narrowing the list of missing persons who may be the deceased. When trying to use multiple correlated long bone measurements to construct stature estimate regression equations, at least one measurement is often found to be *not* statistically significant due to the effect of multicollinearity. Fordisc 3 (Jantz and Ousley, 2005), as in previous methods, circumvents this problem by summing the measurements of several bones, and then regresses these against forensic stature (FSTAT). Fordisc provided the first method to add combinations of three measurements to estimate stature, which enabled narrower prediction intervals. Another solution to the problem of multicollinearity would be to analyze the principal components of several bone measurements.

The present study investigated the use of principal component analysis (PCA) to estimate stature using a sample of 130 White males from the Forensic Data Bank. Ten data subsets were created and each included FSTAT as well as two to five of the following osteometric measurements: maximum length of the femur, condylo-malleolar length of the tibia, maximum length of the humerus, maximum length of the radius, and basion-bregma height. R (R Development Core Team, 2008) was used for all statistical analyses. Principal components were extracted from each data subset and regressed against FSTAT. In each situation, either the first principal component only, or the first and last principal components were found to be statistically significant ($p < 0.05$). The raw measurements were also summed (creating a cumulative variable) and regressed against FSTAT. The precision of the estimates were determined by first using the 95% prediction interval at the mean. Because prediction intervals are narrowest at the mean, the prediction interval two standard deviations above the mean was also evaluated. The precision of the stature estimates obtained using PCA were compared with those obtained by using the summed measurements. Results were interpreted as practically significant if the decreases in the prediction intervals were great enough to affect the stature estimates, which are most often rounded to the nearest inch. Another factor taken into consideration was the great variability that exists in reported statures (Willey and Falsetti, 1991). Thus, the prediction intervals needed to decrease by at least one-half inch to be considered practically significant.

In comparing summed measurements and PCA for stature estimation, PCA provided some small statistically significant prediction interval improvements that were not practically significant. This study also investigated whether there was greater stature estimate precision when using more osteometric measurements to create the cumulative variables. When considering mean values, using four measurements resulted in a prediction interval that was only 0.21 cm (0.1") smaller than using three measurements (the Fordisc maximum) and this difference is not practically significant. When using values that were two standard deviations above the mean, an increase in precision of only 0.40 cm (0.2") was seen using summed variables created from three and four measurements. These decreases in prediction intervals are not practically significant.

While no practical differences in FSTATs were found when using PCA and summed variables, additional studies using cadaver lengths and measured statures are necessary to further investigate the relationship between physical stature and osteological measurements. Areas of further research may include investigating different populations (e.g., White females and Black males and females), both separately and combined, in which the methods above may be more useful.

Stature Estimation, Biological Profile, Principal Component Analysis

H51 An Investigation Into the Rate of Decomposition of Decapitated Heads and Heads With an Attached Body

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After attending this presentation, attendees will understand the key factors involved in the rate of decomposition of the head and whether the rate of decomposition in the head alone varies significantly to the rate of decomposition in the head when attached to the rest of the body.

This presentation will impact the forensic community by presenting data from a controlled experiment in an area where very little research is available. This presentation will further add to the important research being carried out in the area of forensic taphonomy by aiding the understanding of how carcasses decompose and thus enabling a better appreciation of the processes involved in human decomposition.

It has been implied within taphonomic research that the head decomposes at a quicker rate than the rest of the body; however, the causes of this increase in rate are unknown and require investigation. This research explores whether the head decomposes more rapidly than the rest of the body and, if so, why this is the case. Previous work has suggested the advanced rate of decomposition of the head may be due to the preferential attraction of Diptera to the natural orifices of the head as a result of volatile gases emanating from these orifices (Cross and Simmons, in press).

Volatile gases produced during putrefaction result in the release of liquids and gases which are in turn exuded through the body's natural orifices. It has been established through previous research that the nose

and mouth are the two main sites from which such odours emanate (Bass, 1997). Previous research also showed that that the attraction of carrion flies to these volatile gases results in preferential oviposition in the orifices of the head, especially the mouth. The preference of Diptera for head orifices was examined to determine whether this is due to protection from scavengers and the opportunity of a warm, moist shelter provided by such orifices or the presence of volatile gases.

A control group of 24 whole domestic pigs (*Sus scrofa*) and an experimental group of 24 pig heads was used to carry out this research. Both groups were left to decompose in the same environment at the TRACES facility in North West England. Data were collected approximately every 50 accumulated degree days (ADD) until data collection ceased at approximately 750 ADD. The scoring system proposed by Megyesi, et al. (2005) was adopted to visually assess the decomposition rate of the heads; a score according to the rate of decomposition was assigned to the heads of both the control and experimental groups. Three pigs from each group were discarded every 100 ADD to allow for additional data collection (e.g. weight and soil pH) whilst leaving the remainder of the carcasses undisturbed.

It was observed that heads with an attached body decomposed at a quicker rate than heads alone ($p \leq 0.6140$). This supports the paradigm that the expulsion of volatile gases released during the decomposition of the body is a key factor in influencing the rate at which the head decomposes. It was further noted that preferential oviposition occurred in the mouth of the heads with attached bodies, whereas the preferential oviposition on the heads alone occurred at the foramen magnum. A delay in oviposition of 26.85ADD was observed in the decapitated heads in comparison to the heads with an attached body. Moreover the decomposition rate of decapitated heads lagged behind heads with an attached body by a minimum ADD of 21.02 to reach a decomposition score of 2 and a maximum ADD of 103.06 to reach a decomposition score of 10 on the Megyesi, et al. (2005) scale. A score of 11 was the highest score attributed to the heads alone, whereas the heads with an attached body reached a score of 12.

Such findings further support the importance of the presence of volatile gases in influencing attraction of insects and hence decomposition rate.

In conclusion, this study provides evidence to support the primary role that volatile gases play in the rate of decomposition of the head. Furthermore, information gained from this research can be used to improve PMI estimation in cases of decapitation and thus aid in death investigation.

Decomposition, Heads, Taphonomy

H52 An Assessment of a Simple Model and Method for Osteometric Sorting

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The goal of this presentation is to introduce participants to an alternative method for osteometric sorting of paired elements.

After attending this presentation, attendees will learn that alternatives to the paired elements model and method introduced by Byrd (2008) will yield a higher percentage of correct classification. The aforementioned method is examined for the distribution of the parameter "D" as well as the percent correct classification in an independent sample.

The assessment of whether two or more skeletal elements could correspond to the same individual is a relevant problem in a variety of forensic scenarios. Determining the number of victims contained in a feature, sorting commingled remains in mass graves or mass disasters, or simply assessing whether different sets of dismembered remains belong to the same victim, all require the matching of articulating or paired skeletal elements. Such assessments have traditionally relied on visual examination, based on the experience and expertise of the forensic or physical anthropologist. However, in the last decades, the availability of new comparative samples, and the quantitative requirements imposed by the *Daubert* standards, have resulted in the proposal of novel quantitative methods to approach this problem. Among them, Byrd (2008) contributes the most comprehensive approach both to discuss and systematize the conceptual problems attached to the different scenarios usually confronted in forensic settings, and to propose novel quantitative methods specific to each scenario.

This study examines the simplest of these scenarios: "the comparison of left and right bones using models that key on shape" (Byrd, 2008, p. 200.) To confront this problem, Byrd (2008, pp. 201-204) proposes a model based on a parameter "D" (*Byrd's D*, herein), calculated from the pooled linear differences in a set of variables of the two skeletal elements under study. Among other postulates, the model assumes a Student *t* distribution for this parameter, and recommends a diagnosis based on the 90% confidence interval for this distribution.

The present study tests the distribution of Byrd's D, as well as its percentage of correct classification using the same variables and parameters described by this author (Byrd, 2008), and based on a sample of 81 male individuals from the Todd Collection. A sample of 236 male individuals from the Forensic Data Bank (1) are also employed to assess the performance of Byrd's D when standard measurements (sensu Buikstra and Ubelaker, 1994) are employed. An alternative method based on Euclidean distances from Principal Component Analysis is proposed; and the effect of the number of variables and victims on both estimates is tested.

Results suggest that, as assumed in the original model, the distribution of Byrd's D neither departs from normality nor shows a mean significantly different from zero. The equivalence of the 90% confidence interval proposed by Byrd (2008) with a 0.05 alpha-level in a one-tailed conventional hypothesis test is also shown. However, the distributional parameters obtained by Byrd (2008) do not represent the best fit, which would render a negative mean and a larger standard deviation. As a consequence, the method results in a percentage of misclassification much higher than predicted by the model. It is therefore suggested that the larger standard deviation values should be used when applying Byrd's method.

Finally, the accuracy of the assessment is shown to depend heavily on the number of victims considered, so that simply selecting the skeletal element showing the smaller Euclidean distance in the phenotypic space renders percentages of correct classification above 90%, and superior to those attained by Byrd's method, when two to four individuals are considered, and the true pair is present in the sample.

Osteometric Sorting, Commingled Remains, Paired Elements

H53 Improving Histomorphometric Age Estimation: An Application of Osteon Population Density on Kerley's Original Sample Data

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After attending this presentation, attendees will understand the benefit of the OPD variable in histological age estimation.

This presentation will impact the forensic community by demonstrating that Osteon Population Density (OPD) can simplify previously reported age estimation techniques by reducing observer error and eliminating the need to subjectively determine an age interval when

multiple regression models produce overlapping prediction intervals from a single specimen.

In 1965 Kerley developed age regression formulas from 126 undecalcified cross-sections taken from the midshaft of the femur, tibia, and fibula.[1] These samples were of known age, sex, and clinical history. Kerley's statistical models were based on four predicting variables including intact osteons, osteon fragments, non-Haversian canals, and percentage of circumferential lamellar bone. The variables were observed using four circular fields within the outer third of the cortex adjacent to the periosteal surface of the bone at 100x magnification. The individual variables (osteons, fragments, and non-Haversian canals) were counted within each field, including those partly obscured by periphery of the field, and then totaled across all four fields to create a composite value. The percentage of circumferential lamellar bone was averaged for all four fields. These raw counts were then used to develop four different regression models for estimating age from a single cross section of bone. Kerley and Ubelaker[2] revised the original Kerley paper warning investigators that the variance in field diameters of different microscopes would contribute to "apparent errors" and "unreasonable [age] estimates." Kerley and Ubelaker[2] realized that using a smaller field size than Kerley's original field size would underestimate age since the sum of recorded structures would be less than that recorded when the regression models were created. During this revision, it became apparent that the original microscopes were not available for inspection. A survey of available microscopes suggested that the field diameter used by Kerley[1] was most likely 1.62 mm at 100x magnification, rather than the previously reported 1.25 mm diameter. A 1.62 mm field diameter results in an area 2.06 mm2.

Recognizing the contributions of earlier bone histology studies in age estimation, Stout and Paine[3] developed a histomorphometric variable that summed the intact and fragmentary structures over the observable cortical area. This single variable was used as a predicting variable for determining age-at-death, rather than developing multiple prediction models from each of the observed structures. Stout and Paine[3] suggested that combining the number of intact and fragmentary osteons reduced the potential for inter-observer error associated with individual differences in osteon interpretation. Later, Crowder evaluated the effectiveness of OPD and determined that it significantly reduces inter-observer error as had been suggested in the literature.[4]

Kerley's original data from 126 specimens were used to calculate OPD by adding the raw composite values for intact and fragmentary osteons and dividing by the sum of the four 2.06 mm2 field areas (8.24 mm2) as determined by Kerley and Ubelaker.[2] A statistical regression analysis was performed by plotting age-at-death against OPD using SPSS 15. Four separate regression models were created, one for each skeletal element tested and one that combined the data of all three skeletal elements. All models correlate well with age, with the femur analysis providing the strongest positive linear relationship between OPD and age-at-death (R2=0.912), followed by the combined analysis for femur, tibia, and fibula (R2=0.894), tibia (R2=0.889) and fibula (R2=0.888). The results of this study indicate that the OPD variable correlates better with age than the raw counts, and the new models alleviate the need to generate a subjective age interval due to overlapping prediction intervals of the constituent variables. Suggestions for future research in histomorphometric age determination are also discussed.

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Histomorphology, Osteon Population Density, Age Estimation

H54 Histological Age Estimation: Towards Standardizing Definitions of Bone Histological Variables

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After attending this presentation, attendees will be familiarized with certain definitions of bone histological variables that pose interpretation problems when microscopic age estimation methods are employed; and which definitions may help reduce the amount of subjectivity and observer error leading to increased accuracy and reliability of such methods.

This presentation will impact the forensic science community by enhancing the understanding of how to reduce differences in interpretations of various histological definitions, or descriptions, used in histomorphometric age-at-death estimation methods.

The admissibility of expert testimony in federal courts is governed by the U.S. Supreme Court decisions made in *Daubert* v. *Merrell Dow Pharmaceuticals and Kumho Tire Co. v. Carmichael*. While the trial judge must function as a gatekeeper, it is the responsibility of experts in the forensic community to reach an agreement about the reliability and accuracy of scientific methods. Quantitative histological methods can be reliable for estimating age at death. Their reliability is contingent upon the accuracy and precision produced by the method of evaluation. The use of age at death estimations that employ histomorphometry rely on the definitions that the method in use presents. The descriptions, or definitions, of histological variables often differ between methods. These differences in definitions between researchers and methods leave the door open for one forensic expert's testimony to be negated by another forensic expert who may use a method that uses different definitions of the same variables. Forensic scientists should be concerned with standardizing the specificity of these definitions. In doing so, the variation in interpretation of the variables will be reduced, and in turn, inter- and intra- observer error that results from such differences in interpretations can be addressed, and ultimately, disputes about definitions that are employed by forensic scientists in court may be reduced.

This report presents the results of an inter-observer study testing how individuals interpret the definitions set out by the originators of two microscopic age estimation methods commonly used by forensic anthropologists. To explore how differences in definitions affect the identification of histological variables, three groups of readers carried out two age estimation methods: Kerley's (1965) age estimation method was tested on femora cross-sections, and Cho et al.'s (2002) method on cross-sections of ribs. In testing these two commonly used methods that employ different bones, it is clear that the actual description, or definition, of the histological variables affect the accuracy and reliability of the method used. To ensure that the readers read the same defined area, duplicates of the same calibrated digital image of several different areas were taken from cross-sections of bone, as specified by the histological age estimation method being tested, and corresponding grid overlays for each method under review, were distributed to each reader. The readers were divided into three groups, composed of three

individuals each, according to their respective levels of training in skeletal biology. The three groups were divided as follows: novice; intermediate; and advanced. The readers were given written instructions on how to carry out each method and provided with several different definitions of histological structures from different sources. In addition to receiving different definitions of these structures, the readers were provided with images of intact Haversian systems, osteon fragments, primary vascular canals, and primary osteons.

Previous studies have examined the inherent deficiencies in microscopic age estimation methods. This study is unique in that it is concerned with definitions of variables relied upon when employing histomorphometric methods for age estimation. This study takes a step towards recognizing why the process of standardizing histological definitions is important. The standardization of these definitions will make future use of histomorphometric age estimation methods more reliable and easier to use.

Forensic Anthropology, Bone Histology, Age Estimation

H55 And Dens There Were Two: The Utility of the Second Cervical Vertebra as an Indicator of Sex and Age-at-Death

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After attending this presentation, attendees will learn that the second cervical vertebra is a reliable estimator of sex and age-at-death.

This presentation will impact the forensic science community by illustrating the importance of continuing research and data collection from previously under-utilized elements in forensic anthropology because they may also yield reliable results.

Medicolegal death investigation involving cases in which human remains have become skeletonized rely heavily on the preparation of a biological profile. This profile, consisting of age-at-death, sex, ancestry, and stature, serves to assist the investigator in the confirmation of a decedent's identity. Several reliable methods for establishing a biological profile exist, however many of these methods rely on either the recovery of several specific bones or on fragile skeletal elements that are frequently lost or destroyed in archaeological context. It is for this reason new methods utilizing other previously under-documented bones should be established.

In instances of skeletal remains recovery where the most reliable indicators of sex and age-at-death have been destroyed or lost, an investigator must rely on other, less commonly used elements.[1,2] Previous research conducted by Wescott[3] suggests that the second cervical vertebra is a reliable predictor of sex (ranging from 81.7 to 83.4%) while the work of Algee-Hewitt and coworkers[4] suggests that the element may also inform age-at-death estimates. Moreover, the second cervical vertebra has been shown to be more frequently recovered in is entirety than pelvic bones[5]; therefore, warranting further investigation by the forensic anthropological community.

In order to test the utility of the second cervical vertebra in forensic contexts, skeletons were drawn from the donated skeletal collection curated at the Hamilton County Forensic Center (HCFC) in Chattanooga, Tennessee (n=57). Data were collected from 19 adult females and 38 adult males with an age-at-death for the pooled sample ranging from 21 to 89 years with a mean age of 54.19 years. Following Wescott[3], five dimensions of the second cervical vertebra were taken with digital sliding calipers and recorded to the nearest 0.1mm: (1) Maximum Sagittal Length (XSL); (2) Superior Facet Sagittal Diameter (SFS); (3) Superior Facet Transverse Diameter (SFT); (4) Length of Vertebral Foramen (LVF); and, (5) Maximum Height of the Dens (XDH). Measurements of bilateral landmarks were always taken from the left for consistency. In addition, lipping projecting from the superioanterior aspect of the dens was recorded as present or absent. Lipping projecting ≥ 1mm was scored as present.

Metric data collected from second cervical vertebrae were used to calculate five discriminant functions reported by Wescott.[3] These equations use as few as one and as many as five measurements to predict sex. Results mirror those of Wescott[3] and suggest that the second cervical vertebra is a dimorphic bone that can be used to predict sex in forensic anthropological contexts. The correct number of classified cases ranged from 80.7% (two variable model) to 87.5% (four variable model). Moreover, results demonstrated that a single measurement (XSL) correctly predicts sex in 84.2% of cases.

The lipping data collected were used to calculate the age-at-transition for which an individual passed from the absent to the present category. *Nphases*, a Fortran-based computer program written by Konigsberg[6], was used to calculate the age-at-transition for this particular trait. Results indicate an age-at-transition of 35.3 years (sd=11.2).

While additional analyses are required on a larger sample of documented individuals, these results indicate that in the absence of the os coxa, the second cervical vertebra is a good indicator of sex. Also, lipping, present on the dens, may have some utility as an age indicator in forensic contexts. This reality underscores the importance for researchers to continue developing novel approaches for documenting sexual dimorphism in skeletal remains as well as age-related skeletal change.

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Forensic Anthropology, Skeletal Biology, Second Cervical Vertebra

H56 A Radiographic Assessment of Age Using Distal Radius Epiphysis Presence in a Modern Subadult Sample

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After attending this presentation, attendees will be presented new standards for the appearance of the distal radius epiphysis as an age indicator for subadult remains.

This presentation will impact the forensic community by suggesting an age-at-death estimation approach by means of radiographic assessment that provides better predictions than the currently accepted

standards. In conjunction with other methods, further research in this area may ultimately lead to more identifications of subadult remains by providing more precise age ranges.

Due to the increasing number of missing children in the United States and the *Daubert* standards, better age estimation techniques are necessary for a forensic anthropologist presented with a set of unidentified subadult remains. The age indicators traditionally used include dental development, long bone length, and appearance of ossification centers and epiphyseal fusion. For instance, according to Greulich and Pyle (1959), the epiphysis of the distal radius first appears at 13.2 months ± 5.4 months (S.D.) in White males, and in White females at 9.8 months ± 4.1 months. Scheuer and Black (2000) report that the same epiphysis appears, on average, during the first year and is present in all individuals by three-and-a-half years old. However, currently used age standards for subadults derive from data that are at least sixty years old. With today's children maturing faster, age estimations based on data from the early 20th century will overage individuals. Additionally, most of the growth standards were based on middle- to upper-class White children, while forensic anthropologists are faced with a range of populations. Skeletal collections with large enough samples of modern subadults are difficult to obtain, but radiographic analysis of bone is more than manageable and can be used for research. This preliminary study examines the presence of the distal radius epiphysis as a means to estimate age.

The sample consists of 160 radiographs with Black, White, Asian, Hispanic, and Native American populations represented. All individuals were positively identified. For the purposes of this preliminary study, children of different sex and ancestry were pooled. To ensure a modern subadult sample, all were born between 1998 and 2008 and were between 0 and 156 weeks (approximately 3 years old) at the time of death. In order to provide statistically appropriate age estimates, logistic regression using R (R Development Core Team, 2008) version 2.8.1 was employed. Naturally, the probability of having the distal radius epiphysis present increases as the individual ages. It was reasoned that age estimates should be qualified with a certain confidence level and provide, for example, the minimum or maximum age at death given the presence or absence of the epiphysis, respectively.

In this preliminary study, it was determined with 95% probability that, if the epiphysis is present, the individual is older than 34 weeks (7.8 months), and if the epiphysis is absent, the individual is less than 72 weeks (16.5 months) old. These findings are significant because not only are they younger and narrower than the standards currently in place, but in using a statistical model, estimates with an explicit confidence level can be used.

This research will be expanded to incorporate the appearance of other secondary ossification centers and epiphyseal union times to infer how much earlier modern populations are maturing and allow for better age estimates. In addition, sex and ancestry will be tested to evaluate their effects.

Age-at-Death Assessment, Subadults, Secular Change

H57 New York City Unidentified Decedents From 1980 – 2008

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The goal of this presentationr is to provide attendees with a unique perspective on unidentified decedents in New York City including historical and demographic trends.

By presenting statistics relating to unidentified individuals in New York City for a period spanning nearly three decades, this presentation will impact the forensic science community by providing a better understanding of historical and demographic trends within this population. The presentation of these trends can provide direction for future research in identification techniques and allow for comparison with other large metropolitan areas.

A recent report published by the Bureau of Justice Statistics puts the number of unidentified human remains in the United States at over 10,000 cases during the twenty five year period from 1980 – 2004 (Hughes 2007).[1] According to this study, the State of New York ranks second only to California in number of cases during this period with a total of 2,284. Because the majority of the cases in New York State are likely to originate in New York City, one can safely estimate that New York City accounts for nearly twenty five percent of all cases of unidentified individuals in the United States. The Forensic Anthropology Unit at the Office of Chief Medical Examiner in New York City (OCME-NYC) has recently begun an historical review of cases of unidentified individuals with the goal of collecting all relevant case data into a single location and disseminating that data to national databases such as NCIC and NamUs.

This presentation provides a current assessment of unidentified individuals in New York City from the period spanning 1980 – 2008. The data are analyzed for trends based on a variety of variables including estimated age and sex, and year, month, and location of death. The data are also presented in relation to relevant milestones such as the full-scale use of DNA identification techniques.

Materials and Methods: The data were collected from two sources: the current OCME-NYC case database system, which includes cases from 1998 thru the present, and the New York City Department of Health's (DOH) logbooks of death certificates for the years prior to 1998. The DOH logbooks were searched for cases listed as Unknown Male and Unknown Female. Other name combinations typically associated with unknown individuals were also searched including Jane and John Doe, Unknown Bones, Unknown Skeleton, Unknown Skull, and Unknown Torso. All case files were reviewed to ensure the individual was correctly listed as unidentified. Demographic information was recorded from the anthropology or autopsy reports when available. Reports were generally not available for cases obtained using the DOH logbooks. For these cases the demographic information was taken directly from the death certificates themselves. Sex was listed as Male, Female, or Unknown. Race was listed as White (including Hispanics), Black, Asian, or Unknown. Cases were grouped into three age categories based on the available age estimates: Infant (less than 1 year), Subadult (1 to 18 years), Adult (19-49 years), Elderly Adult (50 years or older), or Unknown.

Results: There are a total of 3065 long-term unidentified cases for New York City during the period of 1980 - 2008, occurring at an average rate of 1.6 per 1,000 deaths. Overall there has been a gradual decline in the number of unidentified cases annually to the current rate of approximately 0.5 per 1,000 deaths. Annual totals do show a high degree of variability in the late 1980's and early 1990's, with fluctuations of around 50% between 1991 and 1995. It is possible that this variability is a byproduct related to the timing of death certificate filings or other factors, but it does appear to correspond with similar fluctuations in the overall death rate for the city. Within the five boroughs of New York City, Manhattan has the most unidentified cases in total, and averages the most cases each year except 1998, 2002, and 2004 when they are surpassed by Brooklyn. Staten Island has the fewest with only 50 cases during the 30 year period.

The majority of cases are males (80%), with White males accounting for about 38% of all cases and 28% for Black males. This differs from the BJS report, which estimated Whites males to account of over 50% of unidentified cases nationwide. Females account for 20% of the sample with nearly equal distribution between White and Black (6% of cases). 35% of the sample is estimated to be in the Elderly Adult category and 60% are estimated as Adult. 3% are estimated as Subadult.

Historical reviews such as this study are important because they allow for continued focus on cases of unidentified decedents that may have otherwise been forgotten about. The accurate accounting of these

cases in the long-term is of vital importance to ensure that correct case data can be distributed to national databases (e.g NCIC and NamUs) and that potential matches with missing persons are not missed. In New York City, this historical review process has led to recent identifications in a number of long-term missing persons cases. The collection of this data also allows for comparison with other large jurisdictions.

Reference:

[1] Hughes, K. – 2007Unidentified Human Remains in the United States, 1980-2004, edited by U. S. D. o. Justice.

Unidentified Decedents, New York City, Missing Persons

H58 Detecting Individuals With Reduced Mobility Using Femoral Morphology

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The goal of this presentation is to demonstrate the unique morphological characteristics associated with reduced ambulatory ability and immobility. Attendees will learn how to recognize characteristics of the femur that provide information about the mobility of individuals whose skeletons they are examining and how this information may provide unique clues to help in the identification process.

This presentation will impact the forensic community by demonstrating that femur morphology can be used to determine activity levels, including reduced ambulatory ability caused by disease or injury.

Bone is an extremely plastic material that constantly modifies itself throughout life, and unique or distinguishing skeletal traits and activity markers, especially those that are likely to be recorded in medical records or observable in photographs, can provide valuable information leading to identification in medicolegal investigations. Osseous morphological features can often allude to distinguishing physical activities regularly conducted by an individual during life, especially if the activities require repetitive movement or commonly result in recognizable bony injuries. For decades physical anthropologists have been examining femur morphology to reconstruct activity patterns and intensity in past populations, and osteological changes expected with increases in particular activity are well known. Bony changes expected with decreased activity have received far less attention, but recent secular change studies demonstrate that Americans have undergone significant changes in femoral shaft morphology and strength over the past 150 years in large part due to reduced daily mobility. Likewise, numerous clinical studies have shown differences in the angle of inclination, angle of torsion, and bicondylar angle between ambulatory and nonambulatory individuals. Information gained from biomechanical, secular trend, and clinical studies can also be used by forensic anthropologists to not only recognize particular activities but also decreased ambulatory ability caused by disease or trauma. In this presentation we compare femur mid and subtrochanteric diaphyseal cross-sectional properties and three functional angles (inclination, torsion, and bicondylar) between normally ambulatory adult individuals and individuals known to have reduced mobility due to cerebral palsy.

Reduced mobility or long-term immobility results in diminished musclar stress and normal weight bearing on the lower limb bones. Depending on the age of the individual when ambulatory problems arise, normal ontogenetic changes in femoral angles often do not transpire and/or wasting of the femoral shaft cortical bone occurs. The angle of inclination (angle between the long axis of the neck and long axis of the shaft), which ranges from 120 to 135 degrees in normal ambulatory individuals, is frequently coxa valga or greater that 135 degrees in individuals with reduced mobility due to decreased muscular and weight stress on the developing hip. The angle of torsion, a measure of the rotation of the femoral head and neck relative to the diaphysis that averages about 12 degrees in normally ambulatory adults, is commonly greater (shows antetorsion) in individuals with cerebral palsy due to differential proximal and distal muscle pull. The bicondylar or tibiofemoral angle results from differential forces on the medial and lateral condyles during normal walking causing greater growth of the medial than the lateral condyle forming the bicondylar angle during childhood. Consequently, the bicondylar angle does not form in non-ambulatory individuals. The presence of the bicondylar angle is indication of at least early childhood ambulatory ability. Finally, wasting of the cortical bone associated with reduced mobility/immobility is reflected in bone strength and mediolateral diaphyseal dimensions. Individuals with reduced ambulatory ability associated with cerebral palsy, for example, are often more than two standard deviations below the average (size standardized) in the mediolateral midshaft dimension, but do not differ significantly from normal in anteroposterior dimensions.

Bone is an extremely plastic material that constantly modifies itself throughout life. Many of the morphological features of the long bones have been used by physical anthropologists to reconstruct activity patterns and intensity in individuals and populations. Likewise, morphological features of the femur can also be used as evidence for reduced ambulatory ability or complete immobility. The unique combination of features may even provide information regarding when the ambulatory problems arose during life.

Forensic Anthropology, Mobility, Femoral Antetorsion and Coxa Valga

H59 Sociocultural Factors in the Identification of Undocumented Migrants

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The goal of this presentation is to discuss the accuracy and utility of the "cultural profile" concept proposed by Birkby et al. (2008) from the cross-disciplinary perspective of a forensic anthropologist and a cultural anthropologist.

This presentation will impact the forensic science community by proposing a precise language with which to discuss non-biological evidence utilized in forensic examinations of believed-to-be migrants from Mexico and Central America, a demographic that is steadily increasing within medico-legal jurisdictions throughout the United States. This presentation also aims to open a discussion within the forensic science community about the ways that regionally specific cultural information can be useful in death investigations, especially when antemortem data is incomplete or limited.

Since 2001, the Arizona-Sonora portion of the U.S.-Mexico borderlands has seen a massive increase in the number of migrants dying in the desert while attempting to cross the border clandestinely. Since then, the Pima County Office of the Medical Examiner (PCOME) has relied on non-biological evidence alongside biological evidence to aid in the identification of human remains.

The unique situation on the U.S.-Mexico border poses particular challenges to forensic science. Because migrants are seeking to avoid detection, many are found in remote desert areas without identification media. Due to economics, fear, and the international nature of the migration issue, the acquisition of missing person's reports is often delayed, and when missing person's reports are filed, they rarely include dental or medical records. Undocumented Border Crossers (UBCs) are a regionally diverse yet socially distinct category–they are defined not by shared ancestry, nationality, or ethnicity, but by the *act* of crossing the border. Although most UBCs identified at the PCOME have come from Mexico or Central America, this is a region too large to be unified into a

category with homogeneous biological (or cultural) traits (Spradley, 2008 and Hefner, 2008).

To respond to these challenges, the PCOME created a profile for UBCs in order to categorize unidentified human remains as either probable migrants or probable U.S. citizens. This was done so that: (a) the proper pool of antemortem records could be compared; and, (b) deceased migrants could be better counted (Anderson 2008). A significant part of the determination of a UBC relies on what Birkby et al. termed the "cultural profile," referring to "the geographic context of recovery, personal effects, dental health, and cultural accoutrements" (2008). In the current paper, the authors expand on the notion of a cultural profile, arguing for use of the term "sociocultural" instead of "cultural" to better indicate the economic nature of much of this evidence. Additionally, a description is provided of the methods used at PCOME to assess the sociocultural profile, and consider the potential for more specific predictive categorizing based on regionally specific insights from a cultural anthropological approach to modern material culture.

Migration, Material Evidence, Anthropology

H60 What's in a Number: Statistical Paradigm Shifts in Forensic Anthropology

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After attending this presentation, attendees will become familiar with statistical paradigm shifts in forensic anthropology and understand how these shifts relate to greater philosophical trends prevalent during the major historical periods of the discipline. Additionally, attendees will learn about limitations of various statistical methodologies and current statistical requisites in forensic anthropology will be discussed.

This presentation will impact the forensic science community by establishing a coherent statistical history of forensic anthropology and by offering suggestions at a time when the profession is working to recommend appropriate standards and best practices for age, sex, ancestry, and stature estimation.

The history of forensic anthropology (FA) is divided into three periods based on the degree to which the field was organized as a professional discipline (i.e.; Formative, Consolidation, and Modern Periods). Notable statistical trends run throughout FA, and these trends follow a similar progression. The role of statistics in FA has elevated from insignificant (no pun intended) to prime player. This escalating emphasis on statistical rigor in FA is linked to intellectual, technological, and political stimuli.

During the Formative Period, FA was primarily a descriptive discipline within osteology, wherein three of the four primary components of the biological profile (age, sex, and ancestry) were determined on the basis of descriptive parameters. Early descriptive methods of estimating age, sex, stature, and race are described by Thomas Dwight in 1878 (*The Identification of the Human Skeleton: A Medicolegal Study)* and in a series of papers from 1881-1905. H.H. Wilder and Bert Wentworth reiterate Dwight's descriptions in *Personal Identification* (1918) and add criteria for sex estimation from the pelvis and skull. Shortly thereafter, Todd (1920) published his descriptive aging criteria on the pubic symphysis. Early methods of ancestry estimation focused on metric and non-metric traits. Although most of these methods were not developed for forensic utility (i.e., Hooton's Peabody forms, Hrdlička's *Anthropometry*, and Pearson's *Coefficient of Racial Likeness*), they played a major role in later developments. Likewise, correlation coefficients and regression formulae for stature estimation were available as early as the late 1800s; these were not developed for forensic use, but influenced later developments in stature estimation.

The Consolidation Period marked a turning point in FA history primarily due to the publication of Krogman's *Guide to the Identification of Human Skeletal Material* in 1939. During this period, an increasing number of physical anthropologists became interested in its forensic application and began researching modern skeletal variation, especially during WWII. The influx of research literature provided the intellectual impetus for developing more accurate and objective methods. Trotter and Gleser (1952, 1958) developed regression equations for stature estimation using a young, modern sample. Giles and Elliot (1962, 1963) broke statistical ground in sex and ancestry estimation with their pioneering use of discriminant functions, thereby paving the way for decades of discriminant analyses on all imaginable bone measurements. Descriptive techniques gradually gave way to statistical methods, with the use of multivariate statistics advancing primarily due to readily available computing packages. Nonetheless, age estimation resisted the statistical pull, with seriation and accompanying sample descriptive statistics remaining an industry standard.

The Modern Period began when the Physical Anthropology section of the AAFS was formed in 1972. By this time, modern computing power was opening up new statistical possibilities, and the growing understanding of the intricacies of modern skeletal variation explicated a need for quantification. Discriminant functions continued to be popular in sex and ancestry estimation and software development began in the 1980s using Giles and Elliot's functions. The 1993 release of FORDISC 1.0 radically changed sex and ancestry estimation for forensic anthropologists and made easy computation available to anyone with a set of calipers and an osteometric board. However, greater statistical awareness also fostered an understanding of the limitations of some of these methods, and researchers sought alternatives to compensate for these weaknesses. Further stimulus was provided by the 1993 *Daubert* decision. The millennium marked a statistical turning point, and geometric morphometrics, maximum likelihood and Bayesian approaches began receiving considerable attention in the forensic anthropology literature. In addition, established error rates became a necessary focus in the field, along with developing objective and repeatable standards.

For 2010, the Scientific Working Group for Forensic Anthropology is actively establishing "best practice" within the discipline. Consequently, it is imperative that forensic anthropologists are conscious of the statistical background in the field and are aware of current statistical trends as appropriate standards are recommended for age, sex, ancestry, and stature estimation. This presentation aims to acquaint attendees with statistical foundations in FA and to offer suggestions for future direction.

Forensic Anthropology, Statistical Methods, Daubert Standards

H61 The Use (and Abuse) of the Sacrum in Sex Determination

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After attending this presentation, attendees will have a better understanding of the use of the sacrum in sex determination, the most accurate measurements of the sacrum to use when determining sex, and the accuracy of the new measurements and techniques proposed.

This presentation will impact the forensic community by serving as a metric technique, cross-validated, for identifying sex in fragmentary human remains.

The sacrum has long been thought to be sexually dimorphic. Anecdotal evidence that the male sacrum is "narrower, longer and more curved" than the "wider, shorter and less curved" female sacrum is

taught in osteology courses, presented in forensic anthropology references, and generally used in the field. A search of the literature yielded six publications and three published abstracts in which the authors attempted to quantify these morphological differences. The results of these statistical studies were highly varied, and none were conducted on modern American skeletal populations, making them questionable for their used in modern forensic cases.

The current study tests the validity of the use of the sacrum for sex estimation on two modern samples: the William Bass Donated Skeletal Collection at the University of Tennessee in Knoxville and the Maxwell Museum Documented Skeletal Collection at the University of New Mexico in Albuquerque. Both of these collections are of modern individuals who donated their bodies to the collections between the early 1980s and today. Date of birth, date of death, ancestry, and sex are known for these individuals, and medical history is known for many of them. A total of 114 males and 61 females were used in the analysis. Measurements were checked for errors and outliers, and aberrant values were removed. Discriminant function analysis (DFA) was performed on the data using Fordisc 3.0 (Jantz and Ousley 2005) and all reported classification percentages were cross-validated.

Of twelve measurements taken, three variables were found using stepwise variable selection that classified the sample 83% correctly. The single best measurement was the antero-posterior diameter of the first sacral vertebra (AD), followed by the (left) maximum auricular surface length (LA), and the anterior width of the sacrum at the level of the inferior auricular surface (MWI).

These measurements do not reflect the curvature of the sacrum, rather they reflect size and shape differences: males showed higher mean AD and LA but virtually the same MWI as females. Substituting the width of the sacral wings for MWI yielded the same correct classification rate of 83%. Further, the superior sacrum is dimorphic enough that using the transverse diameter of S1 (TD) and AD classified the sample 81% correctly. Using three variables that reflected sacral curvature (curved length, maximum depth of curvature and sacral length) did not classify the sample much better than by chance (61%). There appears to be too much overlap between the sexes in sacral curvature, which is overlooked when exemplary sacra are selected for teaching purposes.

This study indicates that dimorphism in the sacrum is useful for estimating sex from skeletal remains, but sacral curvature does not appear to be useful, at least with the measurements used in this study.

Sex Determination, Sacrum, Anthropology

H62 Sex and Ancestry Estimation From Landmarks of the Cranial Base

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The goal of this presentation is to study the nature of morphological variation in the base of the human cranium and the utility of that variation for estimating sex and ancestry from skeletonized remains. Discriminant functions that accurately estimate sex and ancestry for American Whites and Blacks from the cranial base are presented.

This presentation will impact the forensic science community by providing new tools for estimating sex and ancestry from skeletonized human remains, particularly in the case of fragmentary crania where portions of the cranial base remain intact. Sex and ancestry are important components of the biological profile that physical anthropologists seek to establish for unidentified individuals. Methods that are appropriate for use with fragmentary remains expand the range of tools available to practicing forensic anthropologists.

It is well established that craniofacial morphology can be used to estimate sex and ancestry of human remains, but in some instances crania are not recovered intact. Building on earlier research by Holland (1985, 1986) that indicated dimensions of the cranial base can be used for sex and ancestry attribution, it is hypothesized that sex and ancestry can be more accurately estimated using the three dimensional morphology of the cranial base.

A sample of 277 crania from individuals of known sex and ancestry from the Robert J. Terry (National Museum of Natural History, Smithsonian Institution) and William M. Bass (University of Tennessee, Knoxville) collections is used to test this hypothesis. A series of 12 landmarks from the cranial base were observed as three dimensional coordinates and analyzed using geometric morphometric and traditional statistical methods. The Cartesian coordinates were fitted with general procrustes analysis, which brings the configurations into a common coordinate system, rotates and scales them. The fitted coordinates were then subjected to principal component analysis. Principal components representing ninety percent of the shape variation and the centroid size from the procrustes analysis were used to derive discriminant functions for classifying crania as to sex and ancestry (American Whites and Blacks).

Using landmarks from this morphological region, both sex and ancestry can be classified with greater than eighty five percent accuracy. As seen in other studies, shape is the critical component for ancestry estimation, while sex estimation requires both shape and size for accurate classification. For estimating ancestry, only the principal components representing the shape variation between the American White and Black samples was necessary. Nevertheless, for estimating sex the addition of centroid size significantly improved the accuracy of the method. Based on this study, discriminant functions employing interlandmark distances that do not require a digitizer to observe are presented.

Morphpometrics, Sex, Ancestry

H63 Virtual Sex: Phenice and Metrics of the Pelvis From 3D Computed Tomography (CT) Models

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The goals of this presentation are to introduce a new sample of over 70 modern virtual skeletons with known biological profiles, as well as the results of a pilot study using three-dimensional (3D) medical imaging and computer modeling technologies to validate standard sex and novel sex estimation methods of the human pelvis.

This presentation will impact the forensic community by serving to increase scientific knowledge of new technologies and methods available to the forensic community for human identification. It will also attempt to add to the body of knowledge on sex estimation from the pelvis, as well as provide an example for a new source of data.

The University of South Florida College of Medicine has accumulated three-dimensional (3D) data from medical scans (Computed Tomography (CT) and Magnetic Resonance Imaging (MRI)) of donated cadavers and clinical scans into a collection of virtual bodies. Previous studies[1,2] have demonstrated that three-dimensional (3D) imaging technologies are allowing researchers to create virtual computed

models of anatomical structures that go beyond traditional anthropological resources. Virtual models of skeletons from the scanned individuals have been made in order to test anthropological methodologies used in the creation of the biological profile. This study focused on the estimation of sex from the pelvic bones. The most widely accepted technique for sex estimation of the pelvis is based on multivariate evaluation of morphological traits. Sexually diagnostic non-metric traits include the width of the greater sciatic notch, ventral arc, subpubic concavity, and medial aspect of the ischio-pubic ramus. Documented success rates of Phenice[3] and Phenice-derived methods[4,5] consistently report accuracy rates in excess of ninety percent when performed by trained individuals. The goal of this project was to undergo a validation study to determine if sex can be estimated metrically and non-metrically from computed 3D models of the os coxa from a collection of known individuals.

The accuracy of both visual and metric sex traits of the pelvis were statistically evaluated in comparison with antemortem biological profiles. Using a random selection from the 70+ known individuals, os coxa models were extracted from the CT scans and modeled in *Mimics*© version 13. The pelves were then registered against each other and pelvic sex traits were analyzed in 3D space in the software package. Phenice traits[3] were compared with metric curvature modeling of the sub-pubic concavity. All measurements were independently verified by two trained anthropologists with the inter- and intra-observer error calculations. Additionally, student data was also used to evaluate the effects of experience on correct classification and measurement techniques.

This project demonstrates the potential for virtual data such as the USF College of Medicine's Virtual Skeleton Collection to increase the resources available to researchers. With the addition of more modern human data, traditional methodologies such as those used to estimate the biological profile can be re-examined and the current knowledge base expanded. The virtual pelves can provide limitless opportunities for discovery of robust methods applicable to real-world problems in forensic anthropology.

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Sex Estimation, Computer Modeling, Virtual Anthropology

H64 Molar Crenulation as an Attribute of Ancestry in Forensic Cases: Identification and Accuracy

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After this presentation, the attendee will gain understanding of the diagnostic accuracy of molar crenulation as a marker of African ancestry, as well as how to correctly classify and identify the condition.
This presentation will impacts the forensic science community by providing guidelines for the identification of molar crenulation and its utility as a predictor of ancestry in forensic cases.

Forensic anthropologists frequently rely heavily on metric assessment and morphological observation of the mid-face and cranial vault to determine ancestry. Often, dental morphological traits are used to bolster these skeletal ancestry assessments. On a macroscopic level, the differences in the size, contour, and shape of tooth enamel are integral variables used in the determination of ancestry. Well-studied dental characteristics such as the "shoveling" of the lingual surfaces of upper incisors or the presence of an additional lingual cusp adjacent to the protocone on any or all of the upper adult molars (e.g., Cusp of Carabelli) are often used as diagnostic markers of Asian or European ancestry, respectively. However, the complex wrinkling of molar occlusal surfaces (e.g., crenulation) coincident with African ancestry lacks the depth of lucubration evidenced by the shoveling and Cusp of Carabelli ancestry traits used in forensic anthropology.

The dearth of scholarly research concerning molar crenulation provided us the opportunity to investigate the extent to which African ancestry groups expressed the condition relative to European and Asian ancestry groups. To this end, we reviewed forensic skeletal cases (n=85) that were placed within an ancestry group (i.e.; African, European, or Asian) based upon metric assessment using FORDISC 3.0 and/or positive identification through other scientific means (e.g., dental, fingerprints, DNA, or medical records/radiographs) from Florida medical examiner districts 4, 17, and 20.

The forensic anthropologist inventoried each case and charted all teeth to ensure elements necessary to create a biological profile were present (i.e., cranium, mandible, ossa coxae, tibia, or femur). She then metrically and non-metrically analyzed each case to determine age, sex, ancestry, and stature using standard forensic anthropological methods. In order to determine the extent of crenulation necessary for this study, the upper and lower first, second, and third molars were scored for the presence and absence of occlusal crenulations when observable using a 5x hand lens and the naked eye. Three investigators independently scored each case to minimize the propensity for interobserver error. The data was statistically analyzed using SPSS 15.0. Specifically, compared was the frequency of the condition between the three ancestry groups using chi square analysis of variance.

Upon analysis of the data, it was found that molar crenulation was associated with individuals of African ancestry one hundred percent (100%) of the time, while fifteen percent (15%) of those with Asian or Native American descent presented with the condition. None of the individuals of European ancestry showed evidence of molar crenulation. These results were statistically significant (x^2=19.429, df=2, p= 0.00), evidencing that while molar crenulation is an accurate indicator of African ancestry, this is not the only ancestral group that will exhibit this dental morphological characteristic.

Forensic Anthropology, Dental Morphology, Molar Crenulation

H65 Subadult Ancestry Determinations Using Geometric Morphometrics

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The goal of this presentation is to explore the applicability of geometric morphometric techniques in subadult biological profiling.

This presentation will impact the forensic science community by highlighting the importance of understanding biological variation in the determination of ancestry in unidentified subadult remains.

Along with sex, age, and stature, ancestry determination is an essential component of the forensic toolkit. Several established metric and non-metric techniques exist which utilize the cranial and post-cranial skeleton to identify ancestry. However, all of these methods are limited to adult skeletal material, as ancestral differences, like sex differences, are believed to be indistinct in youth until stimulated by the differential growth of adolescence. As such, anthropological protocol tends to reserve judgment in regards to the ancestry of subadult material. However, the work of Strand Viðarsdóttir and colleagues (2002) found that, regardless of sex, population-specific facial morphology manifests at birth and is further modified during ontogeny. Buck and Strand Viðarsdóttir (2004) go on to suggest that geometric morphometrics (GM) is capable of identifying ancestry in subadult mandibles. The traditional metric analyses employed in ancestry determination apply discriminant functions to defined linear distances. Unfortunately, comparative datasets derived from these analyses cannot be applied to subadult material, as these datasets do not reflect the widespread allometric changes occurring during the growth period. Geometric morphometrics, on the other hand, is capable of partitioning biological size from shape, thereby circumventing this obstacle. Ross and Williams (2009) used GM to explore cranial size and shape differences in a single population of subadults and adults and found no significant differences between older subadults (mid-teens) and adults (≥18 years), suggesting that subadults reach their final form earlier than expected.

In order to further elucidate the potential of GM in identifying subadult ancestry, the present study explores how successful GM methods are at correctly classifying ancestry in modern Portuguese subadults both as a group and individually. The sample used for group analysis of craniometric affinity includes Portuguese adults (n=53) and subadults (11 to 16 years-old; n=10) from the Luís Lopes Collection in Lisbon, Portugal; native adult African slaves who died in Cuba (n=15) from the Morton Collection at the University of Pennsylvania; modern adult Cubans (n=21) from a cemetery collection housed at the Museo de Montane, Havana; and, modern adult African-Americans from the Terry Collection at the Smithsonian Institution (n=48). Nineteen three-dimensional type 1 and type 2 anatomical landmarks were collected. The landmark data were transformed by generalized Procrustes analysis (GPA) which optimally translates, scales, and rotates the points into a common coordinate system. In order to reduce dimensionality, a principal component analysis (PCA) was performed on the covariance matrix of the aligned coordinates. Group similarity was evaluated via pairwise tests with Bonferroni correction (α/n). The pairwise results found Portuguese subadults to be significantly different (Pr >F= 0.001) from all of the other populations except Portuguese adults (Pr >F= 0.189). Additionally, ancestry assessment was performed on each subadult via *3D-ID* (Slice and Ross 2009: www.3d-id.org), a software program which utilizes 3D cranial landmark data to classify an unknown specimen into a probable sex and ethnic affiliation. Although the software program does not yet include Portuguese among its 11 diverse reference populations, all 10 subadults were classified as European or European-American (average posterior probability: 0.741; average typicality=0.4621) and only one individual's sex was misclassified.

Although exploratory in nature, these results indicate that GM is capable of correctly capturing ancestry in subadult crania. This suggests ancestral differences are morphologically entrenched earlier in craniofacial development than conventionally believed. Moreover, GM allows comparative datasets of adult measurements to be directly applied to individuals who have not yet completed skeletal growth. Incorporating such information into standard forensic practice may allow for a more informative assessment of ancestry in unidentified human remains of all ages than is currently possible.

Subadult, Ancestry, Geometric Morphometrics

H66 Craniometric Variation in South African and American Blacks

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After attending this presentation, attendees will understand patterns of craniometric variation in two disparate populations with African ancestry and implications for individual identification.

The presentation will impact the forensic community by emphasizing the morphological diversity in continental and regional samples.

The estimation of ancestry is an important part of the biological profile, and in most cases up to the present, race or continental ancestry has been used to narrow down possible identifications. With increasing human rights work and the spread of forensic techniques to more parts of the world, finer-grained analyses will no doubt become important. The Rwandan genocide involving Hutu and Tutsi ethnic groups is a recent example of the need for data specific to a particular forensic challenge. All human populations are relative, are often locally specific, and can be qualified in numerous ways. Spradley et al (2008) illustrated the value of regionally specific population samples in their analysis of ninetenth century enslaved Africans from Cuba.

South Africa is a linguistically and ethnically diverse country, with eleven official languages and a history of immigrants from Europe, India, Indonesia, and Malaysia. Dark-skinned South Africans (blacks) are from many different indigenous groups and comprise approximately eighty percent of the total population, whites are about nine percent of the population, and people of Indian/Asian ancestry are about 2.5%. The other major ethnic group is the Coloreds, persons of mixed ancestry and lighter skin, who are descendants of slaves brought in from East and Central Africa, the indigenous Khoisan, and South African blacks and whites. Black Americans originated predominantly from West Africa and came to America through the slave trade, and show significant admixture with white Americans. Given their different origins and disparate histories, how does morphological variation in South African and American Blacks compare?

The South African sample consists of 64 males and 27 females from the Department of Anatomy at the University of Pretoria, and the American samples of 61 males and 54 females come from the Forensic Data Bank. Virtually all individuals were positively identified and were born after 1930. Most crania were digitized using a Microscribe and Howells standard cranial measurements were calculated from the interlandmark distances, otherwise measurements were collected using

craniometric instruments. Discriminant function analysis (DFA) was performed on the data using Fordisc 3.0 (Jantz and Ousley 2005) and all reported classification percentages were cross-validated.

In a four-way DFA for country and ancestry using 22 variables, seventy one percent were correctly classified, and using nine stepwise-selected variables, seventy-seven percent were correctly classified, indicating significant differences among all groups. South African blacks have relatively shorter and wider noses, longer, lower, and narrower crania, and wider interorbital breadths. Additionally, sexual dimorphism is lower in South Africans because South African black males are on the whole relatively smaller, and South African black females are relatively larger, compared to American blacks. However, despite their larger overall size, South Africans have remarkably smaller mastoid processes, with the South African male mean mastoid height lower than the American female mean. When American white males and females were added in a six-way DFA using eight variables, they were classified with seventy-two percent accuracy and the South African means were intermediate between the means for South African blacks and American whites. These results are not unexpected, given the documented gene flow between white and black Americans, though South African and American blacks originate from different regions in Africa.

Sex-specific analyses also illustrated differences between the American and South Africans blacks. In males, ninety one percent were correctly classified by country using just three measurements (NLH, NOL, and OBB) and likewise in females, eighty five percent were correctly classified using BBH, NLB, and ZMB.

These results illustrate the inherent diversity in samples grouped into traditional races, and complement studies of other Africans, Chinese, Native Americans, and Southeast Asians. The identification of ancestry is relative to the forensic questions asked, and fine-grained estimation of ancestry will likely be successful in many cases. Further, the South African sample itself is ethnically diverse, and with a large enough sample, the recorded ethnic groups can be studied separately. These results also highlight the usefulness of diverse reference samples, which will unfortunately be needed in the future.

Craniometrics, Ancestry, Discriminant Function Analysis

H67 Death on America's Southern Border: A Summary of Five Years of Genetic Data Acquisition and Analysis of the Reuniting Families Project

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After attending this presentation, attendees will have a greater understanding of the issues involved with the identification process of deceased undocumented immigrants in the United States. In addition, attendees will hear a summary of the cases submitted to Reuniting Families for the past five years. The data obtained from HV1 and HV2 mtDNA analysis performed for these cases will be discussed. Of particular focus will be the mtDNA variation across Latin America and the utility of this data in future identification of remains.

This presentation will impact the forensic community and humanity by providing valuable insight into the genetic variation of the undocumented immigrant community, its reflection of the larger source populations of Latin America, and its ability to aid forensic scientist in the identification and repatriation of these persons.

Significant numbers of undocumented immigrants enter the United States each year. According to the Pew Hispanic Center, the average number of people entering the United States illegally was 800,000 per year from 2000-2004 and 500,000 per year from 2005-2008. Roughly 77% of illegal entrants are Hispanic with 59% from Mexico, 11% from Central America and 7% from South America. While accurate statistics are difficult to ascertain, it is appropriate to assert that hundreds of these migrants die each year entering the United States from the southern border. Conservative estimates of deaths due to illegal immigration typically exceed 300 per year, with the U.S. Border Patrol reporting 472 for 2005, for example. Due to a tightening of border security that began in the 1990s, undocumented entry into the United States is confined to areas of desolate, inhospitable terrain. As a result, the remains of many illegal entrants that die along the 2,000 mile U.S./Mexico border are not found for weeks or months if at all. The efforts of migrants to conceal their identities, the large number of migrants per year and the delayed recovery of remains make the identification process for deceased undocumented border crossers extremely challenging.

In 2003 efforts began at Baylor University to assist in the identification process of undocumented immigrants by establishing the Reuniting Families project. In 2004, an online database was launched and cases for DNA analysis were accepted. In 2005, the project teamed with Mexico's Secretaría de Relaciones Exteriores to launch a new database, Sistema de Identificación de Restos y Localización de Individuos, or SIRLI, in an attempt to facilitate efforts of locating missing Mexican citizens abroad, both living and deceased. Since 2004, Reuniting Families has analyzed the mtDNA from the remains of 301 individuals believed to be undocumented immigrants. The samples submitted consist of 294 bone samples, 5 tooth samples, 1 hair, and 1 dried blood sample. The project has identified 69 individuals to date with several tentative identifications pending further analysis.

The data has reached the critical mass required to appropriately analyze the genetic diversity of the source populations from which these cases are derived. Briefly, the majority of cases that have been genetically characterized have mtDNA types that fall into modern American Indian variation. In rank order, the majority of samples are from mtDNA haplogroup A and the next largest haplogroup is B. Very few samples fall outside of one of the 4 major American Indian haplogroups. In addition, the attempted use of this data will be discussed in order to speculate on the origin of unknown samples. By understanding the genetic diversity of the source populations that contribute to the undocumented migrant population, an attempt has been made to pinpoint potential origins for our individuals without identity.

mtDNA, Identification, Immigration

H68 The Scientific Working Group for Forensic Anthropology

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After attending this presentation, attendees will learn about the creation, goals, and current efforts of the Scientific Working Group for Forensic Anthropology (SWGANTH).

This presentation will impact the forensic anthropology community by presenting draft procedural guidelines developed by the Scientific Working Group for Forensic Anthropology in an open forum for the purpose of eliciting comment and discussion prior to finalization.

The Federal Bureau of Investigation (FBI) and the Department of Defense Central Identification Laboratory (DOD CIL) co-sponsored the creation of the Scientific Working Group for Forensic Anthropology, or SWGANTH. The 20-member Board consists of professionals from the forensic anthropological community invited by the sponsors to represent a broad spectrum of expertise and jurisdictional involvement.

The charter of the SWGANTH is to identify and recommend "best practice" within the forensic anthropology discipline. The SWGANTH is not a regulatory board with any formal coercive authority. Rather, the SWGANTH aims to develop consensus guidelines for the discipline of forensic anthropology, and to disseminate those guidelines to the broader forensic community. To this end, the SWGANTH is attempting to identify and codify existing standards, or, where clear standards don't exist, to formulate and establish them. The SWGANTH has created committees, which are populated by United States and international forensic anthropologists, to examine targeted issues for the purpose of identifying what is best practice today and what paths should be followed in the future.

For the purpose of the Scientific Working Group for Forensic Anthropology, forensic anthropology is succinctly defined as: *The application of anthropological methods, techniques, and theory to matters pertinent to civil or criminal law.* This definition is inclusive, not exclusive. Historically, at least in the United States, these "methods, techniques, and theory" of forensic anthropology have been drawn almost exclusively from the anthropological sub-disciplines of human osteology and archaeology, and the "matters pertinent to civil or criminal law" have been largely confined to: (1) the detection of buried human remains; (2) the recovery of buried or scattered human remains; (3) the generation of a biological profile from skeletal remains for the purpose of individual identification; and, (4) the interpretation of hard-tissue trauma. Certainly, while these aspects remain the core of Forensic Anthropology, this historical view has too often served to restrict the scope of the discipline.

But times are changing, and the field of forensic anthropology is at last emerging as a full-fledged discipline in its own right. Concomitant with this emergence is the rapid, and in many respects, uncontrolled, expansion of the role and scope of forensic anthropology. This expanding scope occurs at the same time as there is a growing acknowledgment by forensic anthropologists of the need for standardization of the procedures and protocols currently in practice—both in the "traditional" framework of forensic anthropology as well as in the expanding roles that the discipline is radiating into. Gone, or at least waning, are the halcyon days of individuals employing idiosyncratic techniques and methods that lead to findings by fiat. Already, many anthropologists are employed in laboratories where they are held to regulatory, statutory, and institutional guidelines that leave little room for deviation, and especially in light of the recent report by the National Academy of Sciences, forensic anthropologists in all venues will need to demonstrate adherence to established and standardized protocols.

This paradigm shift of forensic anthropology should not be viewed negatively. It is a healthy evolution, and one, arguably, long overdue. The challenge facing its practitioners is not (or at least should not be) how to arrest the change, or failing to do that, to forestall it as long as possible, but rather the challenge should be to direct the field's development into the most professional, efficient, and profitable pathway.

This symposium will review the SWGANTH's current efforts to meet this challenge and will present summaries of draft guidelines to the forensic anthropology community for review and discussion prior to finalization. The summaries will be presented in four groups, and will conclude with an overview of the SWGANTH.

Forensic Anthropology, Scientific Working Group, Professional Standards

H69 Developing a Regional Forensic Taphonomy: Environmental and Climatic Inputs

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The goal of this presentation is for the attendee to better understand the potential for interdisciplinary environmental data and geographic information systems to improve death investigation using a regional taphonomic approach.

This presentation will impact the forensic science vommunity by assisting the attendee to consider how a regional taphonomic approach might be developed for his or her jurisdiction.

Regionally specific taphonomic models are necessary in forensic death investigation to correctly interpret the condition of the body, estimate time since death, and interpret cadaver dog searches. This is particularly true in outdoor settings where weather, climate, and topography affect temperature, moisture, and scavenging, and hence decomposition patterns. In order to refine the forensic taphonomy model for northern New England, this research uses an interdisciplinary approach (anthropology, geology, botany, entomology, chemistry, cadaver K-9 use, and wildlife management) with a combined methodology of forensic case series analysis and Geographic Information Systems (GIS) mapping of environmental variables. The project will also test key components of the revised model using actualistic experimentation with pig cadavers. In addition to public-use GIS environmental data layers and local GPS point data from the case series, the model incorporates a measure of accumulated degree days to characterize cases in the reference series that have a known time since death. Additional refinements include consideration of the impacts of recent climate change on necrophagous insect metamorphosis and on decomposition patterns.

Although it is readily acknowledged that taphonomic interpretation is ideally an interdisciplinary effort, forensic death investigation generally relies upon anthropology or entomology alone to contribute a taphonomic perspective. The very real limits of jurisdictional financial resources often prevent more elaborate approaches. However, taphonomic input can be critical for forensic investigations, especially in estimating time of death, place of death, and in differentiating trauma from postmortem artifact. Through a university-government partnership we are developing an interdisciplinary taphonomy reference database and model to improve the quality and uniformity of multidisciplinary data collection at outdoor scenes, and provide an evidence base for interpreting these taphonomic data. The initial focus is on the related goals of improving detection of remains and interpreting time since death.

In Phase I of the project a Northern New England GIS-Taphonomy Reference Archive ("NNE GIS-Taph") was created using publicly available datasets, including: topography; soil type and pH; geology; hydrology; vegetation; leaf cover; precipitation; and temperature. These GIS layers were added to statewide orthographic aerial photography data for both leaf-on and leaf-off views. The environmental layers provide an archive of generic data that can be used to inform an investigation of a new forensic site. Those preliminary data can be made more specific as a cadaver search or a body recovery is done. Point data (with specific GPS locations) have been added for cases already in our reference series, which have a known time since death; point data for cadaver dog finds are also included. When remains have been found, data describing body condition and spatial distribution are added to the GIS-Taph, which functions as a relational database. GIS software applications can also accommodate digital photographs linked to spatial locations. In this way the system accumulates case data, which provide an ongoing evidence base for forensic interpretation and modeling.

Another component of Phase I is the development of interdisciplinary assessment and data collection protocols. Members of the team have provided draft standards for a "rapid assessment" of a forensic scene's environmental characteristics: geology (topsoil, topography, drainage, pH), botany (plants, pollen), zoology (insects, scavengers), and aquatic site characteristics, as well as characteristics that potentially impact detection by cadaver dogs. The environmental assessment tools will include data collection protocols for insects, plants, soils, vertebrate and invertebrate scavengers, and volatile chemicals. Data collection protocols will be tested on the pig cadaver experimental sites as they become available. The pig cadaver test sites are each paired with an environmentally similar control site for which the same data collection protocols will be used. Pig cadavers at most sites will be protected from mammalian scavenging by custom-built cages; at other sites scavenging will be documented with video cameras.

Taphonomy, Environmental Assessment, Geographic Information Systems

H70 Human Decomposition Ecology at the University of Tennessee Anthropology Research Facility

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After attending this presentation attendees will understand the importance of ecosystem ecology to studies of human decomposition.

This presentation impacts the forensic community by providing a framework for study in forensic taphonomy as those studies relate to understanding decomposition, microbial activity, and time since death.

Microbially-mediated decomposition of a corpse impacts the body and the soil environment. Carter and colleagues[1] referred to microbially-mediated alteration of the landscape as a Cadaver Decomposition Island (CDI) since the normal processes of the terrestrial ecosystem change in response to a pulse of high-quality resource over a small area. The addition of a rich nutrient source is defined by an increase in total carbon and water that supports an increase in the carrying capacity of the niche. An increase in microbial biomass and energy transformation follows, until the substrate cache of energy-bound biomolecules and nutrients are depleted and the site of cadaver decomposition returns to a level consistent with the larger biogeographical footprint.[1,2]

In order to study changes in the ecological setting of human decomposition, research was conducted at the University of Tennessee Anthropology Research Facility (UTARF). The UTARF has been engaged in human decomposition research for 28 years. Between 1981 and 2006, 782 bodies have decomposed over a small wooded 1.3 acre plot of land.[3] As such, the goal of this research is to identify variation of soil parameters as they relate to microbial biomass, microbial community structure, and human decomposition. To that end, the spatial distribution of soil conditions at was addressed. Specific attention was given to soil type, organic content, moisture content, and pH as these

modulators contribute to the underlying chemical environment where the thermodynamic activities of energy transformations control microbial activity.[4] Total carbon, nitrogen, microbial biomass, and microbial community structure were evaluated in conjunction with these basic soil parameters. Soil samples were collected following a stratified random sampling strategy. Strata were determined based on cadaver decomposition density per unit. A negative control stratum was defined as the area adjacent to the facility, located no less than five meters beyond the outer perimeter. In total, 57 soil samples were collected from the A-horizon (zero to 10 cm) of five different strata; with 12 originating below actively decomposing corpses. The samples were sifted to remove large debris, homogenized, and stored at -20˚C until analysis.

Results of soil analysis classify the soils as very deep, well-drained, clayey soils that are derived from calcareous sandstone and shale.[5] The area encompassing the decomposition facility consists of partially decomposed hardwood leaf litter and dark reddish brown loam (5 YR 3/3) making up the major component, with minor components being composed of yellowish-brown loam (10 YR 5/4). The western half of the facility has less slope than the eastern half, which approaches 25% and also includes a greater concentration of rocks. Chemical analysis of the recovered sediments indicated an average soil pH of 6.6 that varied from 4.8 to 8.0. These recordings are consistent with that reported previously.[2,5] Soil organic matter (SOM) was determined by loss-on-ignition and is reported as a percentage. For the sampled areas, SOM varied from 0.68 to 4.37 percent, and showed only slight differences among the sampled strata. Soil moisture content determined by oven drying 3.0 g to 5.0 g varied from 3 to 27 percent and showed significant differences between low and high concentrations of decomposition density. Interestingly, differences in mean water content were best explained when the data were split by terrain (i.e., slope), rather than the distribution of cadaver decomposition density.

This project evaluated physical and chemical constituents of UTARF sediments since these parameters affect microbial biomass and microbial community structure. As evidenced by the basic soil data collected for this study, soil factors such as water content, organic content, and pH are largely determined by state factors (i.e., climate, topography, parent material, time) of a temperate urban forest biome, rather than the ephemeral and localized pulses of a CDI that have a greater effect on the influx of carbon and nitrogen and the composition of the microbial community.

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Decomposition Ecology, Microbe Community Structure, Taphonomy

H71 Deep Coastal Marine Taphonomy: Interim Results From an Ongoing Experimental Investigation of Decomposition in the Saanich Inlet, British Columbia

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After attending this presentation, attendees will understand the effect of deep coastal marine submergence on carcass decomposition and the abiotic and biotic factors which impact it.

This presentation will impact the forensic science community by showing some of the myriad factors which can affect the breakdown of a carcass in the marine environment as well as recognize some of the artifacts created by animal feeding.

Marine decomposition is a little investigated area within taphonomy. The nature and speed of decomposition, the mechanisms by which decomposition occur, and skeletal survival and dispersal patterns have been the subject of an ongoing marine based high-resolution study of located at a coastal deep sea site within the Saanich Inlet, BC. The study is supported by the VENUS (Victoria Experimental Network Under the Sea) underwater observatory and allows for real time observation using a number of remotely controlled cameras and sensors.

Methods: The initial study deposited three pigs at three differing time intervals onto the sea floor in the Saanich Inlet. The inlet is a deep water fjord with a maximum depth of 230 m and is separated from the Strait of Georgia by a sill, which restricts the flow of water into and out of the inlet. This results in the inlet being anoxic for the majority of the year. The site of the first two carcass placements was at a depth of 94 m and the third was approximately 65 m away at a depth of 99 m. The placement sites were fine silt with cobble, over rock. Each carcass was freshly killed, and weighed approximately 26 kg. A remotely operated video and still digital camera, with an array of lights, mounted on a tripod, was placed at the site a day earlier by ROPOS (Remote Operated Platform for Oceanic Science), and then the weighted carcass was positioned optimally under the camera remotely, by ROPOS. The camera site was close to an array of sensors measuring the physical conditions of the water, including a Seabird and a Falmouth CTD measuring conductivity, temperature, and depth at 1 and 60 second intervals, a gas tension device, an oxygen optode and a Sea-Tech Transmissometer. Data from these instruments can be downloaded at www.venus.uvic.ca. Three carcasses were placed over time, in August and September. The method of observation and data collection was undertaken by real time digital video feed, with desk top control of cameras, and sensor data of salinity, pressure, temperature and oxygen levels.

Results: The results from our ongoing study to date, indicate that there is a key interplay between four key organisms, Dungeness crabs (*Cancer magister* Dana), three spot shrimp (*Pandalus platyceros* Brandt), squat lobsters (*Munida quadrispin*a Benedict, Family Galatheidae), the amphipod *Orchomenella obtusa* Sars (Family Lysianassidae) and dissolved oxygen levels. Low dissolved oxygen levels did not prevent faunal colonization, even at levels considered below tolerance level, indicating that the carcass provided a very valuable resource. Fauna remained at the carcass, rapidly skeletonizing it, even when oxygen levels dropped to 0.2 mL/L. However, when a carcass was placed at the site during a time of extremely low oxygen levels, larger scavengers such as *Cancer magister,* were not attracted and smaller scavengers, such as squat lobsters, could not break the skin, leaving the carcass intact for months.

Decomposition was seen to slow due to reduced faunal activity in borderline hypoxic levels and to be fully inhibited during hypoxic conditions. However, as soon as oxygen levels increased, a recommencement of faunal activity would reassert itself. This interplay

with environmental conditions resulted in the pig carcasses skeletonizing at differing rates. Hence, we conclude, that oxygen is an important co-factor in skeletonization rates in concert with the dominant fauna at this experimental site.

Faunal diversity was much less than at shallower depths in nearby waters although actual numbers were much higher and carcasses were skeletonized much faster, despite lower water temperatures and lower dissolved oxygen levels[1].

Conclusions This study has shown that decomposition and taphonomic changes in the marine environment are very variable and depend greatly on the abiotic and biotic factors of the surrounding area, in particular, oxygen levels. As long as scavengers are originally attracted to a carcass during times of adequate oxygen levels, they will remain despite drops to near anoxic levels. However, if the carcass is deployed during a period of very low dissolved oxygen, larger scavengers are unable to colonize. This is an ongoing study.

Reference:

[1] Anderson GS, Hobischak NR. Decomposition of Carrion in the Marine Environment in British Columbia, Canada. Int J Legal Med. 2004;118(4):206-9.

Marine, Taphonomy, Oxygen

H72 An Experimental Study of Putrefaction and Decomposition in Aqueous Environments

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After attending this presentation attendees will have a better understanding of the stages of decomposition in both salt and fresh water environments, helping them to determine a more accurate postmortem interval for submerged corpses.

This presentation will impact the forensic community by serving as a controlled experiment recording the postmortem changes that occur during decomposition in aquatic environments during two seasons in Southern California. The majority of previous research conducted on decomposition in aquatic environments is primarily based on case studies, thus making this research invaluable for aquatic death investigations.

Understanding the process of putrefaction and decomposition in all types of environments is crucial for both forensic anthropologists and law enforcement officials. Although the relationship between decomposition and postmortem interval has been well studied, actual controlled studies of the physical disturbances occurring as a result of decomposition of corpses in aqueous environments is rare. This represents an unfortunate lapse in research, because many forensic cases are recovered from marine, riverine, or lacustrine environments. Such cases tend to create considerable taphonomic difficulties, because the majority of forensic remains found in water are inextricably bound to their hydraulic behavior as carcasses, their loss of soft tissue and subsequent disarticulation, and the taphonomic environment in which these processes occur.

To document differences in the stages of the decomposition process in salt versus fresh water, a controlled experiment was designed to mimic a submerged corpse in a forensic setting. Four adult swine (*Sus scrofa*), purchased and euthanized at the Meat Science Facility at California State Polytechnic University in Pomona, California, were used for the experiment. The swine were placed in four separate seventy-five gallon tanks. Tanks A and C were filled with saltwater obtained from a depth of ten feet off the coast in San Pedro, California. Tanks B and D were filled with freshwater from Lake Cahuilla in La Quinta, California. To account for the seasonal difference in California, the water in tanks A and B were chilled to pre-calculated temperatures that mimic California's winter water temperatures while Tanks C and D were chilled to mimic California's summer water temperatures. Data collected included visual observations and photographs made twice a day for the first four weeks and then once a day for the remaining six weeks of the study. The presence or absence of insect activity was also noted.

At the end of the seventy-five day experiment significant differences in the stages of decomposition were observed between the saltwater and freshwater carcasses. In both the winter and summer carcasses in saltwater, the decomposition process was significantly slower than in the freshwater carcasses.

- Pig A (Saltwater/Winter): The specimen in this tank was the most expressive of the impact of saltwater on the rate of decomposition. By day four of the study, the specimen showed very minor bloating in the abdominal region. On day twenty of the study, a bulge in the abdomen split exposing a minor section of the intestines. Deflation began on day forty-five. Complete skeletonization did not occur during the duration of the study.
- Pig B (Freshwater/Winter): Minor bloating began on day four of the study and the abdomen split revealing a large section of the intestines on day twenty. Deflation of the carcass began on day thirty-two. Complete skeletonization did not occur during the duration of the study.
- Pig C (Saltwater/Summer): On day four of the experiment, the specimen began bloating slightly. By day eight, the abdominal region had opened exposing the intestines. Dead flies were found floating on the surface of the water on day twenty-four and deflation of the carcass began on day forty-two. Complete skeletonization did not occur during the duration of the study.
- Pig D (Freshwater/Summer): The bloat stage began on day three and continued for the majority of the experiment. The bloat was so severe that the carcass nearly fell out of the tank. On day seven of the study, the abdomen split completely, exposing the intestines and stomach. By day twenty-seven of the study, deflation of the abdomen and upper torso began. On day twenty-eight, skin slippage appeared on the exposed surface of the carcass. On day sixty of the experiment, disarticulation began and continued until the end of the study. Complete skeletonization of the carcass did not occur during the duration of the study.

In addition to providing preliminary insight into the impact of saltwater and freshwater on decomposition, this study may be used as a catalyst for further study into aquatic decomposition and more specifically the stages of saltwater decomposition in comparison to freshwater decomposition.

Decomposition, Aquatic, Putrefaction

H73 Decomposition in Water: The Effects of Climate on the Rate of Decay in New England

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The goals of this presentation are to educate attendees on the differences in the rate of decay in New England versus regions with temperate climates and to bring to attention the gap in the literature in regards to both cold climate and water decomposition.

This presentation will impact the forensic community by helping medical examiners and forensic pathologists become more accurate in their postmortem interval estimations. This will, in turn, aid lawyers and investigators because they can establish a more accurate timeline of events and corroborate alibis more efficiently. Families of victims will also be aided by this work because accurate time since death estimations can help medical examiners and medicolegal death investigators identify decedents that might have otherwise remained unidentified.

New England experiences variable weather throughout the year. New England winters are often very cold and dry, while summers are mostly warm and humid. After attending this presentation, the audience will realize the significance of the gap in the literature about cold climate decomposition and decomposition in water. The audience will also understand the differences in the rate of decay in New England versus the hot, humid environments, in which much of the research on decomposition in the United States has taken place.

Medical examiners, forensic pathologists, medicolegal death investigators, and forensic anthropologists benefit immensely from decomposition studies.[1] Previous research that has focused on decomposition has been conducted in different environments, which aids forensic investigators who recover human remains in trying to identify the decedents and estimate time since death.[2] Compounding variables, such as ambient temperature, geographic location, and predator activity, make the task of gleaning information from a body very difficult.[7] Decomposition studies considering these real-life variables are essential for investigators to perform their duties most efficiently.

Cold climate and water both serve to decrease the rate of decay significantly.[3] Ambient temperature influences the rate of decay dramatically; yet, decomposition studies have been performed mostly in temperate climates.[5] Similar experiments must be carried out in different regions of the world with differing environmental conditions.[4] In regard to water decomposition, much of what is known on the subject comes from case studies. Many bodies are found in water every year at different stages of decomposition. There is still much to be determined about how aquatic environments influence the process of decomposition on a stage-to-stage level.[6] Studies must be performed to determine what factors are affected and how when a body is found in the presence of water. Systematic studies on decomposition in water are also necessary to test and confirm hypotheses about how water affects the rate of decay.

This presentation will exhibit the results of a systematic research project on fetal pig decomposition in water performed in two phases. Phase I was performed between the months of February and May of 2009 in a wooded environment in New England. Phase II was performed in July of 2009 in the same environment. Four pigs were used in each phase of the project. Each pig was initially submerged in water in a plastic five-gallon bucket. In each phase, two pigs were placed in salt water and two pigs were placed in fresh water. The saltwater came from an urban beach in Boston, MA and the freshwater was taken from stagnant water in an old cranberry bog. The buckets were kept in aerated cages to prevent vertebrate scavenging; however, the cages permitted insect activity. The carrion in Phase II displayed a rapid rate of decay compared to the carrion in Phase I. Each pig decayed differently, but trends were recognized. Preliminary results indicate that water temperature is the most significant determining factor when considering the rate of decay. Results also showed that the water in each bucket (both fresh water and salt water) became more alkaline over time.

This presentation will impact the forensic community by helping medical examiners and forensic pathologists become more accurate in their postmortem interval estimations. This will, in turn, aid lawyers and investigators because they can establish a more accurate timeline of events and corroborate alibis more efficiently. Families of victims will also be aided by this work because accurate time since death estimations can help medical examiners and medicolegal death investigators identify decedents that might have otherwise remained unidentified.

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Forensic Anthropology, Aqueous Environments, Time Since Death

H74 Dead on Time? The Repellent Effect of Liquid Petroleum Gas on Time Since Death Estimation

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After attending this presentation, participants will have an understanding of the impact of liquid petroleum gas may have on fly colonization, and its potential to lead to an under-estimate of PMI in tested environments.

The presentation will impact the forensic science by indicating possible variables affecting the level of accuracy of postmortem interval methods in domestic gas related deaths from a taphonomic perspective. The findings are relevant in eliminating foul play to include preventing insect colonization, or concealing a body in clandestine disposals.

The succession pattern of *Diptera calliphoridae* in the presence of chemical attractants ethanethiol and sulphur, contained in Liquefied Petroleum Gas (LPG) was observed, with an aim to investigate whether traces of a gas leak can distort postmortem interval (PMI) estimations. After attending this presentation, participants will have an understanding of the impact this type of domestic gas may have on fly colonisation, and its potential to lead to an under-estimate of PMI in tested environments.

The research will impact the forensic science by indicating possible variables affecting the level of accuracy of postmortem interval methods in domestic gas related deaths from a taphonomic perspective. The findings are relevant in eliminating foul play to include preventing insect colonisation, or concealing a body in clandestine disposals.

The transformative process of taphonomic modifications during the decomposition process is universally accepted to depend largely on ambient temperature, with an optimal condition for the development of bacteria and insect succession between 20 C° and 30 C°. Chemical attractants tested are also significantly dependant on climatic conditions with high temperatures and dry climate causing LPG to evaporate at higher speed, effectively reducing its impact on *Diptera* colonisation. The effect of LPG gas leaks on decomposition rates was assessed with hypothesis testing by statistical analysis, assuming that LPG and ambient temperature will act in unison as main factors affecting *Diptera* colonization.

LPG is commonly used in households as well as caravanning and vehicles. It is a low carbon emitting fuel, a mixture of gases primarily propane, butane with traces of ethanethiol, sulphur and mercaptan artificially added so that leaks can be detected easily. These components in domestic gas act as chemical attractants to flies, like decomposing corpses. Here, during the putrefactive process, similar gasses such as sulfur and methane compounds are released and appeal to various insects. Due to its scenting, LPG may have a repellant effect on fly attraction to cadavers during various stages of decomposition. Hydrogen sulphide alone is generally heavy with strong odour concentration and may distract the flies from the cadaver.

Field experiments were carried out on the south Croatian coast (43.02° N, 17.57° E) over a period of 30 days in June 2007, and repeated in June 2008 to confirm previous observations. Fieldwork involved comparison of decomposition pattern between samples exposed to LPG leaks, and those not affected by it, in indoor and outer environments. This was achieved by means of recording and analysing fly succession and decomposition rates at the average ambient temperature of 25 C°. The sample size comprised eight adult carcasses of *Sus scrofa* ranging from 23 to 25 kg, and eight pig livers each weighting approximately 1kg, utilised as control samples. Carcasses tested for the effect of LPG gas leaks were placed in the direct vicinity of gas bottles with the minimum leak set up, whilst control samples were positioned three meters away from the gas bottles. Sticky tapes were placed on the gas bottles, to analyse flies attracted to the chemical attractants themselves. Carcasses were kept in metal cages to minimise interference by local scavengers. Sampling, recording and observation was conducted randomly twice a day during the first week, and once a day for the rest of the experiment. Environmental data was obtained from the local Hydro-meteorological Station.

Statistical analyses confirmed that increased ambient temperature reduced the impact of a gas leak on decomposition rates in both environments (Mann-Whitney p=0.6772; p=0.6722). Statistically significant time of an average of 10 days in indoor ambient, and 7 days in outdoor setting in decomposition rates was demonstrated at an average of 20 C° (Mann-Whitney p=0.0331; p=0.41125), stated with 95% confidence. This way, the null hypothesis is accepted. The Putrefaction stage was the least affected as opposed to the Fresh stage and the late Decay in outdoor environment at an average of 27 C°. Fly succession was further statistically significant (ANOVA, Fisher test, $\alpha = 0.005$), with the maximum delay of 6 hours (S.D. = 4.1) during the Putrefaction stage at 21 C° in outer environment, and maximum of 5 hours (S.D. =3.2h) at average of 20 C° during the Decay stage in indoor settings. No general relation was found between control samples and tested carcasses with regards to the distance of gas bottles.

Variations in the rate of decomposition were associated with the gas leak and the effect of ambient temperature in both tested environments. These preliminary results demonstrate the need for further research in this area and caution when estimating postmortem interval for domestic gas related deaths, especially for subjects in advanced stages of decomposition.

Liquefied Petroleum Gas, Time Since Death, Taphonomy

H75 Predicting the Postmortem Submersion Interval From the Adipocere Formation on Rabbits

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After attending this presentation, attendees will gain a new understanding of the early stages of adipocere formation in relation to accumulated degree days (ADD) in submersed remains.

This presentation will impact the forensic community by assessing the link between adipocere formation and ADD, thus providing information that can assist in a more accurate estimation of postmortem interval (PMI).

Adipocere is often present on decomposing bodies found in damp environments. The formation of adipocere is influenced by a number of factors such as the requirement of a moist and anaerobic environment. In some circumstances the presence of adipocere may retard decomposition. This has the potential to make PMI estimation in such cases difficult. Limited research has been conducted to assess the applicability of adipocere formation to the estimation of postmortem interval, or the impact of adipocere formation on decomposition in relation to ADD. This paper explores the correlation between ADD and the early stage formation of adipocere.

This study, using 60 wild rabbit (*Oryctolagus cuniculus*) carcasses, was carried out in northwest England. A control group (N=30) was deposited on the surface in direct contact with the ground. Chicken-wire cages were used to prevent scavenging. The rabbits of the experimental group (N=30) were submersed in water in individual buckets. Chicken-wire fencing on top of the buckets was used to prevent carcass floatation and to ensure complete submersion throughout the duration of the experiment. Thermocouples and dataloggers were used to measure the water temperatures, individual inner body temperatures and ambient temperature at the site. Data collection protocol for both groups was carried out every 100 ADD. This included assigning a Total Body Score (TBS), taking soil and water samples for pH measurement and for the submersed group, examining the subcutaneous adipose tissue and the internal organs.

The preliminary results of this experiment indicate that adipocere is more likely to form after 630 ADD on submersed remains. No adipocere was formed on any of the control group rabbits. The late occurrence of adipocere establishes the fact that its formation is a feature related to the advanced stages of decomposition. The adipocere found was in its early stage of formation, despite the advanced decomposition of the rabbit carcasses. Previously published case studies indicate that adipocere can also be found on submerged bodies in less advanced stages of decomposition (O'Brien & Kuehner 2007; Nishimura *et al*, 2009). This implies that there are multiple factors influencing its formation.

An important factor in the formation of adipocere is the exposure of the adipose and other internal tissues to water. Intact skin prohibits this contact and therefore may inhibit adipocere formation. Skin slippage is a recognised feature in decomposition which can be used to establish PMI (Heaton, et al., *in press*). In cases where PMI estimation may have been complicated by adipocere formation, knowing that skin sloughing had to have taken place before the adipocere could have been formed could assist in establishing a more accurate PMI.

More extensive research is needed to fully establish the linkages between adipocere formation and ADD.

Adipocere, Postmortem Interval, Accumulated Degree Days

H76 Differential Decomposition in Terrestrial, Saltwater, and Freshwater Environments: A Pilot Study

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After attending this presentation, attendees will learn how decomposition rates can differ between terrestrial, freshwater, and saltwater environments in central Texas.

This presentation will impact the forensic community by helping to expand the knowledge base of information regarding rates of decomposition, which will in turn aid investigators in estimating postmortem interval in forensic settings.

The study of decomposition is essential for any forensic anthropologist for estimating postmortem interval. While surface rates of decomposition are well studied, especially in certain areas (Mann et al. 1990), the decomposition rate of bodies submerged in water have not been well studied using controlled experiments (Haglund & Sorg 2002; Sorg et al. 1997). Most forensic anthropologists simply rely on the generalization that a body decomposing one week on land is equivalent to two weeks in the water (after Mann et al. 1990). In addition, there has not been much investigation into whether a saltwater environment affects decomposition differently than a freshwater environment.

This study aimed to address three questions: (1) Does submersion in water affect the rate of decomposition compared to terrestrial surface decomposition?; (2) Does this effect support the longstanding generalization?; (3) Does type of water (salt or fresh) differentially affects the rate of decomposition? Following anecdotal evidence, it was hypothesized that the surface specimens would decompose the fastest, the specimens in freshwater would decompose slower, and specimens in saltwater would decompose the slowest of all.

This study took place outdoors at the Forensic Anthropological Research Facility at Texas State University-San Marcos, Texas. Though human remains and pig carcasses do float differently in water (Haglund & Sorg 2002), pig carcasses were used in this experiment in lieu of human remains due to their similarity to human tissue, as well as for practical constraints. Six pigs (*Sus scrota)* with weights from 20-30 lbs (9-13.6 kg) were humanely euthanized following Institutional Animal Care and Use Committee guidelines. Carcasses were placed on the surface of the ground (N=2), in saltwater tanks (N=2) with water created by mixing freshwater with a purchased saltwater mix, and in freshwater tanks (N=2) with water from the local Edwards Aquifer. Salinity in the saltwater tanks was the same as the Gulf of Mexico (34-36 ppts; Boatman 2006). Air and water temperatures were recorded daily. The surface carcasses and tanks were penned to prevent animal scavenging. The study was completed when all specimens were fully skeletonized.

While placement in water affected the rate of decomposition, placement in freshwater made the specimens decompose much faster than those on land or placed in saltwater, at least in the summer environment of central Texas. This was due to the high temperatures killing the maggot masses present on the surface carcasses only one day after hatching, while the maggot masses on the freshwater carcasses lived and thrived, possibly because the water was on average 8-12 degrees Fahrenheit cooler than ambient temperature. Thus, the effect of water on decomposition did not support the longstanding generalization in the field, as the carcasses in freshwater decomposed much more quickly than the surface carcasses. In addition, the type of water differentially affected the rate of decomposition, as the carcasses in saltwater decomposed much more slowly than the carcasses placed in freshwater or on the surface. The reason for this slower rate is likely related to the fact that the carcasses in saltwater did not have burst abdomens with intestinal protrusion present in the carcasses in freshwater, which were most likely the result of osmosis. The intestinal protrusion on the freshwater specimens attracted blowflies, while the carcasses in saltwater did not, and thus with no insect activity the decomposition rate stagnated. This differential decomposition in diverse environments, whether open-air terrestrial or in fresh or saltwater, is important to consider in Texas because there because of an abundance of freshwater lakes and rivers and the proximity of the Gulf of Mexico.

Forensic Anthropology, Decomposition, Postmortem Interval

H77 Inter- and Intra-Element Variation in Carnivore and Rodent Scavenging Patterns in Northern California

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After attending this presentation, attendees will gain a more complete understanding of postmortem artifacts from human remains created by animal scavengers, and their distribution in forensic cases from northern California. The goals of this research include: 1) an assessment of inter and intra-element patterning of postmortem modifications on human remains caused by animal scavengers; 2) a metric analysis of canine impact damage in relation to carnivore tooth dimensions; and 3) an evaluation of taphonomic models for predicting disarticulation sequences and time-since-death estimates in the western United States.

This presentation will impact the forensic community by providing a critical evaluation of the various taphonomic signatures caused by animal scavengers and their relationship to understanding sequences of disarticulation.

Taphonomy has become an integral area of research within forensic anthropology since the late 1980s. Previous studies have generally focused on field or laboratory-based experiments, retrospective case reviews, or individual case reports. However, little recent attention has been devoted to more detailed study of postmortem damage created by animal scavengers in larger forensic collections. Throughout rural northern California, decomposed and skeletonized human remains recovered from outdoor contexts commonly show evidence of carnivore and rodent tooth impact damage. Although their distribution varies by region, key mammalian scavengers include black bears, coyotes, raccoons, opossums, squirrels, and various rodents. A previous survey of scavenged forensic cases from northern California indicated that medium-to-large bodied carnivores (canids and black bears) are responsible for the majority of the postmortem damage to skeletal remains (Bartelink and Bright 2009).

This study examines twenty two forensic cases involving animal scavenging submitted for analysis to the California State University, Chico Human Identification Laboratory (CSUC-HIL). Sixteen of the cases are curated at the CSUC-HIL, with the remainder (n=6) documented from previous case reports. The cases derive from 13 counties in northern California, and were originally submitted between 1986 and 2009. With one exception, all cases derive from outdoor contexts. For each case, a complete inventory was conducted and the pattern of scavenging documented. Diagrams were used to record the completeness of all scavenged elements, and the distribution of tooth impact damage (e.g., furrows, pits, punctures, striations) and spiral fractures within each element. The percentage of bone missing due to scavenging was recorded for all appendicular elements using an ordinal scale as a measure of scavenging intensity. A second component of this research attempted to identify involvement of specific scavenger species associated with the tooth impact damage. Digital calipers were used to measure the maximum diameter of shallow pits as well as deeper puncture marks associated with carnivore scavenging. In addition, dental measurements were recorded for the canine teeth of several scavenger species from the CSUC zooarchaeology comparative collection (e.g., black bear, coyote, grey fox, mountain lion, and raccoon). The maximum diameter of the distal canine tip, maximum labio-lingual crown diameter, and maximum mesio-distal crown diameter was recorded with digital dental calipers for each specimen. Bivariate plots were used to compare distal canine diameters with shallow pits and maximum crown measurements with puncture marks.

The results indicate that the most intensively scavenged appendicular segments are the pubis and ischium, followed by the

proximal ulna, tibia, humerus, and radius. In general, distal and especially midshaft segments were less intensively scavenged. The pattern of more intensive carnivore involvement in proximal segments likely reflects differences in the amount of soft tissue available and the extent of decomposition and disarticulation at the time of discovery. Approximately 50% of all elements examined showed evidence of animal scavenging, with 98% of elements affected by carnivores and 7.5% by rodents. Carnivore tooth impact marks were most common on the hand, ribs, and lower limb elements, and rarely observed in vertebrae, sterna, and in the skull. Rodent gnawing damage most commonly occurred on the skull, and along muscle attachment sites of the femora and innominates. Spiral fractures likely caused by scavengers were observed only in six cases, and most commonly affected humeri and ulnae. Preliminary analysis of pit and puncture diameters also appears promising for differentiating tooth impact marks caused by black bears versus medium-sized carnivores (coyote, grey fox, and raccoon). The implications of these findings for understanding disarticulation sequences and limitations of time-since-death estimates are discussed.

Scavenging, Taphonomy, Postmortem Interval

H78 Southeast Texas Applied Forensic Science Facility (STAFS) at Sam Houston State University: A New Forensic Anthropology Human Decomposition Facility

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The goal of this presentation is to introduce the new willed-body donor program and human decomposition facility at Sam Houston State University and discuss current research and training opportunities being conducted there.

This presentation will impact the forensic science community by bringing awareness to this new research and training facility. This facility can be used by researchers to perform various types of research on human cadavers.

In 2007, a proposal for the development of a willed-body donor program and forensic anthropology human decomposition facility was submitted to the administration of Sam Houston State University. The proposal was approved March 12, 2008 and internal funding was allocated for the construction of an outdoor facility and building. Construction of the outdoor facility began in early September 2008. The outdoor facility was completed in October 2008. The construction of the building began in January 2009 and was completed in July 2009. Nine acres of a 247 acre parcel, managed by the Center for Biological Field Studies, was dedicated to the STAFS facility. Both internal and external administrative and governmental requirements were satisfied during the latter part of 2008 and the beginning of 2009.

This new facility is dedicated to research, education, and training for anthropologists, entomologists, other forensic experts, law enforcement agents and students. The College of Criminal Justice at Sam Houston State University is one of the oldest and largest criminal justice education and training facilities. It educates and trains both national and international graduate and undergraduate students and law enforcement agents. The College was established by the Texas legislature in 1965 under House Resolution 469, which directed the university to establish a program of excellence in research, training, technical assistance and consultant services, and continuing education. In 2001, the College of Criminal Justice began a Forensic Science Masters program which was accredited in 2009. In 2006, the College of Criminal Justice and the forensic science program began pursuing the development of the STAFS facility.

Outdoor Facility: As stated above, the nine acre parcel is located within a 247 acre parcel owned by the university. It is restricted to authorized personnel only by a numerical code gate entry and fencing surrounds the whole 247 acre perimeter. A portion of the north, east, and south property borders abut to the Sam Houston State Park. The west property line abuts to privately-owned, undeveloped forest land.

One acre of the nine acre parcel is enclosed with maximum security fence and is used for research on human cadavers that are donated to the facility. The maximum security fence consists of an 8' chain link fence with privacy slats and razor wire attached to the top. Entry to the facility is restricted to a man and field gate, visible from the building. A variety of environmental settings are enclosed in the acre, such as open, unobstructed areas, wooded, shaded, and sun exposed areas. A creek runs through a corner of the acre and an area has been designated for automobile or small building structures for indoor body depositions.

Indoor Facility: The building is located approximately fifty yards from the outdoor facility and is approximately 2,400 square feet. The building contains a necropsy suite, a lab prep room, a collection room, walk-in freezer and cooler units, a digital radiograph area, and an office. The building is equipped with sophisticated equipment, such as a digital radiograph unit and a SpecFinder microscope. It is also equipped with compound and stereomicroscopes, and multiple computer workstations.

The facility has received six body donations as of July 2009 and multiple research projects are underway.

Forensic Anthropology, Human Decomposition, Willed-Body Donor Program

H79 Establishing a Taphonomic Research Facility in the United Kingdom

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After attending this presentation, attendees will have an understanding of the ethical and legislative issues that impact the establishment of a taphonomic research facility using animal models in the United Kingdom. This will also enable comparison with the establishment of facilities using human cadavers within the United States.

This presentation will impact the forensic community by explaining the importance of and need for rigorous experimental taphonomy and the benefits which the uses of animal models bring to taphonomic research. This presentation will demonstrate that with the necessary resources, enthusiasm, commitment and determination, such centres of excellence can be established.

A number of taphonomic research facilities, using human cadavers, have been established in the United States. The Anthropological research Facility at the University of Tennessee was the first contributor to research in this field. More recent facilities include Texas State University, Western Carolina University, and Wichita State University. In May 2009, The University of Central Lancashire, United Kingdom, established TRACES (Taphonomic Research in Anthropology – Centre for Experimental Study), the first United Kingdom facility dedicated to taphonomic research using animal models.

While human cadaver use enables important direct comparisons to forensic cases, and facilitates small scale experimental study, the use of animal models enables much larger studies to be carried out and allows more robust experimental testing of factors that have been considered important influences of the processes of decomposition.

Whether a facility uses human cadavers or animal models the issues that arise can be common to both. Considerable investment of financial resources is required, and this can only be realised with support and commitment from the university's directorate level. A major factor

encountered in the establishment of such a facility anywhere is local community concerns, and these necessitate the need for lengthy consultation with both immediate neighbours and the wider local community. In the United Kingdom planning legislation is complex, and the potential restrictions that result can take considerable time to negotiate. Local authority planning approval is required for any change of land or building use, as well as new developments.

The use of animal models also poses specific ethical and legislative concerns, many specific to the United Kingdom, that require consideration. This begins at the university ethics board which will consider all research proposals relating to animal use. The production of animals specifically for taphonomic research is rarely allowed and such animals must have been bred and reared for commercial meat production and, therefore, destined for slaughter. Environmental protection, with particular emphasis on groundwater pollution is heavily regulated and will require both groundwater vulnerability assessments as well as liaison with external regulatory bodies. Veterinary input is essential to develop procedures and protocols to deal with animal welfare and slaughter. Recent events in the United Kingdom concerning outbreaks of Foot and Mouth, Avian Flu, and Blue Tongue Disease mean that a comprehensive bio-security protocol is required. Related to bio-security are the regulations relating the use of animal by-products and their disposal.

Taphonomic research using animal models is an important contributor to the forensic community, but the establishment of such facilities is complex. However, with the necessary commitment, expertise, enthusiasm and determination, such centres of excellence can be established.

Taphonomic Research Facility, Decomposition, Forensic Anthropology

H80 Forensic Archaeological Recovery of the Victims of the Continental Connection Flight 3407 Crash in Clarence Center, New York

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After attending this presentation, attendees will learn how forensic archaeological methods were used to rapidly document the location and context of human remains within the crash wreckage. The benefits to minimizing further damage to human tissue during recovery and eventual victim identification will be discussed.

This presentation will impact the forensic science community by describing in detail how a complex outdoor scene involving large numbers of fragmented and burned human remains can be processed efficiently and effectively by utilizing standard forensic archaeological scene recovery methods.

On February 12, 2009 at 10:10 p.m., Continental Connection Flight 3407 crashed on approach to Buffalo (NY) International Airport into a two-story house in the Buffalo suburb of Clarence Center, resulting in 50 total fatalities (49 plane passengers and crew, and one house inhabitant). As one of the primary agencies responding to the incident, the Erie County Medical Examiner's Office (ECME), Buffalo, NY, was presented with two primary responsibilities: (1) recovering the remains of the victims from the scene in a timely manner; and, (2) channeling them into the morgue for documentation and identification of the deceased. With respect to victim identification, existing morgue facilities were utilized and supplemented with professional forensic personnel and equipment supplied by the federal government's Disaster Mortuary Operational Response Team (described in detail elsewhere).

Most medical examiner's offices are not prepared to handle disaster scene recoveries of this magnitude involving large numbers of victims. The ECME office solicited the assistance of forensic anthropologists from Mercyhurst College, Erie, PA. This presentation will focus on the evidence and victim recovery protocols employed at the Clarence Center crash site and benefits related to victim identification issues derived from the forensic archaeological methods used at this scene.

In mass fatality situations, there is great pressure to quickly provide positive identification of the victims and return their remains to their families. Two options are available for a recovery in these situations. The first option is the immediate removal of the human remains and surrounding debris primarily by the first responders (i.e., firefighters and law enforcement officials), without further documentation of victim location and position, even if that involves mechanical means, such as backhoes. The benefit to this approach is that the remains can be removed from the scene very quickly, generally in 1-2 days, even when a large number of victims are involved. However, for the agency responsible for victim identification, this type of recovery comes at a high cost in terms of: (1) further destruction of human remains during recovery: (2) increased likelihood of missing tissue: and, (3) loss of contextual information that may aid in victim identification. Lost or missing information such as the proximity of potentially conjoining elements, and association of personal effects, or even key plane parts can potentially adversely affect or delay victim identification. In other words: days saved at the scene can easily result in days or even weeks, lost at the morgue.

The second option is to employ forensic archaeological protocols. Detailed contextual data is recorded during victim recovery and the process includes professionals trained in the recognition and identification of fragmented and burned human remains. The result is an efficient and effective recovery that is conducted at a rapid and systematic pace. Further damage to human tissue is minimized. Key contextual and spatial information is recorded and preserved that may eventually aid in the identification effort. This latter approach was used during the recovery of the victims of the crash of Flight 3407.

The forensic archaeological methodologies employed at the Clarence Center crash site are similar to those utilized on all outdoor crime scene recoveries conducted by the authors (described elsewhere). A "collapsing circle" excavation strategy was employed at this crash scene. Material was removed from the outer edges of the fuselage by hand, working inward in a more or less vertical (cake-cutting) orientation until human remains were encountered. Individual victims were carefully and fully exposed, their position noted via an electronic total station, photographed, placed in an individual body bag, and then removed from the scene. The recovery progressed at a rapid pace without compromising either the National Transportation Safety Board investigation or the condition of the remains. Several excavation teams worked concurrently and the entire recovery process was completed in four days. In addition to the *in situ* exposure and removal of all human remains, all of the fuselage debris was collected and screened through ¼ in mesh screens. The combination of excavation methodologies employed, screening efforts and the relatively small and confined debris field of this particular incident, suggests that nearly 100 percent of the recoverable human remains from this scene was recovered in an efficient and effective forensic archaeological recovery.

Forensic Archaeology, Plane Crash, Excavation Protocols

H81 Spatial Patterning of Clandestine Graves in the Investigation of Large Scale Human Rights Violations: The Example of the Spanish Civil War Rearguard Repression

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After attending this session attendees will understand the importance of studying spatial patterns in the location of clandestine graves in contexts of armed conflict. Attendees will learn about the primary factors that influence offender choice of burial site for victims of wide scale killings in repressive contexts. This method will help investigators conduct more effective searches for victims of forced disappearance.

This presentation will impact the forensic science community by discussing effective methods in the search for clandestine graves in the investigation of Human Rights violations and forced disappearances.

The creation of clandestine graves may be influenced by many factors but few are very influential and these few commonly reoccur across different cultural contexts. This means that grave locations can be reasonably well predicted in certain contexts as part of the search for missing persons, victims of human rights violations.

In the context of the Spanish Civil War (1936-1942), over 100,000 civilians were detained, executed and buried in anonymous, clandestine graves by rebel soldiers and militia members in the rearguard of the war and postwar repression. The lack of formal criminal investigations in this context, and the recent movement (2000-present) to find and exhume victims allows researchers to study various aspects of the crimes, including spatial patterns related to clandestine graves. Similar patterns have been observed by the author in quite different cultural and temporal contexts (e.g., Bosnia, Iraq) suggesting that there are broad factors influencing offender decisions (e.g., logistics, least effort principle, restriction of resources during periods of armed conflict). As anthropologists and archaeologists are commonly called upon to assist with the location and excavation of clandestine graves (both domestically and internationally), it is important to evaluate the context in which the crimes are taking place and the factors that may influence the decisions of those committing the killings.

This study of spatial patterns will assist forensic anthropologists and archaeologists in their efforts to locate clandestine graves in similar contexts of internal armed conflict resulting in the forced disappearance of civilians. Preliminary analysis of results demonstrates that graves are typically located between 1 and 10 km of the location from which the victim was detained. Graves are almost never more than 50 metres from a road, with main roads being the principal route used (rather than secondary and minor roads). The physical locations of gravesites are typically in areas not visible from the point of origin, urban areas or even close surroundings (e.g., olive groves, low-lying basins). Commonly, pre-existing features are used, such as wells, mines and ravines. All of these features speak principally of the importance of cost in resources when having to dispose of victims. It appears that although the offenders are acting as the local authority and with consent from the governing military – and so acting with impunity – there is still a clandestine element in their behavior resulting in them committing killings and creating burials in places not easily seen but also those which are not costly in terms of time and energy. Despite the social disorder in armed conflict and the justification of killings in rhetoric employed by the military and civil authorities, there continues to be a degree of deliberate secretiveness when authorites choose where to dispose of the bodies of their civilian victims. There is also a fair degree of consistency in behavior across broad geographic areas governed by different individuals. A greater understanding of the factors that influence killer behavior will result in more effective searches for graves by forensic anthropologists and archaeologists involved in the investigation of crimes against humanity, genocide, forced disappearance and similar human rights violations.

Clandestine Grave Prospection, Spatial Analysis, Forced Disappearance Investigation

H82 Validity of Portable X-Ray Fluorescence in Assistance With Identification of Individuals in a Burial Setting by Comparison With mtDNA

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After attending this presentation, attendees will be able to discuss practical usage of portable X-Ray fluorescence in a burial setting with unknown individuals.

This presentation will impact the forensic science community by increasing knowledge of the application of new technologies to old questions to help thoroughly understand the limits of the technology itself, and what it can do in cases of unknown identity.

The Jackson Street Burials were excavated in 1997 after being discovered during work on a road construction site in Youngstown, NY. The eleven burials (five adults and six children) under investigation have no known history either from physical evidence or from past burial records. Based on the likely association of artifact assemblage and the history of Fort Niagara, the cemetery was used sometime between the late 1700s and 1840. The individuals were buried in an extended (supine) posture, in an east/west orientation with the head towards the west end of the grave. Based on the orientation of the burials, preliminary analysis suggested these individuals may be of European ancestry or buried by Christians. The purpose of this study was to gain insight into the identity and relatedness of these unknown individuals by DNA analysis, and to explore the possible application of portable X-ray Fluorescence (XRF) in a burial setting.

Certain trace elements in bone provide specific and pertinent information about the individual's environmental exposure, diet and geographical location of residence. XRF is a nondestructive method for analysis of trace elements and portable instruments are available which allow trace element analysis of samples in the field or in collections. The remains of the eleven individuals were analyzed by portable XRF. The results show individuals can be divided into groupings based on statistical analysis using Ward's agglomerative method, focusing on strontium readings from bones and teeth. Due to strontium's incorporation in bone and teeth from the local environment, it is theoretically possible to assess if an individual moved between areas of different strontium levels. Teeth incorporate strontium during fetal (deciduous) and childhood (permanent) development, and represent the intake at that specific point in time. Bone is constantly remodeling throughout one's life, and only represents the strontium intake for years before death. The hypothesis of this analysis was that the individuals may be related to one another due to dietary intake of strontium based on geographical location. Individuals 2, 10, and 13 had high bone strontium concentrations. Individual 2 had high teeth strontium concentrations. Individuals 7 and 13 had intermediate strontium concentrations in their teeth. Individual 7 had intermediate bone strontium concentrations. All others (1, 3-6, 8-10) had lower strontium in teeth, and intermediate in bones. This suggests groupings as follows for bone: Group 1 (Individual 13), Group 2 (Individuals 2 and 10), Group 3 (Individuals 3,

4, 7, and 8), and Group 4 (Individuals 1, 5, 6, and 9). For teeth, the groupings are as follows: Group 1 (Individual 7 and 13), Group 2 (Individual 2), and Group 3 (Individual 1, 3, 4, 5, 6, 8, 9, and 10).

Advancements in DNA extraction and amplification techniques have produced successful studies utilizing ancient DNA (aDNA) in various anthropological studies. Mitochondrial DNA (mtDNA) has been more successful in genetic analysis of skeletal remains, due to its high copy number than nuclear DNA. Many studies have utilized the mtDNA in understanding population history based on its unique characteristics including no recombination, maternal inheritance, and higher mutation rate particularly in the non-coding, control region. We extracted DNA from teeth specimens from each individual and sequenced the mtDNA control region following standard procedures. Results show that six individuals (burials 3-6, 8, and 9) have Native American ancestry. Two individuals (burial 8 & 9) have the exact same haplotype, suggesting shared maternal ancestry. Other individuals are not maternally related. Burial 2 seems to be of European origin and we were unable to resolve burial 7, while three samples (burials 1, 10, and 13) failed to produce successful DNA results.

Our study utilizing XRF and mtDNA analysis show conflicting results when compared with the osteological assessment with regards to geographical origins. The XRF groups formed based on strontium concentration compared to the related groups of mtDNA individuals presents some interesting scenarios. XRF may not be the best method to use for geographical region or relatedness within a group like this, but does offer insight into who these people may have been when used in combination with the mtDNA evidence. This study draws attention to problems that can arise from archaeological deductions and to the utilization of genetic analysis, which can validate or reject old conclusions to further our understanding.

Forensic Anthropology, Portable X-Ray Fluorescence, Mitochondrial DNA

H83 The Assessment and Determination of Forensic Significance in Forensic Anthropology

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After attending this presentation, attendees will better understand the theoretical groundwork from which to assess forensic significance via three models of decision making.

This presentation will impact the forensic science community by examining and formulating more systematic, supportable investigative, and analytical processes; and, by developing a higher theoretical framework for the field of forensic sciences as a whole.

The purpose of this presentation is to examine the decision making processes and underlying theory governing the determination of the forensic significance of human remains. Currently, decisions of forensic significance are made based largely on investigator experience, with little in the way of a systematic examination or discussion of the theory underlying conclusions. Attendees of this presentation will gain a theoretical groundwork from which to assess forensic significance via three models of decision making. The impact of this discussion on forensic anthropology will be felt not only in courtroom, by further codifying and systematizing our methods, but throughout the field of Forensic Science, by introducing a higher theoretical platform from which to unify its sub-disciplines.

Forensic significance, the relevance of human remains or physical evidence to a medico-legal case, is the cornerstone of forensic investigation. Establishing the forensic significance of found human remains is often the first step in the investigative process and the basis upon which human and material resources are allocated in a death investigation. The determination of the forensic significance of human remains may seem to be an obvious decision, based on context or the investigator's experience, but a closer examination of the decision making process is warranted in the age of *Daubert* and *Mohan*. Transparent, repeatable and statistically supportable methods of positive identification, assessment of the biological profile and trauma analysis have been required of the discipline as a result of these rulings, but the crucial step of establishing the need for a death investigation to begin have not. Rather, forensic significance is taken as the basis from which all other methods proceed. Authors such as Byers (2008), Rogers (2005) and Berryman (1991) have addressed specific issues of establishing forensic context, but the decision making process and the theory underlying it have not been examined systematically in the literature. Dawes et. al (1998) demonstrate the superiority of actuarial (information/calculation) over clinical (experience/discretionary) based methods of decision making in medicine and psychology. Klepinger argues; however, that age of automatic, formula based decision making in forensic anthropology has not yet arrived and may never (2006). In an attempt to bridge the gap between these approaches and to address the underlying theory behind the determination of forensic significance, three models are proposed for the decision making process: the Forensic Significance Paradigm, The Bayesian Model, and the Hierarchy Model.

The Forensic Significance Paradigm borrows its structure from Inman and Rudin's (2002) discussion of the origins of evidence. The focus in this model is the identification or inclusion of human remains within a class (modern, historic, archeological) along with the individualization of those remains by excluding specific characteristics (cemetery, autopsy, coffin artifacts). The Bayesian Model uses the concept of hypothesis formation followed by iterative decision making at each step of evidence collection and analysis (Taroni, 1998). The hypothesis of forensic significance is re-evaluated with each piece of evidence collected and at each step of the analysis of the remains. The Hierarchy Model, based on the Hierarchy of Propositions Model described by Cook et al (1998) requires a pair of opposing propositions at each of three levels of decision making. This model combines the identification/individualization process of the Forensic Significance Paradigm with the step by step deliberation of the Bayesian Model.

By assuming that the determination of forensic significance is an obvious, experience based activity, without investigating the underlying theory and thought processes behind decisions of significance, forensic anthropologists run the risk of a lack of transparency in the courtroom and potentially incorrect judgment. Examining the processes by which we determine forensic significance serves two purposes: the formulation of more systematic, supportable investigative and analytical processes; and, the development of a higher theoretical framework for the field of forensic sciences as a whole.

Forensic Anthropology, Forensic Significance, Theoretical Models

H84 A Radiographic Database for Forensic Anthropology

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After attending this presentation, attendees will understand the need for updated aging standards in subadults and learn of a resource for age estimation methods in subadults.

This presentation will impact the forensic community by informing practitioners of a future resource for researching skeletal development and methods of aging subadults.

There are large numbers of children who are murdered or go missing every year in the United States. In analyzing modern subadult remains, it is surprising that few *Daubert*-compliant standards exist for skeletal or dental age estimation. Instead, forensic anthropologists estimating age in children rely uncritically on data that may have been collected over 80 years ago or from historic archaeology contexts. For instance, Scheuer and Black (2000), the standard anthropological reference text used in evaluating immature skeletal remains, provides average bone lengths by age, citing Maresh (1970). Although Maresh's work was published in 1970, it was based on data collected in the 1930's, as are most aging methods based on dental eruption and development. It has been well documented that American populations, and many others, have shown significantly greater early childhood growth, earlier development and maturation, and larger stature than in previous generations, so estimates for modern individuals using older data will be biased upwards. Further, growth and development varies by ancestry. The reference data come overwhelmingly from middle-class white children, while substantially more and more forensic casework involves non-whites. Therefore, the validity of current methods is in doubt.

Additionally, statistical approaches using dental or skeletal indicators have rarely been employed, and anthropologists have instead used published mean bone lengths by age, as in Scheuer and Black (2000). Such age estimates are merely reasonable guesses based on subjecting weighing of indicators and an arbitrary age estimation range. Because the error rate of such a method can't be reliably estimated, it also falls short under *Daubert*. Statistical approaches, including transition analysis and logistic regression, provide explicit confidence intervals, allowing errors to be controlled for, and address *Daubert* requirements for errors in estimation.

Recognizing that methods for constructing the biological profile in modern adults were based on nineteenth century samples, the Forensic Data Bank (FDB) at the University of Tennessee, Knoxville, was started in 1986 with a grant from the National Institute of Justice. Similarly, because the current methods used to estimate age in subadults are also outdated, funding was awarded for the creation of a digital radiographic database in October 2008. In the absence of modern subadult skeletal collections, forensic anthropologists must turn to radiographs.

Data were collected from files in medical examiners' and coroners' offices and were limited to positively identified individuals born after 1990 and less than 20 years old. Most medical examiner's offices practice radiography in their daily protocol, and full body surveys are often performed on all infants. As of July 1, 2009, over 7,000 radiographs had been scanned from over 1,500 children, and some offices will continue to contribute digital radiographs. The sampling method has produced samples that are geographically and ethnically diverse. Demographic information, including age, sex, ancestry, ethnicity, date of birth, date of death, and cause of death were collected, along with other routinely collected data (height, weight, other measurements, and other information) and entered into an electronic database. The scans and demographic information will be made available for online access in a manner similar to the National Biomedical Imaging Archive (http://ncia.nci.nih.gov/) thanks to additional funding. Making the database available online will allow researchers to develop new methods for identifying subadult remains and allow contributors to submit digital resources remotely.

Some preliminary results have already revealed important benefits to collecting modern data and analyzing them in a statistical framework. For instance, as suspected, the initial appearance of certain epiphyses on radiographs occur earlier in the modern data, and using a ninety-five percent confidence interval produces narrower age predictions than previous estimates, which were apparently most often based on ages of earliest and latest appearance. Further research involves establishing new bone length standards, investigating changes in bone proportions during maturation, and adjusting for magnification and distortion effects when measuring radiographs.

Subadult Age Estimation, Daubert, Secular Changes

H85 New Scapular Measurements for Determining Sex

Natalie Uhl, MS, 308 North Orchard Street, Apartment 7, Urbana, IL 61801*

The goal of this presentation is to inform attendees about the performance in sex estimation of eight new linear measurements on the human scapula. This research illustrates new scapular measurements that effectively discriminate between male and female scapulae.

This presentation will impact the forensic community by presenting new linear measurements which correctly estimate sex from the human scapula using discriminant analysis.

It has long been noted by physical anthropologists that the human scapula shows a large amount of variation (Dwight, 1887) yet typical osteological examination includes only two measurements of this bone (maximum height and scapular breadth). Not surprisingly, these measurements do not effectively capture scapular variation and generally fail to accurately estimate sex or ancestry. Uhl et al. (2007) noted that a discriminant function analysis using these two measurements yielded only 58% correct classification for ancestry between two groups for 499 individuals in the Forensic Databank. Further, maximum height has shown only about a 30% classification rate when discriminating between males and females (Dabbs, 2009). Previously, Bainbridge and Tarazaga (1956) noted shape differences in several areas of the scapula, including the acromion process, scapular spine, suprascapular notch, superior angle, and vertebral and axillary borders. However, they treated these features as non-metric rather than metric variables, thus making quantification and application difficult.

Recently, geometric morphometrics has allowed for the quantification and visualization of scapular variation for ancestry determination (Uhl et al., 2007). Unfortunately, to be of practical use to most forensic anthropologists, variation must be captured by linear measurements. Therefore the goal of this research is to develop new linear measurements to estimate sex based on areas that were previously shown to have the most shape variation (Uhl et al., 2007)

Eight linear measurements were taken (medial muscle attachment-lateral muscle attachment, maximum height of glenoid, A-P size of the glenoid, superior glenoid border-superior scapular angle, lateral acromial angle-inferior acromial angle, medial acromial angle-inferior acromial angle, lateral acromial angle-medial acromial angle, coracoid root-coracoid tip) on a sample of 51 individuals from the Hamann-Todd Collection, housed at the Cleveland Museum of Natural History.

These eight measurements were subjected to stepwise discriminant function analysis (DFA) with $p(F) = 0.05$ to enter and $p(F) = 0.10$ to remove. The DFA was significant (Wilk's $\lambda = 0.298$, $p<0.001$) and three measurements (A-P size of the glenoid, superior glenoid border-superior scapular angle, and lateral acromial angle-inferior acromial angle) were found to correctly classify 94.6% of cases, with a correct classification rate of 89.6% when cross-validated with a leave-one-out procedure.

This study indicates that much more information can be gleaned from the scapula with the inclusion of a few additional linear measurements. These measurements may be especially useful in cases of incomplete sets of remains which do not include a pelvis or cranium. Some potential drawbacks of these scapular measurements include broken scapular angles, as they can be somewhat fragile, and the presence of *os acromiale*, which would preclude the use of the acromial measurement. In the future, linear measurements may also prove useful for discriminating between different ancestry groups.

Sex Determination, Discriminant Function Analysis, Scapula

H86 Sex Estimation From the Calcaneus Using Discriminant Function Analysis

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After attending this presentation, attendees will be better informed of the importance of the uses that the calcaneus can serve in estimating sex during the creation of the biological profile.

The presentation will impact the forensic science community by showing the importance the calcaneus can serve in providing an additional reliable method for sex estimation via discriminant functions based on an American forensic population.

Reliable methods for sex estimation during the creation of a biological profile are important to the forensic community in instances when the common skeletal elements used to assess sex are absent or damaged. Sex estimation from the calcaneus has potentially significant importance for the forensic community. Specifically, measurements of the calcaneus provide an additional reliable method for sex estimation via discriminant function analysis based on a North American forensic population.

The calcaneus was chosen for study because of its size and the durability, which permit it to withstand postmortem alteration (Drechsler et al 1996; Bidmos and Asala 2003, 2004; Introna et al 1997). Previous studies have estimated sex using the calcaneus and other tarsal bones (Bidmos and Asala 2003, 2004; Gualdi-Russo 2007, Introna et al 1997, Murphy 2002, Steele 1976; Wilbur 1998), However, these studies use populations from an older American sample (birth years from late 19th-early 20th century), Italy, South Africa, prehistoric Polynesian, and prehistoric Native American and thus are not applicable a modern North American population. It is important to take into account demographics, secular change and regional origin of the collection being used (Komar and Grivas 2008). Due to secular change and regional origin, previous studies must be revised and existing methods evaluated for populations of differing geographic origin.

Research on a modern American sample was chosen in order to develop up-to-date population specific discriminant functions for sex estimation. The current study addresses this matter, building upon previous research (Bidmos and Asala 2003, 2004; Gualdi-Russo 2007, Introna et al 1997, Murphy 2002, Steele 1976; Wilbur 1998) and introduces a new measurement, posterior circumference that promises to advance the accuracy of use of this single, highly resistant bone in future instances of sex determination from partial skeletal remains.

Data was collected from The William Bass Skeletal Collection, housed at the University of Tennessee. Sample size includes 260 adult American White individuals born between the years 1900 and 1985. The sample was comprised of 131 females and 129 males. Skeletons used for measurements were confined to those with fused diaphyses showing no signs of pathology or damage that may have altered measurements, and that also had accompanying records that included information on ancestry, age, and sex. Measurements collected and analyzed include maximum length, load-arm length, load-arm width, and posterior circumference. Posterior circumference was obtained by measuring the minimum circumference of the area between the dorsal articular facet and the most posterior point on the calcaneus avoiding the calcaneal tuberosity.

The sample was used to compute a discriminant function, based on all four variables, and was performed in SAS 9.1.2**.** The discriminant function obtained an overall cross-validated classification rate of 86.90%. Females were classified correctly in 90.08% of the cases and males were correctly classified in 83.72% of the cases.

Due to the increasing heterogeneity of current populations, further discussion on this topic will include the importance that the re-evaluation of past studies has on modern forensic populations. Additionally due to secular and micro evolutionary changes among populations, future research must include additional methods being updated, and new methods being examined, both which should cover a wide population spectrum.

Calcaneus, Sex Estimation, Discriminant Function

H87 Sex Determination Using the Calcaneus in Koreans

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After attending this presentation, attendees will understand the utility of sex determination using the calcaneus and an example of a practical application of unknown skeletal remains for sex determination.

This presentation will impact the forensic science community by suggesting the possibility for sex determination using the calcaneus when analyzing a Korean skeletal sample. This study is the first to test use of the calcaneus for sex determination by discriminant function analysis in Koreans. The results will be helpful for sex determination and distinguishing population differences in the calcaneus.

Sex determination from skeletal remains is of major interest to forensic anthropologist and important variable for personal identification. The calcaneus is the largest of the foot bones and is often recovered intact in forensic cases. The skull and many bones, such as the femur, tibia, and humerus, have been used for sex determination but the calcaneus has not been sufficiently assessed for use in individual identification. The aim of this study is to define an equation for sex determination using discriminant function analysis and compare with other populations.

The sample consisted of 90 sets of the dry calcaneus of known age and sex at Department of Anatomy, Yonsei University College of Medicine in Korea. The calcaneal sample consisted of 63 males and 27 females. The method was investigated based on 10 metric variables: three length measurements, three breadth measurements, and four height measurements. Data was statistically analyzed with the computer program SPSS 17.0.

Bilateral asymmetry was assessed using paired t-tests. Four of the 10 measurements differed significantly between the right and left sides ($P < 0.05$). Most measurements (nine of 10), showed statistically significant difference between sexes ($P < 0.05$). A discriminant function analysis was applied to assess accuracy for both the right and left sides. The accuracy of discriminant function analysis was 87.2% for the right side, and 81.6% for the left side. For the right side, the discriminant function is: $D = 0.227 \times (\text{maximum height}) + 0.227 \times (\text{cuboidal facet height}) - 16.062$. The sectioning point is -0.7296. The canonical correlation of discriminant function is 0.610, and Wilk's Lambda is 0.627. For the left side, the discriminant function is: $D = 0.368 \times (\text{dorsal articular facet length}) + 0.248 \times (\text{dorsal articular facet breadth}) - 16.808$. The sectioning point is -0.8047 and the canonical correlation is 0.66, and Wilk's Lambda is 0.564. The statistical results indicate that it is possible to discriminate between males from females using measurement of the calcaneus

Bidmos and Asala among other studies used measurements similar to this study. Bidmos and Asala (2003, 2004)[1,2] concluded that the calcaneus of a South African sample showed statistically significant differences between sexes. The accuracy of discriminant function analysis was 90.6% in South African White, and 85.3% in South African Black using stepwise discriminate function analysis. The discriminant

equation was composed three variables in Bidmos and Asala and two variables in this study. The variables used are different between the South African and Korean samples. The results of the two studies indicate that the calcaneus is useful for sex determination of unknown skeletal remains. Furthermore, this study will be compared with other studies in detail, we can distinguish among populations.

References:

1 Bidmos MA and Asala SA. Discriminant function sexing of the calcaneus of the South African Whites. *J Forensic Sci* 2003; 48:1213-8.

2 Bidmos MA and Asala SA. Sexual dimorphism of the calcaneus of South African Blacks. *J Forensic Sci* 2004; 49:446-50.

Calcaneus, Sex Determination, Korean

H88 Postcranial Sex Estimation of Individuals Considered Hispanic

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After attending this presentation, attendees will learn which elements of the postcranial skeleton and specific measurements are the most accurate in estimating the sex of individuals considered Hispanic in the United States.

This presentation will impact the forensic science community by discussing the rapidly growing Hispanic population within the United States and why it is important to provide population specific methods for sex estimation.

According to the U.S. Census Bureau in 2005, the Hispanic population in the United States represented the largest minority, totaling 42.7 million individuals. This number continues to grow every year. It is critically important that forensic anthropologists are able to identify deceased individuals considered Hispanic, although currently, the field of forensic anthropology lacks the data needed to effectively do so. Today, the majority of identification methods currently used in the United States by forensic anthropologists were developed using American Black and White individuals.

When unidentified skeletal remains are found, estimating sex is one of the primary aspects of the biological profile. To estimate sex, when bones of the pelvis are not present, the initial observations are typically aimed at the skull and the overall size of the skeleton. According to Spradley et al (2008), these observations cause Hispanic males to frequently be misclassified as female. Hispanic individuals have been described as smaller and more gracile than the groups to which they are compared, including American Whites, Blacks, and (sometimes) Native Americans (Spradley et al 2008).

To help the forensic anthropological community more accurately estimate the sex of individuals considered Hispanic, this study used Hispanic individuals from the Forensic Anthropology Data Bank. Only positively identified individuals or individuals with known sex and ancestry were used, which consisted of a sample of 17 females and 70 males. Further, only standard postcranial metrics were used in the analysis (Buikstra and Ubelaker 1994). First, a stepwise discriminant function was run in Statistical Analysis Software (SAS) 9.1.2 on each postcranial element to determine the best subset of variables for sex estimation, followed by a discriminant function analysis (DFA) on the stepwise selected variables. A comparison of the cross-validated classification rates, from the DFA, for each post-cranial element revealed that the radius and ulna are the best elements for sex estimation for individuals considered Hispanic. Cross-validated classification rates using the radius are 87.5% for females and 85.7% for males. Cross-validated classification rates using the ulna are 88.9% for females and 85.3% for males.

Sex estimation rates from the radius and ulna are higher than when using metric methods derived from American Black and White individuals (Spradley 2008). The results from this study are considered preliminary due to the fact that the individuals used in the present analysis are not all from known geographic origins and the small female sample size. However, the results highlight that individuals considered Hispanic exhibit sexual dimorphism differently than American Blacks and Whites and require different methods of sex estimation. Forensic anthropologists are impacted by the growing Hispanic population in the United States, and studies, such as this one, are important to the growing field of forensic anthropology, as well as the changing dynamics of the United States.

Forensic Anthropology, Sex Estimation, Hispanics

H89 The Use of Geometric Morphometric Analysis for Subadult Sex Estimation Utilizing Innominates

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The goal of this presentation is to inform attendees about a new geometric morphometric analysis (GMA) approach to the estimation of sex of subadult skeletal remains via innominates.

The presentation will impact the forensic science community by exploring the potential of sex estimation of subadult innominates using GMAs and discriminant function analysis.

The estimation of the biological profile, particularly the estimation of sex, is notoriously difficult in subadults because of the immaturity of the skeleton. This issue affects both bioarchaeologists and forensic anthropologists working with juvenile skeletal remains. The difficulty in the estimation of sex is because the skeleton is not fully sexually developed before puberty and is therefore less sexually dimorphic. In skeletally mature adults; however, the innominate is recognized as one of the best indicators of biological sex. Due to the high reliability in sex estimation of mature adult skeletal remains, the innominate was selected as the focus of this study.

Non-metric studies of juvenile innominates have been previously conducted with a wide range of accuracy rates from slightly better than chance, to almost perfect classification. However, most relate to the morphology of the sciatic notch and do not take other morphologies into account. Further, these subadult sex estimation accuracy rates often increase as the individuals' ages increase, which may bias the results of the younger specimen estimates. Metric studies of subadults are difficult to conduct because of the age related variation in size and relatively small sample sizes available. The geometric morphometric study presented here provides a method to accommodate age related size variation thus focusing on shape. In addition, this research captures the morphologies of the innominate using 3D landmarks that have been shown to have a high accuracy of sex estimation in adults (Klales et al. 2009; Vollner 2009).

A sample of 36 left subadult innominates from the Hamann-Todd Osteological Collection, which is housed at the Cleveland Museum of Natural History, was utilized. The individuals were of known age, sex, and ancestry without any apparent pathological conditions. Age-at death of the individuals ranged from 4 to 19 years. A total of 18 landmarks were collected using a digitizer on each individual and analyzed in

MorphoJ (Klingenberg 2008) to conduct a Procrustes' fit. A discriminant function analysis with a Wilks' stepwise option was then conducted to prevent overfitting and to generate classificaiton rates.

The initial discriminant function analysis after the Procrustes' fit in MorphoJ demonstrated that correct classification increased with the age of the individual. The shape differences as displayed by MorphoJ indicate that sub-adult pelvic sexual dimorphism is similar, yet more subtle, than adult pelvic sexual dimorphism. The discriminant function yielded a 75% correct cross-validated classification for the estimation of sub-adult sex using a Wilks' stepwise function. Females were classified at a higher rate of accuracy at 81.8% correct, while males classified at 64.3% correct. This high classification rate for females versus males may suggest that subadult innominates tend to illustrate more female morphologies before skeletal maturity. Further studies will be conducted using larger sample sizes to more conclusively analyze the geometric morphometric morphologies of subadult innominates.

Geometric Morphometrics, Sex Estimation, Discriminant Function Analysis

H90 Secular Trends in Cranial Morphological Sexing: The Mastoid Process

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After attending this presentation, researchers will be aware of the metric changes in size of mastoid processes in American Whites from 1829-1983.

This presentation will impact the forensic science community by demonstrating how increasing the understanding in the changes a population has undergone since the inception of a particular sexing technique will strengthen the accuracy of the forensic practitioner by allowing them to adjust for skeletal changes over time.

Cranial morphology has markedly changed over the last two centuries (Godde and Dautartas 2009; Meadows Jantz and Jantz 2000)[3,4] causing contemporary American head shape and size to vary from earlier Americans. Both cranial nonmetric (Godde and Dautartas 2009)[3] and metric (Meadows Jantz and Jantz 2000)[5] morphology changes suggest that enough differentiation has occurred to render modifying current methods of sex estimation. This paper further explores the secular trends in cranial morphological traits for cranial sex estimation, specifically by metrically modeling the mastoid process.

In 1920, Hrdlicka officially adopted cranial morphological traits as indicators of sex. He incorporated characteristics and research that he read about in French and German literature. Later, Buikstra and Ubelaker (1994)[1] included this methodology in their volume for standardization of skeletal data collection. However, both Hrdlicka (1920)[4] and Buikstra and Ubelaker (1994)[1] did not take a forensic approach; these methods were not tested on a modern American population. Walker (2008)[6] applied the cranial morphological sexing method on two relatively modern collections, the Terry Collection and Hamann-Todd Collection. He found that the method published in Buikstra and Ubelaker (1994)[1] could be applied by observers of various backgrounds and levels of experience with accurate results. However, as Godde and Dautartas (2009)[3] pointed out, there was a significant change in morphology from individuals born in the 1850s (Hamann-Todd Collection) to those born in 1930s and on (William M. Bass Donated Collection), indicating the cranial morphology for sex estimation has changed and forensic techniques that have been developed on archaeological populations (Buikstra and Ubelaker 1994; Hrdlicka 1920)[1,4] and tested on an almost contemporary American population (Walker 2008)[6] are not reflective of the current trends in cranial morphology.

Godde and Dautartas (2009)[3] applied categorical time series techniques and teased out the patterns of secular change in their report of secular trends in cranial morphology from the 1820s through the 1980s. In order to support their prior study with continuous data, this project mathematically modeled the mastoid process for use in well-established continuous time series methods. Howells' mastoid measurements, mastoid length and mastoid breadth, were collected along with a new measurement, mastoid width (defined in Dautartas and Godde 2008).[2] These three measurements were selected as they can metrically model the mastoid as a cone, and thus volume of a mastoid can be calculated. Data was collected from two skeletal collections: Hamann-Todd and William M. Bass Donated Collection (Donated Collection). At the Hamann-Todd collection, 99 white females and 81 white males were measured that had documented birth years associated with the remains. Conversely, 55 white females and 55 white males with known birth years were observed at the Donated Collection. Collectively, the birth years of the individuals from both collections span 1829-1983, allowing for investigations into skeletal changes spanning 154 years.

The best time series model applied to the data indicates that secular change has occurred over the time period represented in the sample. The results show that in the last century and a half, females have become larger, while males have become smaller. In other words, mastoid processes in both sexes of American Whites are beginning to resemble and overlap each other in size. It is important for forensic scientists to understand that mastoid size has changed, lending to more ambiguity among the sexes. Moreover, these changes also imply that techniques developed on archaeological populations need to be adjusted for application in a contemporary forensic context.

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Time Series, Mastoid Volume, Nonmetrics

H91 Twentieth Century Change in Facial Morphology and Its Relationship to Metric Sexing

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The goal of this presentation is to bring attention to secular change over the past 80 years in the most dimorphic dimension in the skull, bizygomatic breadth. Attendees will learn the magnitude of secular change in this dimension and how it can influence sex assessments.

This presentation will impact the forensic science community by demonstrating the changing nature of facial morphology and the need for appropriate data.

Secular change in craniofacial morphology has been documented (Jantz and Meadows Jantz (2000).[2] The most pronounced changes are seen in vault morphology, and these have been seen to impact ancestry assessment, at least as far as Blacks and Whites are concerned (Ayres et al. 1990).[1] Facial morphology, especially bizygomatic breadth, is normally the most important dimension in metric sexing from crania. Trials with Fordisc 3 show that bizygomatic contributes from 30 to 50 % of sex discrimination, depending on number of variables, and is always chosen in stepwise procedures. Bizygomatic breadth alone can correctly sex over 80 % of crania. It is therefore important to understand the nature of secular change in facial dimensions.

Measurements were taken from crania in the forensic anthropology data bank. Samples were available as follows: White males (N=436), Whites females (N=319), Black males (N=205), Black females (N=146). Individuals were limited to those with twentieth century birth years. Birth years range from 1900-1988. Analysis was focussed on bizygomatic breadth, because of its high sex dimorphism. Whites and Blacks were analyzed separately, be sex. The crania were grouped by decade of birth for purposes of analysis. Analysis of variance was run on nine decade of birth cohorts.

Anova results on the decade of birth cohorts are as follows:

White males	F=2.96	P=0.0031
White females	F=1.61	P=0.121
Black males	F=0.83	P=0.580
Black females	F=3.43	P=0.0013

The pattern among groups is inconsistent. White males exhibit a consistent decline in bizygomatic breadth, beginning about 1940. Maximum values prior to 1940 are about 131 mm., while by 1960 they have reduced to about 128. Black females exhibit a less regular pattern, but generally one sees a decrease in bizygomatic after 1920, followed by an increase after 1960. Black males and White females do not exhibit significant variation among decade of birth cohorts, and there is no pattern to be seen in the variation.

The reduction in face breadth in white males influences sex classification using bizygomatic alone. There are 83 White males born 1960 and after. One quarter of them are mislcassified using a sectioning point from Fordisc's current data base. Misclassification is less pronounced in multivariate sexing, since other variables also contribute to the function.

In both Blacks and Whites, significant change in one sex and not the other may suggest that sex dimorphism varies significantly among decade of birth cohorts. The interaction term of sex and decade of birth in two level analysis of variance is not significant, so that hypothesis is not supported.

Insight into the relationship of bizygomatic breadth to other craniofacial features may be gained by observing its correlation with other dimensions. Bi-auricular breadth is the most highly correlated variable, followed by biorbital breadth. Both of these dimensions also show significant variation among decade of birth cohorts, which to a considerable extent parallels that seen in bizygomatic breadth. Maxillary breadth and face height have low correlation with bizygomatic and do not exhibit variation among decade of birth cohorts.

These results demonstrate that secular change in face dimensions that influence metric sex estimation is continuing among modern Americans. This finding emphasizes the importance of continuing to collect information from skeletal remains of modern Americans.

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Sex Estimation, Secular Change, Cranial Morphology

H92 Foramen Magnum Shape as a Potential Indicator of Ancestry

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After attending this presentation, attendees will be familiar with the variation present in the shape of the foramen magnum and its potential as an indicator of ancestry.

This presentation will impact the forensic science community by highlighting the advantages and disadvantages of using foramen magnum shape as an ancestry indicator when crania are fragmentary.

Accurate assessment of ancestry is essential in forensic anthropology to lead to a positive identification of unknown remains. The cranium has been used for numerous studies and many researchers believe it to be an excellent indicator of ancestry based on metric and non-metric characteristics (Rhine 1990).[3] The cranial base also has been studied on several different occasions (Holland 1986a, Holland 1989)[1,2] to determine ancestral similarities and dissimilarities and is the focus of this presentation.

A total of 462 intact cranial bases for persons of known ancestry were measured and visually assessed during a blind study. The database included crania from four different collections: Louisiana State University's Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory, Pima County Office of the Medical Examiner, University of New Mexico's Maxwell Museum of Osteology Laboratory, and University of Tennessee at Knoxville's William M. Bass Donated Skeletal Collection. The crania in the sample set represent the major ancestral groups typically seen in forensic cases (white, black, Hispanic/Southwest Hispanic, Native American and Asian). First, twelve measurements were taken on each cranial base; then, the foramen magnums were assessed visually and were placed into different categories based on their respective shapes. The twelve measurements that were taken from each cranial base are: maximum length of the right occipital condyle, maximum width of the right occipital condyle, minimum width of the right occipital condyle, maximum distance between occipital condyles, minimum distance between occipital condyles, maximum interior distance between occipital condyles, maximum length of the left occipital condyle, maximum width of the left occipital condyle, minimum width of the left occipital condyle, maximum length of the foramen magnum, maximum width of the foramen magnum, and maximum length of the basilar process (based in part on Holland 1986).[1] The different shape categories that every foramen magnum was placed into are Arrowhead, Egg, Circle, Oval, and Diamond.

Statistical results suggest some association between foramen magnum shape and ancestry. Of 334 skulls of known white ancestry, almost half (46.4%, N=155) possessed an arrowhead-shaped foramen magnum. Of 70 skulls of known black ancestry, 40% (N=28) also had an arrowhead-shaped foramen magnum. The other four shapes were somewhat evenly distributed throughout both groups. Of the 55 Hispanic/Southwest Hispanic crania studied, none possessed the egg-shaped foramen magnum. This suggests that the presence of an egg-shaped foramen magnum has the potential as an eliminator for Hispanic/Southwest Hispanic ancestry. Both American Indian and Asian ancestries could not be categorized sufficiently due to the low number of each ancestry (three crania total) available for study. Results are also presented regarding measurements of the cranial base.

Finally, in an effort to test the practicality of such a technique, one of the purposes of this research is to determine the amount of subjectivity and accuracy for this new method of non-metric ancestry determination. Conference participants are asked to fill out a short survey based on the example images on the poster and the different foramen magnum shapes on the survey to determine whether or not this method is user friendly or if it is too subjective for regular use. Results of the survey will be presented.

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Ancestry, Foramen Magnum, Biological Profile

H93 Prognathism and Prosthion in the Evaluation of Ancestry

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After attending this presentation, attendees will understand the advantages of another landmark, subspinale, as a valid substitute for prosthion in the estimation of ancestry.

This presentation will impact the forensic science community by offering an alternative methodology for estimating ancestry via discriminant function analysis (DFA) of crania when prosthion, a major landmark currently used for this purpose, is unavailable.

The estimation of ancestry is an essential part of the biological profile. Prognathism, expressed in cranial measurements involving prosthion—the most anterior point on the alveolus between the central incisors—is useful in estimating ancestry. American blacks are more prognathic than American whites, and this is especially clear in the relationship between basion-prosthion length and basion-nasion length. Crania that are edentulous or display antemortem loss of the central upper incisors with resorption, or postmortem damage, preclude the use of measurements involving prosthion. When unidentified human remains are concerned, using subspinale as a substitute for prosthion in such cases of edentulous crania has not yet been explored for ancestry estimation. Subspinale is defined by Howells (1973) as the most posterior point on the crest inferior to the anterior nasal spine. In analyzing differences due to ancestry, this study helps to define and identify prognathism and what it entails.

FORDISC 3 (Jantz and Ousley 2005) was used for a Discriminant Function Analysis (DFA) of 102 adult Black males and 83 adult White males from the Terry Collection, a nineteenth century skeletal collection. All individuals were digitized and standard Howells measurements were calculated from the landmark coordinates. In the first set of tests, standard Howells craniometrics were evaluated, including cranial base length (BNL), maximum cranial breadth (XCB), maximum cranial length (GOL), nasal breadth (NLB), minimum frontal breadth (WFB), nasal height (NLH), basion-prosthion length (BPL), and nasion-prosthion height (NPH) from black and white males. Using these measurements, which include ones involving prosthion, FORDISC 3 correctly classified 88% of Black males and 86% of White males. In all, 87% (161 out of 185 individuals) were correctly classified. Very similar results are obtained when using 20th-century samples. When measurements involving prosthion were removed, simulating antemortem loss and resorption, the overall accuracy fell to 77%, confirming that measurements utilizing prosthion are especially valuable in estimating ancestry.

Next, basion-subspinale (BAS_SSP) and nasion-subspinale (NAS_SSP) were substituted for BPL and NPH, respectively, and analyzed with the six other standard measurements previously used (BNL, GOL, NLB, NLH, WFB, and XCB). In this analysis, the sample size was 103 Black males and 95 White males. With the substitutes, 83% of Black males were correctly classified, while 88% of White males were correctly classified, and overall, 86% (170 out of 198) of individuals were correctly classified. Therefore, measurements using subspinale can be used in place of those involving prosthion with little or no loss in classification accuracy.

In running more analyses with subspinale, morphological differences between Black male and White male subnasal regions became apparent. Black males showed a larger distance between nasospinale and subspinale when NLH and NAS_SSP measurements were compared. Additionally, morphological differences between Black males and White males were seen when basion was used as an anchor to compare relative projections of subspinale and prosthion. In Black males, the average BAS_SSP and BPL lengths are 97.1mm and 104.6mm, respectively, a difference of 7.5mm. In White males, average BAS_SSP and BPL lengths are 92.4mm and 95.8mm, respectively, with a difference of about 3.4mm—less than half the distance seen in Black males. In other words, the average Black male displays about twice as much anterior dental projection, or prognathism, relative to the subnasal region than does the average White male. Another advantage to using subspinale is suggested by the fact that the total sample size increased from 185 to 198 individuals, because some of the sample included edentulous individuals. Additionally, results revealed more specific morphological differences in the expression of prognathism between white and black males. This is a proof of concept study, in that a technique based on a nineteenth century sample is of uncertain validity for twentieth century populations, though we anticipate that similar relationships will be found in twentieth century individuals, the subject of further research.

Forensic Anthropology, Ancestry, Prognathism

H94 Craniometric Variation Within Southeast Asia

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After attending this presentation, attendees will understand the utility of discriminant function analysis, Mahalanobis' Generalized Distance, and cluster analysis as a means of observing regional differences in supposedly homogenous "Asian" populations.

This presentation will impact the forensic science community by proving that intra-regional differences can be seen in Southeast Asian populations, thus allowing anthropologists to create a more accurate biological profile which can aid in narrowing a missing persons list.

Craniometrics are frequently used to investigate human variation within and among populations. Work by W. W. Howells (1973, 1993, 1995) investigated craniometric variation among geographic areas worldwide. More recently, Pietrusewsky (1992) investigated craniometric differences in modern Southeast Asian populations. While his focus was population history, this study focuses specifically on regional differences in Southeast Asia.

The ability to accurately discriminate between populations is beneficial in aiding in a more accurate biological profile which could potentially narrow down a missing persons list. In forensic anthropology, Ancestry is largely based on geographic origins, and Southeast Asian populations are generally considered "East Asian," though population differences are found among them (Ousley et al. 2009). Forensic anthropologists should bear in mind the arbitrary nature of sample labels. For instance, a single sample from Laos, Cambodia, or Vietnam may be labeled "Southeast Asian," though it may not represent the variation present throughout the region. Further, samples may be labeled using nationality, language, tribe, or religion, with similar assumptions. FORDISC, for example, uses reference samples that are categorized by nationality or language. Southeast Asia's recent, as well as past, population history has been dominated by wars and political unrest that may have modified earlier patterns of variation. This study explores craniometric variation in Southeast Asian populations to examine intra-regional differences.

Craniometrics from 110 male skulls were collected by Pietrusewsky and samples are as follows: 15 from Hanoi, 34 from Ho Chi Minh City, and 51 from Ba Chuc, Vietnam, 10 from Cambodia, 29 from Laos, 50 from Bangkok, Thailand, and 16 from Mandalay, Burma. All samples are from the nineteenth and twentieth centuries and from dissecting rooms or cemeteries. The Ba Chuc sample is from a village located near the border with Cambodia that was part of the "Killing Fields" massacre. Its location was part of a frequently disputed border area between Vietnam and Cambodia. At the time of the massacre, its residents were citizens of Vietnam, though many were probably ethnic Khmer they were culturally and linguistically Cambodian. The Vietnamese sample in FORDISC 3 comes from Ba Chuc. It was hypothesized that North and South Vietnamese crania would be more morphologically similar to one another, while the crania from Ba Chuc would be more similar to Cambodia, which it was historically a part of until recent history. As these relationships were observed, data from surrounding countries was introduced and examined.

Data were analyzed using FORDISC 3.0 (Jantz and Ousley 2005) and statistical program R (R Development Core Team 2008). The data were checked for normality and any outliers were removed. Discriminant Function Analysis (DFA) was employed using FORDISC, and R was used for cluster analysis. Analyses were conducted using variable numbers that were limited to one-third of the smallest sample size. This ensured that the data were not being over-fitted. Groups that did not prove to be significantly different using DFA were pooled and the analyses continued. As groups were pooled and sample sizes increased, the number of variables used in the discriminant function were increased in conjunction with the one-third rule.

Results show the emergence of three distinct clusters, though with overlap, using 15 variables. The North and South Vietnam crania clustered together, as did Laos and Burma, while Ba Chuc, Cambodia, and Thailand formed a third cluster. Generally, the Vietnamese cluster showed longer crania with narrower palates, while the Ba Chuc, Cambodia, Thailand cluster and Burma and Laos cluster had crania with wider palates and shorter crania. The Ba Chuc sample was craniometrically more similar to the Cambodian and Laos samples. With three clusters, a random determination of geographic affinity would be 33.3%, and these three clusters were classified with 69% accuracy when cross-validated. This function, then, proves to be more accurate in group assignment. This initial study has shown that it is possible to regionally differentiate Southeast Asian populations into more specific geographic entities. These results act as a reminder to not take DFA classifications too literally, because biological samples are always assigned labels that are considered meaningful, though they are often arbitrary. Additionally, the labels are most often based on cultural criteria, independent of the groups' biological affinities.

Discriminant Function Analysis, Craniometric Variation, Southeast Asia

H95 Ancestry Trends in Trophy Skulls in Northern California

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The goals of this presentation are to: (1) document the ancestry of trophy skulls curated at the California State University, Chico Human Identification Lab (CSUC-HIL); and, (2) assess trends in the ancestry of trophy skull specimens between the 1970s and the present. After viewing this presentation, attendees will gain a greater understanding of the ancestral affiliations of trophy skulls.

This presentation will impact the forensic community by highlighting the broad range of ancestral affiliations that are associated with trophy skulls observed in forensic contexts.

Although research involving human trophy taking has a long history within bioarchaeology and archaeology, few studies have been directed towards human trophies from forensic contexts. Prior studies have focused on trophy skulls brought back to the United States by service men after armed conflicts. However, trophy skulls are routinely submitted for analysis from a broad array of contexts. In many instances, it may be difficult to differentiate trophy skulls from those that derive from archaeological, forensic and souvenir contexts (Sledzik and Ousley 1991).[1] This presentation will discuss osteological and contextual information that will aid in identification of trophy skulls.

Willey and Leach (2003)[3] define human trophies as remains that are originally acquired under suspect circumstances and kept as a memento of the event. For this study, trophy remains are defined as skulls that show evidence of postmortem modification, including decoration. According to Sledzik (1991),[1] trophies also include the opportunistic or passive collection of human remains as well as the deliberate peri-mortem collection of skeletal material. Therefore, trophies should not include remains that were obtained unintentionally, or those that did not serve as a form of memento. For this study, one non-modified skull was included because contextual information indicated that the remains were displayed as a trophy.

Eight forensic cases are examined involving trophy skulls submitted to the CSUC-HIL for analysis. Ancestry estimation was conducted using both metric and non-metric traits, and the data are addressed in light of contextual information for each case. Craniometric analysis was conducted using Fordisc 3.0.

Of the eight forensic cases included in the analysis, four of the eight skulls were estimated to be female. This finding is inconsistent with the trends observed in trophies brought back to the United States during times of war, which typically are male (Taylor et al. 1984).[2] Only two of the eight skulls were brought back as mementos during times of war. It is worth noting however, that Fordisc is not always an accurate indicator of sex in gracile specimens and therefore non-metric analyses of sex were also taken into account. Also, postcranial remains were unavailable for analysis and were therefore not used to provide a secondary verification of sex assessment.

The ancestral affiliation of these cases is highly variable. This may be explained by the fact that each trophy skull used in the analysis was

drawn from a unique forensic context. This also may be attributed to the small sample size used for the study. This study highlights the broad range of ancestries that trophy skulls can be attributed to. Trophy taking of human skulls and body parts has a long history, and will continue to impact future forensic anthropological casework

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Trophy Skulls, Postmortem Modification, Ancestry Estimation

H96 Ancestry Estimation From the Tibia: Size and Shape Differences Between American Whites and Blacks

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After attending this presentation, attendees will become familiar with size and shape differences between American Black and White tibiae. Attendees will also be provided with measurements that offer the highest discrimination between these two groups.

This presentation will impact the forensic science community by providing criteria for determining ancestry from the tibia.

Background: As the United States becomes more of a melting pot, ancestry estimation is an increasingly challenging task for forensic anthropologists. Consequently, gathering ancestry information from multiple skeletal elements can augment assessments based on cranial morphology. While significant ancestral differences exist in cranial dimensions, shape differences are substantial, as well. In addition, researchers have documented ancestry differences in the lower limb, focusing primarily on the pelvis and femur. Stewart (1962) suggested that American Black femora are straighter and less torqued than White femora. In addition, Trudell (1999) reported significant differences in length, curvature, epicondylar breadth, and torsion between American Blacks and Whites. Intercondylar notch height has been shown to be a useful discriminator, as well (Craig, 1995; Gill, 2001). The primary morphological difference in the innominate is that American Whites have wider hips than Blacks (Iscan, 1983; DiBennardo and Taylor, 1982, 1983).

These and other studies have captured size and shape differences in the hip and thigh, but few studies have addressed the leg. Since the lower limb is a functional anatomical unit, it follows that the morphology of the upper leg should influence the form of the lower leg. In fact, only one article has addressed ancestry differences in the tibia in the American population, noting differences in length, width, and proximal breadth between Blacks and Whites (Farrally and Moore, 1975). The present study aims to address the need for documentation of metric and geometric morphometric ancestry differences in the tibia in the modern American population by using three-dimensional bone modeling and automated measurements from computed tomography (CT) scans.

Methods: A sample of 112 American Black and White males from the William M. Bass Donated Collection was used for this analysis. The DICOM image slices from the CT-scanned tibiae were manually segmented, and three-dimensional models were constructed of the right tibiae. A subset of the models was used to create ancestry-specific statistical bone atlases. A statistical atlas is an average mold that captures the primary shape variation in the bone and facilitates rapid and accurate generation of automated measurements. The final result is a sample of tibiae that all contain the same number of points and share the same spatial relationship.

Shape analysis was conducted by performing Principal Components Analysis on the atlases to reduce the data space and then using Fisher's Discriminant Ratio to pinpoint the areas of greatest difference. The resulting deviation vector magnitudes were subsequently applied to a color map in order to visualize the areas of greatest difference. Metric differences were evaluated by taking 28 computer-automated measurements on all of the bones in the atlases. These measurements include traditional measures of length and robusticity, as well as measurements of the intercondylar eminences, tibial plateau dimensions, cross-sectional areas of the midshaft, proximal shaft, and distal shaft, and indices and angles designed to capture information about shape, torsion, and position of bony landmarks. T-tests, power tests, and linear discriminant analysis (LDA) with cross-validation and stepwise variable selection was performed on the measurements.

Results: The shape analysis of principal components 2-10 (95% of variation) shows relatively low magnitudes of difference in tibial shape between American Blacks and Whites. The area of highest difference is at the tip of the medial malleolus. -tests reveal that the there are significant differences in length and shaft robusticity (reflected by diameters and cross-sectional areas of the middle, proximal, and distal shaft). American Blacks have longer tibiae, larger antero-posterior and medial-lateral shaft dimensions, and larger cross-sectional areas. These results confirm Farrally and Moore's (1975) earlier study. The cross-validated LDA attained 78.6% accuracy with a 6-variable model; Blacks were misclassified more often than Whites. This could be an artifact of the smaller Black sample, but the authors hypothesize that it reflects the phenomenon that American Black skeletal morphology is becoming more similar to the American White morphology. These results indicate that the tibia is useful in ancestry estimation, but that the major differences are due to size, not shape. Combining tibia and femur measurements may offer discriminatory power approaching that of the cranium.

Ancestry Estimation, Tibia, Discriminant Analysis

H97 Recollected Versus Actual Stature: How Does the Height Reported by Next of Kin Measure Up?

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After attending this presentation, attendees will learn of the inaccuracy and bias of the estimated heights of individuals obtained from their next of kin, how they compare to self-reported statures, what factors may influence accuracy and how useful these estimated heights can be in aiding in the identification of missing persons in post-conflict settings. This study proposes that recollected statures (RSTATs) obtained from next of kin can be useful in identification, as they are representative of actual height within defined limits.

This research will impact the forensic science community by providing information on the reliability and validity of antemortem height information obtained from family. The usefulness of stature estimations in human identification at an international level has been questioned. A reason for this is that RSTATs are believed to be inaccurate and unreliable. Inaccuracy and bias are known to occur in

heights that are self-reported, but those of recollected stature had not been extensively studied

In human rights investigations, an integral role of forensic anthropologists is identifying the victims of mass graves. In order to do this, the creation of a biological profile (in which stature is a key component) is important so that it may be compared to antemortem (AM) information. In post-conflict areas, AM records are not always available and if they are, their reliability is often doubtful. In such circumstances, AM information of a missing person's physical features, including their height, is obtained from interviewing their closest relatives and/or friends. Metric values may not be understood, or families may not be able to state the height of the missing person in metres. Because of this, the interviewer will ask the family member to indicate how tall the individual is compared to him/her.

Volunteers were obtained from the City of Greater Sudbury, Ontario, Canada. A total of 367 RSTATs were collected (210 females, 157 males, ages 18-85). Families were interviewed and each member was asked to fill out questionnaires about themselves (e.g. their age, sex, how tall they think they are, etc…) and the kin whose height they were estimating (e.g., their relation, how long they have known them, etc…). RSTATs were obtained following the guidelines of the Physician's for Human Rights AM Data Collection protocol for Kosovo (1999). Participants were asked to indicate, using their hand, how tall they thought their kin were compared to the interviewer. A tape measure was used to take the measurement of the RSTAT from the floor up to the inferiorly facing palmar surface of the participant's fingers, with their arm extended in front of them. The height of each participant was then measured using an anthropometer.

The inaccuracy and bias of the self-reported heights and RSTATs were assessed in relation to the measured height of the individuals and then compared to each other. Accuracy is the average deviation of height estimation from actual height; bias is the direction of that deviation (i.e., over- or underestimation). Similar to other studies of reported stature, self-reported heights and RSTATs showed a correlation with measured height ($r=0.97$ and 0.87, respectively) but were significantly different and inaccurate ($p<0.01$). Self-reported heights show an average positive bias of 1.8cm (i.e., overestimation of actual height), while RSTATs show a negative of 1.1cm (i.e., underestimation of actual height). Self-reported heights had a mean accuracy of 2.3cm, while that of RSTATs was 4.5cm. A one-way ANOVA found these to be significantly different from each other ($p<0.01$). Other factors that may influence the accuracy and bias of the RSTATs were explored (e.g., relatedness, age, sex, height of the person being estimated, etc…). A correction factor was obtained with 95% confidence intervals so that measured height could be calculated from an RSTAT.

The underestimation of measured height by the next of kin differs from the observations made in the investigations of the Former Yugoslavia, which indicated that stature was over-estimated by family. It appears that the self-perception of one's own height is more accurate than the perception of their height by others. RSTATs can be of use in identification, provided one is aware of their limitations. Understanding the inaccuracy and bias of RSTATs can allow for a better interpretation of height information provided by families.

Stature, Human Identification, Height Estimation

H98 The Use of Morbidity and Mortality Patterns in Transitional Justice Initiatives Towards Human Identification

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The goal of this paper is to analyze the morbidity and mortality rates within a Nigerian population through a retrospective study of coroner cases.

This presentation will impact the forensic science community by presenting data on human variation for a previously unstudied population in Nigeria. These patterns highlight current issues in human rights and human identification research.

There has been ongoing transitional justice reform in Nigeria with the improvement of the coroner laws in Lagos State. As a result medico-legal death investigations and training for forensic pathology, anthropology and science in general are underway. Understanding human variation, among diverse populations, is critical for postmortem methods of identification, such as age at death or sex estimation and is important for implementing medico-legal death investigations.

The main purpose of the study is to look at the demographic structure of coroner cases among a sample of Nigerians to better understand morbidity and mortality patterns. With the improvement of the coroner laws in Lagos State, patterns of morbidity among the population can now be evaluated. Initial investigations into this area involved a total of 2,480 cases (n=1,766 males and n=714 females) autopsied at the Office of the Chief Medical Examiner for Lagos State at the Lagos State University College of Medicine from 2006-2009. These cases represent some of the only autopsies systematically performed in Nigeria, which has a population of more than 150 million people.

This preliminary investigation illustrates the impact of morbidity due to natural disease and inflicted trauma among a relatively young population, and the implications of such for developing population specific age parameters or other methods based on biometric data for human identification. Approximately 47.18% of those included in this analysis died of natural causes, including hypertensive heart disease, asphyxia, congestive cardiac failure, and pneumonia. Disturbingly, these cases involved individuals under 30 years of age, with low average ages at death; males = 38.43 years and females = 34.89 years. The low ages of death, particularly due to natural causes rather than accidental or violent causes, speaks to possible health disparities and has implications for other transitional justice initiatives centered around human health securities.

The morbidity and mortality patterns observed in Nigeria and the implications of such on developing methods for human identification and understanding population variation are explored in this presentation through survivorship analysis and descriptive statistics. For example, among males the ages at death ranged from newborns to 85 years old, and males most affected were in their twenties and thirties. Approximately 37.60% died of natural causes, 27.52% from motor vehicle accidents, 25.82% from trauma related accidents, and 9.06% due to homicide. In comparison, the ages at death among females ranged from newborns to 75 years, and females most affected were in their twenties and thirties. Approximately 70.87% died of natural causes, 16.11% of motor vehicle accidents, 10.78% trauma related accidents, and 2.24% due to homicide. Among the female population, the natural causes of death included hypertensive heart disease, septicemia, ventricular failure, congestive cardiac failure, and eclampsia.

The overall impact of low ages at death due to natural causes speaks to basic health insecurities. This finding has relevance for a variety of

human rights issues and highlights the significant role forensics can play in monitoring health disparities and human rights.

Morbidity Patterns, Age Estimation, Nigeria

H99 Forensic Anthropology and Age-at-Death Estimation: Current Trends in Adult Age Estimation

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The goal of this presentation is to summarize the preferred skeletal age-at-death estimation methods across the field of forensic anthropology by analyzing forensic practitioner responses to a questionnaire.

This presentation will impact the forensic science community by familiarizing attendees with the high degree of variation present in methods used to generate adult skeletal age-estimates, providing an opportunity to unite the field and discuss future improvements in standardization.

Determining an accurate estimation of age-at-death from unknown adult skeletal remains continues to be a challenging responsibility of skeletal biologists. As the discipline of forensic anthropology continues to advance as a science it is crucial to be aware not only of one's own methodological decisions, but how these decisions are being made throughout the field. This is a difficult task when different skeletal regions may be used to estimate age, and numerous aging methods for the same skeletal region/s are available. Each method may provide different forms of phases, mean ages, age ranges, standard deviations and/or standard errors which may be used to produce an age estimate. Many of these methods have been developed or tested on distinct temporal and/or geographic skeletal samples, resulting in inconsistent reports of accuracy and reliability. Furthermore, there is no standardized way of combining information from multiple age-estimation methods. These are all questions that could be raised in a court of law, especially in light of the *Daubert* Challenge.

Given the variation of preferred skeletal aging methods and the lack of standardization to the age-estimation process, the authors were interested in understanding how forensic practitioners actually determine which age estimation method to use. A questionnaire was devised to determine if there is a universal set of methods used by all forensic anthropologists, or if methodological preferences are unique to each practitioner. The study investigated whether the accuracy and reliability of the techniques when applied to various age, sex, or ancestries of the individuals are considered? How much does personal experience weigh into these decisions? How are the results from multiple methods incorporated into a final age-estimate for the unknown set of remains and how discrepancies between two methods are resolved? Are the standard deviations, standard errors, age ranges, or means used when considering the possible age-estimate of the decedent? Is there pressure from officials to present unrealistically narrow age ranges and if so, how is this issue approached?

An anonymous questionnaire was sent to members of the Physical Anthropology section of the American Association of Forensic Sciences as well as other skeletal biologists. Information regarding experience, preferred aging techniques, and methods used in producing a final age-estimate were blindly collected through the use of an online survey application. The results of more than 125 questionnaires were then analyzed, producing descriptive statistics to be used to inform the forensic society of the variation in currently practiced aging methods. From this knowledge, areas necessitating future advancements in age-estimation techniques can be identified, and improvements suggested.

Preliminary results suggest that personal experience weighs very highly both in determining an age range within a single method and when combining results from multiple methods to obtain a final age-at-death estimate. The Suchey-Brooks pubic symphysis method remains the most highly favored age-estimation technique, with cranial sutures and dental wear being reported as the least preferred, regardless of experience. The majority of respondents stated that they vary their skeletal age-estimation process case-by-case and ultimately present to officials both a narrow and broad possible age-range. Overall, however, respondents displayed a very high degree of variation in skeletal regions preferred, the methods chosen to age those regions, age information extracted from the methods, and ways in which information from multiple sources is pooled and contribute to a final reported age-at-death estimate.

To maintain the reputation of forensic anthropology as a science, there should be standardized methods in determining accurate age estimates, which have been validated, and proven reliable and replicable. The first step of this process must be awareness of the current state of the discipline.

Age-at-Death, Biological Profile, Standards

H100 Understanding Uncertainty in Age Estimation: Error Associated With the Mann et al. Maxillary Suture Method

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After attending this presentation, attendees will gain further understanding of the Mann et al. maxillary suture method, the types of error that are associated with adult age estimation methods, and ways to approach the estimation of uncertainty in measurement as required by the ISO and ASCLD/LAB.

This presentation will impact the forensic science community by providing error rates for the Mann et al. maxillary suture method in response to critiques raised by the National Academy of Sciences concerning the need to evaluate the reliability and accuracy of methods used in forensic science.

Age estimation using cranial sutures is not generally accepted as an accurate or reliable adult age estimation technique. Cranial suture obliteration is most commonly used to place an unknown individual into a general age group (e.g., young versus old adult) or when no other age indicators are present. While techniques utilizing cranial suture closure have come under significant attack, the perceived failure of these methods may also be due to the use of inappropriate statistics and problems with associated error intervals.

The Mann et al. maxillary suture method is based on palatine suture obliteration. There are two versions of the method: the 1987 version relies on measuring the amount of obliteration and the 1991 version is the revised visual method of assessment. Gruspier and Mullen (1991) claim that the 1987 method is inaccurate and Ginter (2005) found that the revised method is more accurate than commonly used age estimation methods such as the pubic symphysis and sternal rib ends. Given these findings, an examination of the performance of the maxillary suture method and the error associated with its use is warranted. Error can result from the method itself (e.g., improper statistical basis for age intervals or the method does not express the total range of human variation possible) and human observer error (e.g., improper assignment of individuals to phases of a method or misunderstanding of methodology).

This study was designed to examine the error associated with the 1991 visual maxillary suture age estimation method. Error was analyzed

by comparing the known and estimated ages-at-death of individuals identified at the JPAC/CIL between 1972 and 31 July 2008 whose case documentation referenced the revised maxillary suture method (*n*=55); a sample size of *n*=7for the 1987 method precluded error analysis. The following calculations were employed: correct classification (percent of individuals whose known age fell within the assigned age interval), inaccuracy (average error in years), bias (directionality of the error), and Pearson's *r* (strength and direction of the relationship between known and estimated age-at-death). To further test error associated with application of the visual maxillary suture method, volunteers in attendance at the 2009 AAFS Annual Meeting and JPAC/CIL anthropologists (*n*=38) were asked to age two individuals.

The sample for the visual maxillary suture method (*n*=55) has a mean age-at-death of 23.9 years, an age range of 18 years (youngest individual=18, oldest individual=36), and is entirely male. There is a statistically significant difference (p=0.003, ANOVA) in mean age-at-death between this sample and the total known age-at-death sample (*n*=979, =27.2). The visual age estimation method has a correct classification rate of 87.3%. Only those age estimates reporting closed intervals (e.g., 25-30 and not 30+) were further analyzed (*n*=27). The method has an average inaccuracy of 2.3 years, a negligible tendency to over-age (bias=0.1), and a statistically significant positive relationship between estimated and known age-at-death (*r*=0.8, p<0.001, ANOVA). The full range of error extends from -6.5 years to 7 years. Error, as measured by bias, is normally distributed.

Approximately half (48.7%) of the participants in the interobserver error study had never used the maxillary suture method and of the 46.2% that had, only 16.7% use it on a regular basis. Participants reported a "low" level of comfort with this method. Sutures reported as obliterated for each of the two samples were consistent between observers, but age assignment based on observations of obliteration was not. For sample one, participants most frequently reported being 60% sure that their observations of obliteration were correct and 75% sure that their interpretation of the age interval was correct. For sample two, confidence in observations of obliteration and interpretation of the age interval were reported most frequently at 80%.

Results from analyses of the JPAC/CIL casefiles and applications of the method to two crania of unknown age indicate that there are significant problems in assigning age intervals based on the reference method. Given the overall low error rates associated with this method, the method would benefit from standardization in reporting age intervals.

This study does not provide information concerning method performance for older adults. Future improvements to the method should include the development of 95% prediction intervals, a more clear definition of what constitutes obliteration, and testing on a larger, older, and more varied sample.

Adult Age Estimation, Maxillary Sutures, Error

H101 X-Ray Diffraction as a Tool for the Analysis of Age-Related Changes in Teeth

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After attending this presentation, attendees will be introduced to a technique for using X-ray diffraction (XRD) to determine the crystallite size of hydroxylapatite, or the crystalline portion, in human teeth and will learn how the crystallite size of hydroxylapatite has the potential to be used to estimate age at death.

This presentation will impact the forensic community by demonstrating the usefulness of XRD and the crystallite size of the hydroxylapatite found in tooth and bone material as a method for age estimation.

Estimation of age is an important component of the biological profile that forensic anthropologists construct in order to attain a positive identification of a deceased individual. This research is a proof of concept study for the use of XRD on a tooth sample to estimate age. Previous research (Meneghini et al. 2003; Hanschin and Stern 1992)[1,2] has concluded that the crystallite size of hydroxylapatite in bone will increase with increased age. This study explores the trends that were seen in crystallite sizes of bone and applies that concept to the hydroxylapatite in teeth. The initial hypothesis for this research states the crystallite size of tooth hydroxylapatite will increase as the age of an individual increases.

The feasibility of the use of teeth in XRD analysis was first tested using a tooth from three separate pigs to determine if there were differences among individuals. Three other pig teeth from a single pig were analyzed to determine if there were differences in tooth type for a single individual. Ten human tooth samples were collected from individuals of known age in order to establish whether the crystallite size of hydroxylapatite changes with increased chronological age. Each sample was ground into a coarse powder using a mortar and pestle and then reduced to a fine powder using a micronizer. Each sample was loaded into a sample holder and run with an X-ray diffractometer.

XRD is a technique that can be used to analyze any crystalline material. When an X-ray beam is produced by the XRD X-ray source, the X-ray hits the sample and diffracted radiation comes from the sample. The characteristics of the diffracted X-rays give a profile for the sample. The resulting diffraction patterns, or sample profiles, from the XRD testing were analyzed using Jade 6 software to determine the full width half maximum (FWHM) for each of the samples. FWHM gives the standard size for the peaks within the sample. The crystallite size was calculated using Scherrer's formula, which takes into account the FWHM and XRD settings to determine the size of the crystals within each sample.

The first set of pig samples proved that it was possible to analyze teeth with XRD. The second set of samples demonstrated that there were crystallite size differences in the tooth types. The human teeth confirmed that there were differences in tooth type and presented evidence that there was a downward correlation between chronological age and crystallite size in teeth. Due to the rejection of the initial hypothesis, an alternative hypothesis was constructed stating that the crystallite size of the hydroxylapatite will decrease in teeth as age increases in an individual. Results of this research suggest the trend toward a decrease in crystallite size as an individual increases in age. The difference with respect to bone may be a result of the unique nature of enamel in teeth.

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X-Ray Diffraction, Age Estimation, Dental Age Estimation

H102 Using the Acetabulum to Estimate Age: A Revised Method

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The goal of this presentation is to evaluate the Rissech et al. (2006) method of estimating skeletal age using the acetabulum and to demonstrate the benefits of simplifying the technique for use in a forensic context. This is the first step in a two-stage process involving the recognition of potential problems with the Rissech et al. (2006) method and the development of effective solutions. The second and future stage of the research will include devising and testing specific age ranges to accompany the modifications. At this juncture, emphasis is on the need to alter the criteria utilized by Rissech et al. (2006) and to demonstrate the resulting improvements to precision in scoring traits, while maintaining the potential for accuracy in age estimation. Attendees will gain a better understanding of how morphological features of the acetabulum change with age, as well as some of the difficulties in distinguishing states within each criterion in the original method. Participants will be introduced to a new, more effective approach to acetabulum age estimation.

This presentation will impact the forensic field and larger community by providing a new, reliable age estimation technique to increase the likelihood of identifying human remains in forensic practice.

In this study, Rissech and colleagues' (2006) existing scoring method was analyzed using multiple stepwise regression to identify the traits that contribute most to age estimation. Through this process, the technique was simplified to reduce the number of morphological features and scoring states. Three variables were found to account for most of the variation associated with age. These traits were tested on males and females to determine if the simplified method does in fact increase precision, while maintaining the potential to accurately reflect age changes. Because Rissech and colleague's (2006) method relies on the use of a known comparative collection to generate age ranges for the scores obtained by examining an unknown skeleton, there are no fixed age categories in the original method. The current research was designed to simplify the scoring and to assess the potential of the modified traits to reflect age consistently, regardless of the ancestry of the individual, thereby eliminating the need for a reference population. For this purpose, it was necessary to first determine the ability of the modified method to simply reflect broad age changes.

The revised non-destructive method to estimate broad categories of age was developed on two twentieth century anatomy series, the University of Toronto Grant Skeletal Collection (males) and the William M. Bass Donated Skeletal Collection (females). Based on trait occurrence, broad definitions of age were established: Young Adult (17-39 years); Middle Adult (40-64 years); and, Old Adult (65+ years). Descriptions distinguishing key features for phase identification are defined in this manner to reflect the greatest variation observed among individuals. The method was tested blind on two contemporary North American skeletal populations – the William M. Bass Donated Skeletal Collection and the University of New Mexico Documented Collection (n=249). Both collections contain complete skeletons from donated persons and positively identified forensic cases with documented demographic information, representing diverse socioeconomic classes and ethnic affinities. This study utilized 85 individuals from the William M. Bass Donated Skeletal Collection and 164 from the University of New Mexico Documented Collection, ranging in age from 19 to 101 years, who died between 1984 and 2006. The left os-coxa of each specimen was examined one at a time, to mimic forensic situations. Individuals with non-inflammatory osteoarthritis or diffuse idiopathic skeletal hyperostosis were not excluded since such manifestations are related to age. Known ages for each individual were not documented until each specimen had been examined in order to eliminate observer bias.

Although males (n=189) and females (n=60) were examined separately, non-significant sex-specific differences were found. The inaccuracy of the modified method is 8 years. The direction of bias indicates this acetabulum technique tends to *under*estimate age. Three statistically significant characteristics are highly correlated with age ($p<0.05$), and together are capable of estimating age-at-death with 82% accuracy, both sexes combined. Results of intraobserver error testing were extremely low (4.4%) indicating that very little error exists when estimating the degree of development of features. Consistency in scoring, reduction in data collection time, and exclusion of a reference population are significant advantages to using this technique and, as a result, is more flexible and useful in forensic situations than the original technique proposed by Rissech et al. (2006). Forensic investigators should be aware that delicate features of the acetabulum are more difficult to distinguish on greasy bone and specimens may appear younger in these cases.

Improving the accuracy and precision of estimating age for adults requires a conservative but reliable approach. Based on successful correlations with age that explain similarities between individuals in the near age classes and differences among groupings of distant age classes, the second (and ongoing) step of this research is to develop narrow age categories from morphological descriptions of 8 phases based on 10-year age classes for individuals from 20-99 years.

Forensic Anthropology, Skeletal Age Estimation, Acetabulum

H103 Error and Uncertainty in Pelvic Age Estimation Part I: Younger vs. Older Adult Males

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After attending the presentation, attendees will understand how the error rates of four commonly-used pelvic age estimation methods differ among different age groups and how to quantify uncertainty in forensic anthropological analysis.

This presentation will impact the forensic science community by responding to Recommendation #3 of the National Academy of Sciences publication, *Strengthening Forensic Science in the United States: A Path Forward*, which calls for research determining causes of bias and work toward quantification of method error in forensic investigations.

It is often stated that adult skeletal age estimation methods have lower error rates when applied to young adults than to older adults. Additionally, age estimation methods are widely understood to overage the young and underage the old. This paper supports these assertions by offering quantified measurements of error for four frequently-used pelvic age estimation methods, as applied to a large male sample of individuals between the ages of 19 and 94. The methods include auricular surface and pubic symphyseal techniques: Lovejoy *et al.* (1985); Suchey-Brooks (1990); Buckberry and Chamberlain (2002); and Osborne *et al.* (2004).

The sample for this study was compiled from two sources: male individuals sampled from modern known-age Iberian skeletal collections housed at the Universidad de Valladolid and the Universidad Autònoma de Barcelona; and male individuals identified at the JPAC-CIL between 1972 and 31 July 2008 whose case documentation included known age-at-death and estimated age based on specific pelvic age estimation methods. The entire sample was divided into ten-year age groups (e.g., 20-29) with a final age group of 60+. These divisions were distilled into two broad categories based on age ("young" individuals ≤ 39 years and "older" individuals ≥ 40 years). Error with respect to the methods'

assigned means was analyzed in terms of bias (directionality of error) and inaccuracy (absolute mean error in years). Percent of correct age classifications (i.e., the method's predicted age range included the individual's actual age) was also calculated.

The Suchey-Brooks (1990) and Lovejoy *el al.* (1985b) methods show low mean positive biases for the group of individuals between the ages of 20 and 39. The Osborne *et al.* (2004) method shows a low mean negative bias for this age group. The Buckberry and Chamberlain (2002) method shows a substantial positive bias for individuals between 20 and 39. All four methods have substantial negative biases for individuals 40 years of age and older. In all four methods, the differences between mean bias in individuals under 40 and individuals 40 years and older are significant at the $p \leq 0.001$ significance level (Student's *t*-test).

For the Suchey-Brooks, Lovejoy *et al.*, and Osborne *et al.* methods, mean inaccuracy approximates four years in individuals between the ages of 20 and 39. For the Buckberry and Chamberlain method, mean inaccuracy is greater than 13 years. In all four methods, mean inaccuracy is never less than 11 years for individuals 40 years and older. In all four methods, all differences between inaccuracy in the younger and older age groups are statistically significant at the $p \leq 0.001$ significance level (Student's *t*-test).

For the Suchey-Brooks and Osborne *et al.* methods, percent of correctly classified individuals is approximately 95% for individuals ≤ 39 and 85% for individuals ≥ 40. For the Buckberry and Chamberlain method, percent of correctly classified individuals is approximately 94% for individuals ≤ 39 and 95% for individuals ≥ 40. For the Lovejoy *et al.* method, percent of correctly classified individuals is approximately 63% for individuals ≤ 39 and 31% for individuals ≥ 40.

Full ranges of error (in years) for each method for individuals ≤ 39 are as follows: Suchey-Brooks (-8.3 to 28.2); Lovejoy *et al.* (-6.5 to 16); Buckberry and Chamberlain (-1.7 to 35.7); Osborne *et al.* (-10.9 to 18.8). For individuals ≥ 40, full ranges of error (in years) are as follows: Suchey-Brooks (42.4 to 20.2); Lovejoy *et al.* (-44 to 22); Buckberry and Chamberlain (-22.6 to 29.3); Osborne *et al.* (-40.2 to 15.9).

This study indicates that pelvic aging techniques estimate age in young adults (≤ 39) with lower error than older adults (≥ 40). The error of the Suchey-Brooks method increases with age, suggesting modifications of upper phases are warranted. However, auricular surface methods are problematic regardless of age group. Narrow age intervals in the Lovejoy *et al.* method result in low percentages of correctly classified individuals. The Buckberry and Chamberlain method frequently results in extreme overaging of the young and has the highest error for every age class under fifty. Of the three auricular surface methods, the Osborne *et al.* method has the broadest applicability.

There will always be error associated with age estimation; the focus now should be on understanding and quantifying error so as not to overstate method performance.

Adult Male Age Estimation, Pelvis, Error

H104 The Impact of Obesity on Morphology of the Femur

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After attending the presentation, attendees will better understand how differences in bone shape between weight classes might be explained by biomechanical adaptations used by overweight individuals to cope with increased adiposity. Additionally, attendees will see key theories behind adaptive cellular bone remodeling, and how direct, noninvasive bone measurements can be used to make inferences into activity and mechanical load.

This presentation will impact the forensic science community by illustrating how weight can indirectly alter bone shape. As obesity clearly affects how an individual appeared to others in life, this has great potential to aid in efficient identification of the deceased using skeletal remains.

The goal of this project was to evaluate whether adult weight (specifically obesity), impacts the human skeleton. The project design operated under the null hypothesis that biomechanical adaptations made by overweight individuals would *not* trigger adaptive cellular bone remodeling and therefore would not result in significant alteration of long bone shape or size. External measurements of diaphyseal cross-section were used as an indication of morphology, as these properties are said to be influenced by load and mechanical action. Using standards largely devised by Ruff (1983), anteroposterior (AP) and mediolateral (ML) dimensions were measured at 20%, 35%, 50%, 65% and 80% of diaphyseal length, measuring superiorly from the distal end.

The left femur was used as it possesses two unique properties: (1) it is a weight bearing bone; and, (2) its unique articulation with the pelvis results in forces that do not travel longitudinally through the diaphysis (as in the tibia). The latter property offers greater potential for morphology to reflect differences in force movement between weight classes due to biomechanical modification of overweight individuals. Three categories were formed based on body mass index (BMI): underweight (BMI < 17.5), normal weight (BMI between 19.5 and 24.5) and overweight (BMI < 26.5). To ensure each category was distinct, individuals with intermediate BMI scores were not included for analysis. To control for morphological differences due to ancestry and sex, only males of European ancestry were evaluated. To control for the effect of age on cross-sectional geometry, individuals in all three groups were age-matched to within one year, and age was included in all statistical analyses. The sample consisted of 184 individuals, 67 of whom were overweight, 59 normal weight, and 58 underweight.

After controlling for age, multivariate statistics show significant (*p-value* < 0.05) elongation of the ML dimension of the proximal and midshaft femur in overweight individuals, with t-tests confirming that ML dimensions are significantly large in this weight class (*p-value* < 0.05). These results suggest that femora of overweight individuals undergo abnormally high rates of sagittal stress. These findings correlate well with biomechanical gait analyses, which show that overweight individuals display significant increases in step width and hip abduction, disproportionately large ML ground reaction forces, and longer periods of stance when compared to normal weight controls. These activities, especially when coupled with movement of excess mass, could explain abnormal sagittal stress of the proximal femur.

In addition, size and shape variables were computed according to Mosimann and colleagues (Mosimann 1979; Darroch and Mosimann 1985); however, they were not log transformed. The ANOVA results show that BMI has a significant effect on overall ML size (*p-value* < 0.05). However, these same tests show no significant effect of BMI on bone shape. This suggests that increases in BMI are associated with increases in ML size, but do not appear to be associated with a change in shape.

As the prevalence of obesity in the American public continues to increase, so too does the need to estimate weight in forensic contexts. The implication that weight can indirectly alter bone shape has great potential to aid in efficient identification of the deceased, as obesity clearly affected how an individual appeared to others in life. Additionally, these findings can contribute to public health and outreach endeavors related to health implications of obesity.

Obesity, Bone Morphology, Biomechanics

H105 Mortality Structure and Age Estimation in Nigerian Populations

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The goal of this presentation is to analyze the morbidity and mortality structure of a modern Nigerian population to aid in the development of age estimation formula for the population. Further, population variation among Nigerian and American populations is discussed and the affects of nutritional disease and pathology on aging is explored.

This analysis reviewed the morphological changes of the pubic symphysis and sternal rib ends for more than 300 identified cases in Nigeria. This presentation will impact the forensic science community by presenting the outcome of a detailed analysis of the age at death distributions for males and females which will aid in the development of age estimation methods for West Africa and enable further study of human variation throughout the region.

The ability for authorities to identify unknown decedents in cases of homicide, human rights abuse, enforced disappearances, or extrajudicial executions is contingent in large part on a system for human identification that includes a protocol based on population specific standards. Nigeria's population is more than 150 million people, representing just over twenty-five percent of Africa's inhabitants. Nigeria also has a global population with a large number of international workers, refugees from neighboring countries, and migrant workers. The life expectancy for males and females are only 46 and 47 years, respectively. A high number of infectious diseases, deaths related to child birth, and a low prevalence of medical care contribute to the low life expectancy. Additionally, in the past several years, there have been over 10,000 extrajudicial killings of suspects, innocent civilians, multi-national oil workers, and politicians by the police, the military forces, vigilante groups, and armed militants in various parts of Nigeria. More recent sectarian violence has claimed more than 1000 lives in the past year.

Transitional justice initiatives in Nigeria are transforming the coroner laws which now require medico-legal death investigations. Currently, the College of Medicine at Lagos State University in Nigeria is one of the only forensic pathology programs in the country and performs about 3,000 autopsies each year. The facility also houses the Office of the Chief Medical Examiner for Lagos State. Basic biological information such as age and sex are the first parameters for establishing the identification process among unknown decedents. The assumption that one protocol is efficient across global populations is at times challenged because of both biological and social factors.

To study population variation and the applicability of applying American based aging methods to Nigerian populations, the mortality structure of the Nigerian population autopsied and contributing factors influencing this structure are investigated. Demographic data for n=2650 cases and biometric scores (n=300) for the pubic symphysis and fourth ribs, scored in the manners of Suchey-Brooks and Iscan and co-workers, were collected for identified individuals autopsied at the College of Medicine, Lagos State University in Nigeria. Additional comparative data for identified American males and females were collected for 2,078 pubic symphyses and 250 fourth ribs. American data comes from numerous American forensic and anatomical reference collections including The University of Tennessee Forensic Data Bank (FDB) and William M. Bass Donated Collection, Gilbert-McKern skeletal data, McKern-Stewart Korean War Dead data, Los Angeles County Medical Examiner's Office, and the Robert J. Terry Anatomical Skeletal Collection.

Hazard analysis is used to model mortality and survivorship among Nigerian and American samples. Age related changes of the pubic symphyses and sternal ribs are also compared for each population through an analysis of deviance calculated using an improvement chi-square to test for population variation. The outcome is a detailed analysis of the age at death distributions for males and females which will aid in the development of age estimation methods for Nigerian populations and enable further study of human variation throughout the region.

Age Estimation, Population Variation, Human Rights

H106 Dead Man's Curve: How Scoliosis Affects Rib Aging

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The goal of this presentation is to present gross and radiographic methods used in the identification of abnormal spinal curvature, e.g., scoliosis, and the possible effects this condition has on the accuracy of rib aging estimation from skeletal remains.

The presentation will impact the forensic community by elucidating the possible effects scoliosis has on rib aging criteria developed for the analysis of skeletal remains.

Abnormal lateral curvature of the vertebral column, or scoliosis, currently affects 2-3% of the United States population. Due to its fairly uncommon occurrence, the presence of the condition may help to establish a positive identification from unidentified skeletal remains when medical records or radiographs are available. In the absence of antemortem medical information, scoliosis becomes one aspect of the broader biological profile (i.e., age, sex, stature, and ancestry) used to compare the unknown individual with NCIC and NamUS missing and endangered persons profiles.

Two types of scoliosis are identified in clinical settings—adolescent scoliosis and adult degenerative scoliosis. Clinicians visually identify both types through the presence of asymmetric shoulders, scapulae, and hips. The diagnosis is then confirmed through antero-posterior radiographs. Once the displaced vertebrae are radiographically identified, the degree of the abnormal curvature is calculated using the Cobb angle. On the radiograph, one line is drawn from the superior vertebral body of the uppermost-displaced vertebrae. A second intersecting line is drawn along the inferior vertebral body of the most inferiorly displaced vertebra. The angle between these two lines as measured by a protractor is the Cobb angle. A 10° curvature is the minimum angulation required for a clinical diagnosis of scoliosis with most scoliotic spinal deformities falling between 10° and 30°.

The postmortem skeletal identification of scoliosis is typically determined through gross analysis of the ribs (e.g., asymmetrical length and shape of rib antemeres), isolated vertebrae (e.g., deflected transverse processes, lateral wedging, rotation, and/or torsion of vertebral bodies, asymmetrical presence of sclerotic bone, and/or ossified intervertebral disc spaces), as well as the abnormal appearance of the articulated vertebral column. These changes to the ribs and vertebrae may cause the analyst to over estimate the age of the individual if the scoliotic pathology is present but slight in its expression or if the analyst does not recognize the condition. It is hypothesized that the loss of rib symmetry caused by the curvatures, which is attributed to the adaptation the ribs

must make to accommodate spinal deformities, as well as the potential ossification of spinal ligaments and intervertebral disc space, results in changes to the sternal rib ends that inevitably complicate age assessment.

For this study, a series of skeletons (n=44) under the jurisdiction of various medical examiners, including the offices of District 4, 17, and 20, were evaluated for scoliosis indicators. Twenty-five percent (n= 11) of the forensic skeletal sample revealed scoliotic curvatures upon reconstruction. Left and right fourth ribs were aged of each individual and assigned a phase score using the Iscan and colleagues technique. In addition, the Cobb angle was calculated for each reconstructed skeleton within our forensic sample. Lastly, five analysts were used in this study in order to account for interobserver error.

It was found that the more severe instances of spinal curvatures were caused by underlying congenital defects, the most common being hemivertebrae. Most instances of scoliosis observed presented with a double curvature and exhibited osteoarthritis; thereby, suggesting the curvature was attributed to age-related changes. In general, rib ends did not necessarily age older, but in some cases sustained such a high degree of distortion they appeared more flattened or youthful as defined by the Iscan and colleagues' technique. Therefore, we suggest that when skeletal analysts age scoliotic individuals shape criteria should be de-emphasized. Rather, features such as porosity and pitting criteria should supplant shape changes when using Iscan and colleagues aging technique on scoliotic skeletal remains.

Forensic anthropology, Scoliosis, Fourth rib end aging

H107 The Effect of Axial Developmental Defects on Forensic Stature Estimates

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The goal of this presentation is to explore how the presence of axial developmental defects affects living stature estimates.

This presentation will impact the forensic science community by helping to establish methodological standards when calculating living stature estimates from human skeletal remains that evidence vertebral developmental defects.

The accurate estimation of stature is vital to the establishment of an individual's identity in medicolegal investigations involving human skeletal remains. In forensic anthropological analyses, stature is commonly estimated by: (1) combining the measurements of those bones responsible for living stature (i.e., anatomical method); or, (2) using regression equations based on intact long bone measurements (i.e., mathematical method). The use of Fully's anatomical method to estimate living stature, for example, involves the measurement of cranial height, maximum anterior height of the vertebrae C2 through S1, bicondylar length of the femur, physiological length of the tibia, and the maximum height of the articulated calcaneus and talus. Conversely, stature estimates derived solely from long bone measurements, with the occasional addition of sacral height, do not consider the entire vertebral column.

Congenital anomalies or malformations are produced by pathological changes in the normal development during intrauterine life. Specifically, axial developmental defects affect the skull, vertebral column, ribs and sternum. Because a major component of skeletal height is the combined length of C2 through S1, vertebral agenesis, supernumerary vertebrae and irregular vertebral segmentation such as those seen in axial developmental defects may influence stature. It is hypothesized that using stature estimations based solely upon long bone measurements may under or overestimate stature, depending on the type of axial developmental defect present. Very little research has been conducted on how these anomalies, especially those involving the vertebral column, affect the estimation of living stature. To this end, stature was estimated using both anatomical and mathematical methods for skeletal remains with and without the presence of axial developmental defects in order to determine the variance, if any, between the two methods.

Study materials for this research came from skeletal cases under the jurisdiction of Florida medical examiner districts 4, 17, and 20. The sample consisted of 32 adult individuals, of which 23 were male and nine were female. At least 50% of each individual was present, including the elements necessary to ensure accurate sex, age, ancestry, and both anatomical and mathematical stature estimates. Each case was inventoried, a biological profile was determined, and the remains were analyzed for vertebral developmental defects. The presence or absence of vertebral anomalies such as irregular vertebral segmentation (e.g., block vertebrae), vertebral border shifting (e.g., lumbarization, sacralization, etc.), supernumerary vertebrae and vertebral agenesis was recorded. Interobserver error was minimized by having three investigators estimate the stature on all individuals. Stature was determined using both anatomical (i.e., revised Fully method) and mathematical (i.e. regression equations from long bone measurements using FORDISC 3.0) methods. Data using chi square analysis of variance.

Upon analysis, eight of the 32 individuals presented with at least one axial developmental defect. Most individuals exhibited only one type of developmental defect; however, two individuals had defects in multiple vertebral regions. Overall, there were three instances of irregular vertebral segmentation, four instances of general vertebral border shifting, one instance of supernumerary vertebrae and two instances of vertebral agenesis. The chi square analysis of variance revealed a significant difference in mean stature, as well as standard deviation within each stature estimate for those sets of remains with axial developmental defects ($df = 7$, $p = 0.005$). The difference in mean stature for the remains without axial defects was not significant ($df = 23$, $p = 0.619$). In individuals with vertebral agenesis and block vertebrae, the mathematical method tended to overestimate stature, thereby emphasizing the vertebral column's impact on living stature.

Forensic Anthropology, Stature Estimation, Axial Developmental Defects

H108 Automatic Skull Landmark Determination for Facial Reconstruction

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The goal of this presentation is to present new methods for determining landmark positions on skeletal remains.

This presentation will impact the forensic community by making the facial reconstruction process more objective by lessening the requirement for user judgment in determining the initial landmark locations.

When building a computer based facial reconstruction in ReFace, key locations need to be indentified on the questioned/found skull. These key locations, or landmarks, are used in the reconstruction and are historically selected manually by the ReFace user. After attending this presentation, attendees will understand a number of principles regarding the automatic determination of landmarks on skulls or any similar three-dimensional shapes.

The automatic landmark determination will also reduce the time and effort required to set up a facial reconstruction. The goal is not to

take the user out of the loop. To this end, the user will be able to review and override any or all automatically determined locations. This may be necessary for unusual skulls or where skull material is missing.

Automating the detection of key locations involves the use of a prediction algorithm that is trained using existing data. For the purposes of skull landmark determination the ReFace database of known skulls (over 400 CT scans containing both skull and soft tissue information) are used as the training data. The known skull landmark locations have been previously entered into ReFace by the system developers using their best judgment regarding these locations.

A three-dimensional shape descriptor was developed to characterize any point on the skull and provides a training basis for the prediction algorithms. The shape descriptor is generally spherical and has sub regions separated by angles and radial layers. At any location on the skull the shape descriptor counts the number of three-dimensional model points in each sub region, with the result being an array of numeric values. The quantity, shape, and size of the shape descriptor sub regions are controlled by control variables with inputs for the initial radius, the number of angular sectors and the number of layers. Different configurations of the control variables were evaluated based on location determining capability. Performance and other results will be presented.

When a new questioned skull is to be analyzed by ReFace, the system can compare the results of the shape descriptor evaluation at various points on the questioned skull with the algorithms trained by similar evaluations on the known skulls. Several different algorithms were evaluated and will be reviewed during the presentation, including boosting and cost based methods.

Depending on the concentration of points on the three-dimensional model, skull data can be large in size. Larger models will take longer to process so the algorithm needs to perform efficiently and the amount of the skull that is evaluated should be reduced as much as possible. Using information about the known skulls in the ReFace database, the landmarks were normalized within the skull's bounding region in order to provide an initial guess with respects to the location of the landmark and the volume of possible locations. The normalized estimate allows a region much smaller than the overall skull to begin a more detailed exploration of the location. Other methods to address and improve performance will also be presented.

An example case in which the methods described are used to build a successful face reconstruction will be presented. The presentation will show the capability of automatically determining the location of the skull landmarks within a few millimeters of the correct location.

Skull, Reconstruction, Algorithmnstruction, Algorithm

H109 In Vivo Facial Tissue Depth Measurements of African Nova Scotian Children for 3-D Forensic Facial Reconstruction

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After attending this presentation, attendees will be aware of groundbreaking research that has expanded the facial tissue depth data to include African Canadians. They will also learn the significance of collecting data that is specific for similar ancestral populations living in different geographical regions.

This presentation will impact the forensic science community by increasing the facial tissue depth data available in Canada to include African Canadians, and thus helping forensic artists generate more accurate 3-D forensic facial reconstructions. Consequently, a more accurate facial reconstruction will increase the likelihood of recognition and positive identification. As a result, this research will impact humanity by providing data that may help alleviate the psychological, emotional, and physical suffering endured by relatives and friends of missing persons.

The purpose of this research is to expand the facial tissue depth data available in Canada to include African Canadians. Population specific facial tissue depth data helps increase the accuracy of three dimensional forensic facial reconstructions as well as the chance for establishing a positive identification for unknown individuals. Specifically, this study involves collaborating with the African Nova Scotian community to create the first African Canadian tissue depth database to help identify missing children of African Nova Scotian descent.

The specific goals of this research are to: (1) report standard summary statistics, including means, standard deviations, and ranges of tissue thicknesses for both sexes and varying sub-adult age groups; (2) determine if there is a relationship between age and tissue thickness for males and females; (3) determine if there are significant differences of facial tissue depths between and within sexes of differing sub-adult age groups; (4) compare the results of this study to contemporary data for African American children (Manhein et. al., 2000); and, (5) provide sonographic training for African Nova Scotian students.

This study utilizes ultrasound technology to collect the facial tissue depth measurements since it is the most accurate method of measuring tissue depth; it is non-invasive, safe, and portable. Tissue depth measurements are collected from fifty living volunteers of African Nova Scotian descent. Participants included males and females between three and 18 years of age. Height and weight were recorded and photographs of the front and right side were taken of each participant. To maintain consistency in locating the nineteen anatomical landmarks on living individuals, the protocol developed by Manhein and colleagues (2000) was followed.

The participant was seated in the upright position, facing forward, with facial muscles and jaw relaxed. The transducer was coated with a non-allergenic gel and lightly applied to the skin at a 90° angle to the underlying bony landmark. To prevent depression of the soft tissues, the gel was the only substance in contact with the skin.

The participant remained still while the measurement was being taken to ensure an accurate reading. Once the coated transducer was in the correct position, the image was frozen on the monitor and the participant was able to relax for a few moments prior to the next measurement. An ultrasound output was generated and the depth of the soft tissue was measured using calipers built into the computer system. This process was then repeated for all nineteen anatomical points. Averages of each point were taken for males and females of specific age groups and a reference table was generated. Statistical analyses were used to analyze the data. Results and preliminary findings will be presented.

This presentation will impact the forensic science community by increasing the facial tissue depth data available in Canada to include African Canadians, and thus helping forensic artists generate more accurate 3-D forensic facial reconstructions. Consequently, a more accurate facial reconstruction will increase the likelihood of recognition and positive identification. As a result, this research will impact humanity by providing data that may help alleviate the psychological, emotional, and physical suffering endured by relatives and friends of missing persons.

African Canadian, Tissue Depth, Facial Reconstruction

H110 Skeletal Identification by Radiographic Comparison: Blind Tests of a Morphoscopic Method Using Antemortem Chest Radiographs

Carl N. Stephan, PhD, and Andrew J. Tyrrell, PhD, JPAC-CIL, 310 Worchester Avenue, Hickam AFB, HI 96853*

After attending this presentation, attendees will have an appreciation for how identifications can be established using the bone

morphology depicted on chest radiographs, what error rates can be expected, and why the methods form the last viable modality for the identification of many United States personnel unaccounted for from the Korean War.

This presentation will impact the forensic science community by providing data for the most rigorous validation test of a non-dental radiographic comparison method that has so far been undertaken (see methods reported below). Additionally, it demonstrates the potency that normal radiographic anatomies of the claviculae and C3-T4 vertebrae hold for the correct identification of unknown human skeletons (when of course, antemortem [AM] chest radiographs are available).

Radiographs of the chest form the second-most frequently captured x-ray image after dental radiographs; however, chest radiographs are typically easier to locate (i.e., they form part of the medical record) and, therefore, they hold greater potential forensic value. Despite this, research on chest radiographs (at least from an identification perspective) has been limited and past validation studies have been hampered by the use of simulated AM radiographs and relatively easy test protocols (multiple pair matching tasks from the same, typically small, simultaneous array [n<40 individuals]). Here we redress these limitations using twelve field-recovered skeletons, authentic AM chest radiographs (including those of >1390 non-matching individuals), postmortem radiographs taken and utilized by independent examiners, and a radiographic comparison method that employs the claviculae and C3-T4 vertebrae. Rigorous method assessments were undertaken by using: examiners who operated in the blind; a single target individual in each identification test; new non-target individuals across all tests; up to 1000 radiographs in any single simultaneous array; sequential arrays in some trials (= examiners blinded to identification universe size, no opportunity for examiners to compare array radiographs side-by-side, and no opportunity for examiners to review decisions and/or radiographs); < quarter-size 50-year-old radiographs of suboptimal image quality; skeletons in various states of preservation (including varied states of erosion/completeness, two very poorly preserved skeletons and four other skeletons that had fifty percent of one clavicular shaft missing due to prior mtDNA sampling), back-to-back tests wherever possible (to encourage examiner fatigue), and time pressures for some trials. Thus, the performance levels observed in this study should represent baseline values. Eight examiners took part in the study: two trained on the radiographic images/methods and six other untrained examiners (= persons not receiving in-depth training on methods and additionally with limited radiographic experience [especially for the chest]; and/or limited knowledge of the *in vivo* position of the thoracic human skeleton; and/or limited understanding of x-ray principles/equipment operation).

Only true positive identifications were made for the simultaneous arrays (accuracy = 100%, sensitivity = 100%; n = 6 trials). While erroneous identification responses were made during the sequential trials they were almost exclusively made by untrained examiners. That is, the accuracy, sensitivity and specificity for trained examiners was 90%, 80% and 100% respectively (n = 10 trials), whereas the accuracy, sensitivity and specificity for the untrained examiners was 35%, 50% and 29% respectively (n = 20 trials). Furthermore, untrained examiners took twice as long as trained examiners to reach identification decisions during the sequential trails, even though they performed with less accuracy (mean = 68 sec compared to 34 sec for trained examiners). Method limits were established by the very poorly preserved remains in conjunction with the sequential trials administered under an identification context; but when these very incomplete remains were tested using simultaneous arrays and/or sequential trials under exclusion/inclusion contexts, the methods retained their value in the hands of trained examiners (accuracy = 100%, specificity = 100%, n = 2 trials). In view of the purposefully imposed stringency of this study, these results indicate that AM chest radiographs hold value for skeletal identification when implemented by trained examiners, especially for moderate-to-well preserved skeletal remains. Moreover, since benchmark accuracies for other radiographic identification methods have been set using more lenient tests, we suspect that the identification power of the method reported here at least rivals (and possibly even surpasses) that for higher esteemed body regions. These results justify the employment of the method in future forensic casework and should encourage attempts to make future improvements to these methods. Additionally, the results underscore the danger for untrained practitioners to employ the technique in its current unquantified state, but they also indicate that competency can be quickly induced by training with practice sets of images (c. 100-200 individuals) administered under simultaneous formats.

Skeletal, Identification, Radiographs

H111 Positive Identification Using Radiographs of the Lumbar Spine: A Validation Study

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After attending this presentation, attendees will learn the results of a validation study/survey that was carried out to establish accuracy and error rates among practicing forensic anthropologists with regard to positive identifications made by comparing "antemortem" and "postmortem" radiographs of the lumbar spine.

This presentation will impact the forensic community by adding to the existing literature on validation, accuracy rates and the potential risk of arriving at false positives when using radiograph comparison as a means for arriving at positive identifications of unknown decedents.

Following court rulings, such as *Frye v. United States* (1923), *Daubert v. Merrell Dow Pharmaceuticals* (1993) and *Kumho Tire Co. Ltd. v. Carmichael* (1999), in addition to the recent recommendations included in the 2009 report from the National Academy of Sciences, the forensic community is increasingly mindful of the importance of evaluating, improving, and standardizing the methods employed by scientists practicing in all disciplines of forensic science. Specifically with regard to the *Daubert* ruling, guidelines were established for admissibility of expert witness testimony: a method must have been or have the potential to be empirically tested, there must be established error rates, it must have been subjected to peer review, and it must be generally accepted in the relevant scientific community. As a result, several studies have been published to validate identification methods used by anthropologists. Existing publications on methodology and validations studies involving comparative radiography include, among others: Christensen 2004; Hogge *et al*. 1994; Hulewicz and Wilcher 2003; Kahana *et al*. 2002; Koot *et al*. 2005; Kuehn *et al*. 1997; Mundorff *et al*. 2006; Quatrehomme 1993; Telmon *et al*. 2001; Weiler *et al*. 2000. Though several published case reports and studies involve the use of lumbar spine radiographs, none have sought to validate the comparisons of antemortem and postmortem x-rays of the lumbar region with the specific goal of establishing the method as admissible evidence in a court of law.

This project was designed to evaluate the validity of rendering positive identifications by comparing antemortem and postmortem radiographs of the lumbar spine, and to evaluate the specific features anthropologists most often employ when carrying out such identifications. With permission from the Willed Body Program and the Department of Radiology at Michigan State University, the research being presented made use of cadavers from the MSU Gross Anatomy Laboratory. To mimic the antemortem condition, A-P abdominal x-rays were taken of 29 cadavers, using standard clinical procedures. Five of those individuals were then randomly selected to have their lumbar spines extracted, defleshed, rearticulated and x-rayed a second time to mimic the postmortem condition. Careful attention was paid to orient these "postmortem" images as closely as possible to the "antemortem" images.

After duplicating the radiographs and selecting suitable images, packets of materials containing sets of 20 "antemortem" and 5 "postmortem" radiographs, along with a letter to participants, the project's abstract, consent forms, and data sheets were sent to the study subjects (practicing anthropologists and forensic anthropology graduate students) who participated voluntarily. The first portion of the data sheets contained questions asking personal information such as highest degree, whether the participant was a graduate student or a professional, years of experience each participant has practicing forensic anthropology, whether they had experience using radiographs to make positive identifications, whether any of those identifications were made based on radiographs of the spine, and approximately how many of their cases have involved such identifications. The second portion of the data sheet asked the study participants to identify which "antemortem" radiographs corresponded to the "postmortem" radiographs, how many similarities they found between the radiographs, and which specific features they took into consideration.

Analysis was carried out using contingency tables to evaluate the relationships between the independent variables (i.e. level of education, years of experience practicing forensic anthropology, number of cases involving radiographs, and number of cases involving radiographs of the spine) and the dependent variable (% correct of the five simulated identifications). Results suggest that level of education and years of professional experience may be unrelated to the accuracy rates associated with this type of identification. However, there appears to be a significant relationship between the amount of experience observers have with making identifications using radiographs and the number of identifications they made correctly.

Identification, Validation, Radiographs

H112 Hand Comparison: The Potential for Accurate Identification/Recognition in Cases of Serious Sexual Assault

Xanth Mallett, PhD, University of Dundee, Centre for Anatomy & Human Identification, Dow Street, Dundee, UK DD1 5EH, SCOTLAND*

After attending the presentation, attendees will have an understanding of the differences between human identification, recognition, and comparison in forensic body mapping scenarios, forensic photographic comparisons methods, as discussed in relation to body mapping – using the human as example, and different geometry and biometric identifiers, in terms of developing multi-modal systems.

This presentation will impact the forensic science community by providing an overview of a new and innovative human identification/recognition system which does not require the offender's face to be visible, offering another mechanism for the detection and confirmation of the identity of serious sex offenders, including members of international paedophile rings, providing inter-agency and cross-boundary support to investigative agencies outside of the United Kingdom investigating serious sex crimes in which faces are not visible, and making the system details available to other law enforcement agencies, with a view to increasing the number of successful prosecutions of serious criminal, including those guilty of sexual offences.

This presentation will summarize a number of high profile cases that have been heard recently in the United Kingdom courts – one of which was described by the residing judge as Scotland's worst child sex abuse trial – which have utilized a novel and innovative hand comparison method to identify and corroborate the identify several pedophiles.

Researchers at the Centre for Anatomy & Human Identification, University of Dundee, Scotland, have developed the world's first large database for hand recognition and identification, with thousands of images which can now be used as a reference sample to show the occurrence of features within a discrete population. This database was developed as a direct result of a case that was presented the anthropological team at the Centre by the Metropolitan Police Service (MPS), London, which consisted of an offender taking illegal photographs of under-aged children while on a business trip to Thailand – who was careful not to catch his face on camera; however, his hands were in clear evidence. Previous to the Dundee team's work, only circumstantial evidence linked the suspect to the offender in the images.

The resulting report showed that it was unlikely that the hand in the photographs could have belonged to anyone else; that there was more variation between the suspects' two hands than there was between the suspect's left hand and the hand in the offender image. This result was achieved by comparing multi-modal features, such as overall finger size and shape, in addition to more individualistic characteristics such as scar, moles, freckles, etc. When confronted with the evidence the suspect confessed, and was subsequently found guilty of indecent assault of children under the age of 14 years, together with other serious sexual assault charges. This ground-breaking forensic identification case was revealed to the media by the MPS (2009) and the British Crown Prosecution Service (2009).

Subsequently, a second hand comparison was undertaken for Lothian and Borders Police, Scotland, which resulted in the successful conviction of a pedophile ring, with eight men being found guilty of child pornography and sex abuse charges. Since this time, and a considerable media attention, an increasing number of similar scenarios have been presented to the team for analysis, demonstrating that there are significant applications for the work being undertaken in Dundee. This presentation will summarize the methods under development, and detail the most significant cases reviewed by the team to date.

References:

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Forensic Anthropology, Forensic Hand Comparison, Body Mapping

H113 Forensic Characteristics of Hand Shape: Analysis of Individuation Potential and Sexual Dimorphism Using Geometric Morphometrics

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After attending this presentation attendees will learn of the issues surrounding the biometric use of hand geometry and its forensic anthropological basis, and methods which may be applied using advanced shape analysis statistical techniques in order to standardize the individuation of hand shape.

This presentation will impact the forensic science community by presenting a novel standardization method for the quantitative analysis of hand morphology as an aid in individuation and sex assessment.

The human hand is often used for verification of identity only (using one-to-one comparison), as the dimensions of hands have been considered to be too alike to individuate based on a one-to-many comparison. Past research has often focused solely on lengths and widths of the fingers and palm to compare variation in the hand, and this has led to the belief that hand dimensions are insufficiently individuating

for human identification. The research here presented utilizes geometric morphometric techniques to investigate and quantify shape and size variation in the human hand, and consequently the potential for forensic human identification and recognition. The results are presented of a novel hand biometry study, the goal of which was to develop a methodologically and statistically robust means of investigating the individuating potential of the human hand by studying the extent of morphological variation within a sample population. It was imperative the developed technique was simple and highly repeatable, as currently there is no universally accepted method for hand comparison capable of facilitating a systematic assessment of individuation.

Simultaneous digital images were acquired of the dorsal and palmar surfaces of the left & right hands of male and female participants. Ten repeat runs were acquired with varying time-lapses between image capture in order to assess variation due to hand placement. Nine 2D landmarks were selected on both surfaces of both hands, and were subsequently digitized using [TPS Digit.] The resulting landmark configurations (n=720) were subjected to Generalized Procrustes Analysis (GPA) with Full Tangent Space Projection in [Morphologika 2.5.] Principal Components Analysis (PCA) was applied in order to assess individual and populational variation. Factor loadings were subject to Canonical Variates Analysis with stepwise and leave-one-out classification in order to assess individuation potential and the effects of sexual dimorphism on hand shape. The results showed individuals to be correctly classified in 95.3% of cases, with 87.5% being correctly classified by sex (males were correctly classified in 91.9% of cases, and females in 83.1%). These results are strongly significant and suggest the human hand offers significant individuating power for forensic identification purposes. They also indicate male and female hands to have sufficient shape variation for sex-based discrimination with the effects of allometry being strongly implicated. These and other implications of the shape analysis will be discussed.

Hand Biometrics, Geometric Morphometrics, Sex Assessment

H114 Bionic Remains: Positive Identifications From Surgical Implants

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After attending this presentation, attendees should appreciate the forensic potential of surgical implants in making positive identifications. The attendees will become aware of the forensic and future bioarchaeological implications of the information presented, the types of procedures that require surgical implants, and a novel method for rapid identification of the implants and their uses.

This research will benefit the forensic community by facilitating positive identifications of victims who possess surgical implants. Additionally, this research may provide future bioarchaeologists a valuable single-source reference on twentieth and twenty-first century medical procedures.

Surgeries as treatments and preventative medicine have been around almost as long as man has had ailments. From trepanation in prehistoric times to complex neurosurgery in modern times, surgeries of all sorts (preventative, treatment, or cosmetic) have left their mark on human skeletal remains for millennia. Increasingly, surgeons are relying upon devices—from simple to electronically or mechanically driven—to replace or enhance organs and organ systems. Medical implants are now used in surgeries involving all major organ systems and are a frequent find in decomposed, burned and skeletal remains. Their significance in life as a medical aide is transformed in death to a tool for identification. This paper proposes to provide a single-source compilation (i.e., printed and/or online reference manual) of common surgical implants along with their forensic significance for identification.

The presence of an implant of any type tells the investigator that medical records exist on the questioned remains. The presence of certain types of remains (e.g., testicular implants, breast implants, fallopian tube rings or clips, etc.) may provide an indication of the sex of the questioned remains, or, in some cases, the preferred sex of the questioned remains. A general indication of age may be revealed by the presence of implants such as porcine verses mechanical heart valves, since porcine heart valves are at risk of calcification and breakdown and are not commonly placed in the young. The postmortem interval (PMI) may be garnered from the style of the implant as the manufacturer frequently modifies or redesigns them, varies manufacturing materials through time as research dictates, or the implant may contain power sources with known limits. A baseline for time since death (TSD) can be determined through identification of the implant and when it was manufactured. Finally, the morphological uniqueness of the implant may provide a means of specific identification from comparisons of antemortem and postmortem radiographs.

When analyzing forensic remains to determine identity, specific information on an implant is a valuable source of information, but is often problematic and time consuming to find. Although many implants possess manufacturer names and logos, contact information for the manufacturer may not be readily obtainable and may require library or computer searches. The purpose of this paper is to provide a convenient source of information on implants commonly used in a variety of medical specialties, including orthopedics and sports medicine, cardiothoracic surgery, bariatric surgery, and cosmetic surgery. Specifically, under each specialty the name and representative photographs or illustrations will be provided of the more common implant, a description of their function, the manufacturers' logos when present, contact information for the manufacturer, whether lot numbers are present on the device, and any known forensic value.

Forensic Anthropology, Surgical Implants, Positive Identification

H115 Epidemiology of Homicide in the Spanish Civil War

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After attending this presentation, attendees will understand how archaeological and forensic anthropological data can be used to reconstruct the manner in which extrajudicial executions occurred during the Spanish Civil War and how the execution modes varied by perpetrator group.

This presentation will impact the forensic science community by showing how multidisciplinary cooperation among historians, archaeologists, forensic anthropologists, pathologists, and ballistic experts excavate seventy-year-old mass graves in Spain to reconstruct historic memory of the Spanish Civil War.

Forensic scientists involved in the exhumation, recovery, and analysis of victims of human rights atrocities are often tasked with

evaluating opposing testimonies concerning the number and identity of the victims as well as the nature of the event(s) surrounding the deaths. While investigators working on many sites within a single conflict may informally comment on a recognized pattern of execution and disposal, the modus operandi of perpetrators has received little formal attention. This is in large part because of the perceived heterogeneity of conflict behavior across space and time. However, patterns can arise within conflicts. The focus of this paper is to apply archaeological and physical anthropological data from a number of well-documented human rights investigations around the world, as well as Spanish historic information, to help define who was targeted for execution and define the manner of executions in recently excavated mass graves from the Spanish Civil War (1936-1939) and subsequent period of Franco rule (1939 – 1975). The epidemiology of homicide focuses on who was targeted for execution and how the process by which executions were carried out varied over space and time and whether the perpetrators were military or civilian.

Despite the death of Franco in 1975, Civil Society in Spain is still struggling with when and how to reclaim historic memory of the Civil War and investigations of the atrocities committed by both sides are only recently underway. Most graves investigated to date are of the political left who were killed by the military as well as civilian Fascist groups. It is predicted that there will be distinct differences in the modus operandi between army and civilian perpetrators. Published and unpublished reports on documented clandestine execution methods from Iraq, Argentina, Guatemala, the former Yugoslavia, and several other conflict zones are compared to reports of controlled excavations of mass graves in Spain to establish the procedures to target, capture, and execute noncombatants during the Spanish Civil War and to document any regional or temporal variation.

The data collected for this study focus on the grave, any activities associated with the execution event at the site, and detailed information about the victims. The first dataset provides information concerning the actions of the perpetrators and includes: (1) geographic location of the graves; (2) the number of graves at the site (e.g., a single mass grave or multiple contiguous or nearly contiguous pits that may indicate use over a period of time); (3) dimensions of the grave(s); (4) evidence of primary or secondary interment; (5) evidence of postmortem disturbance of graves; (6) presence or absence of ballistic evidence in and around the grave (e.g., shell casings, bullets); (7) presence or absence of ballistic evidence near likely execution sites (e.g., cemetery walls); (8) type and number of firearms used; and, (9) position of individuals within the grave.

The second dataset focuses on the remains of the victims to examine who was targeted, whether it is likely they were combatants or unarmed civilians, the nature and frequency of peri-mortem trauma, and the positional relationship between the victim and perpetrator at the time of execution. Such data include: (1) number of individuals per grave; (2) demographic profile of victims; (3) date of execution; (4) number of individuals with peri-mortem gunshot, sharp or blunt force trauma; (5) number of individuals with multiple forms of peri-mortem trauma; (6) spatial relationship between perpetrator and victim (as determined by direction of gunshot fire and/or blunt force blows); (7) anatomical location(s) of peri-mortem trauma; and, (8) presence or absence of bindings (blindfolds, ligatures).

The results demonstrate that the mass graves investigated by our team, as well as most graves throughout Spain, involved little construction effort and that the majority of the victims were males who did not support the military revolt. Two or more types of bullets are recorded for most of the mass graves. The distribution of gunshot wounds on the skeletons are largely confined to the torso and entered the bodies from multiple directions. While some bullets entered the skull, the evidence is most consistent with death by firing squads as documented in Iraq. Importantly, the physical evidence of the graves and bodies is inconsistent with claims of battlefield deaths and support the local oral histories indicating unarmed men were rounded up and illegally executed by both military and civilian firing squads.

Forensic Anthropology, Human Rights, Spanish Civil War

H116 Forensic Anthropology in Colombia: Working Amidst Armed Conflict

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The goal of this presentation is to describe the current status of forensic anthropology in Colombia and its challenges. Forensic anthropology efforts are conducted amidst on-going armed conflict, as opposed to other Latin American countries.

This presentation will impact the forensic science community by providing an overview of the obstacles posed by armed conflict in terms of forensic anthropology activities.

Since the twenieth century, Colombia has been going through an armed conflict among various players: leftist insurgents, rightist paramilitary groups, drug traffickers, and the government itself. The conflict has resulted in countless deaths, displacements, and missing persons. These cases need to be resolved in court and victim reparation is essential.

In 2005 the law offered benefits to illegal group members who were willing to surrender and provide useful information. It was required that illegally obtained assets had to be returned to contribute to the victim reparation process and perpetrators had to give up their criminal activities. This strategy resulted in the discovery of countless clandestine graves. Investigating and processing these graves required additional forensic teams and the strengthening of anthropology teams existing at government agencies. These teams are responsible for exhuming remains and collecting evidence to support identification processes and help establish the truth.

Forensic anthropology in Colombia is unique. Despite multiple legal, military, and diplomatic efforts, armed conflict is an on-going problem that forces anthropologists to continue working amidst conflict. As a result of the continuing state of conflict, forensic anthropology emerged as a government initiative.

Working amidst conflict creates some unique problems for the investigating forensic teams which may bring about legal and historical challenges in the future. Some of these problems include:

1. **Collection of Victim Information:** No precise information is available on the actual number of deaths or missing and displaced persons. These figures are constantly growing and there is no consensus between victim organizations and state agencies. Victims are reluctant to provide information because of their fear of retaliation from armed groups that are still operating in conflict areas. It if very difficult to locate civilians who may provide information about the death of their loved ones because most of them have been displaced by violence, live away from their place of origin, or their whole families have been exterminated.
2. **Exhumation of Clandestine Graves:** In many cases the parties to the conflict state that bodies of the victims were disposed of to avoid prosecution. Exhumations are frequently conducted in a very short time and there is the risk of missing essential evidence to help clarify the circumstances of the victims' death.
3. **Laboratory Analysis and Victim Identification:** Due to difficulty gathering antemortem information about missing persons frequently results in a lack of information to

compare against the evidence obtained from the skeletal remains. This situation delays identification and creates a backlog of unresolved cases.

The above represents multiple challenges for Colombian forensic anthropologists. Fieldwork and laboratory protocols based on the country's reality must be developed and adapted. Further research is required to develop standards specific to the Colombian population. Additionally, the modus operandi of armed groups must be understood to interpret field and laboratory findings.

Colombia has a long way to go. Even though the country has received invaluable support from nations such as the United States, which have made significant financial and logistic contributions to victim search and identification processes, work teams still need training and laboratory and field standards need to be developed. Such advancements would not only help solve cases, but contribute to the construction of the country's historical memory. It would be the first step towards justice and reconciliation, which will ultimately lead to lasting peace.

Forensic Anthropology, Armed Conflict, Colombia

H117 Ten Years On: Problems Relating to Victim Identification in Timor Leste

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After attending this presentation, attendees will learn of the specific factors limiting the efforts of the United Nations Forensic Team in identifying victims of the 1999 conflict in Timor Leste.

This presentation will impact the forensic science community by providing vital information on standards and practices associated with human rights investigations.

In the fall of 1999, a referendum was held to determine whether the area known as East Timor (now Timor Leste) should seek independence from Indonesia. The Timorese voted overwhelmingly for independence. The Indonesian militia responded with a scorched earth policy, during which over 1,000 Timorese were reportedly killed. In the decade since, the United Nations has been responsible for investigating and documenting the offenses committed in 1999. The current unit, known as the Serious Crimes Investigation Team or SCIT, is given jurisdictional authority to investigate by, and reports directly to, the Office of the Prosecutor General of the Timorese government. The SCIT contains a Forensic Unit that is responsible for the exhumation and autopsy of victims of the 1999 conflict.

To date, personal identification of the victims is not DNA based, despite the considerable efforts of all anthropologists associated with the mission and offers to conduct DNA testing from numerous organizations. The decision to utilize DNA testing rests with the Prosecutor General. As a result, the identification of victims remains presumptive and the process is suspect because of the following confounding factors: the requirement of family consent to exhume; the practice of monetary incentives; reliance on family identification; and, the use of North American methodological standards. Each of these factors will be examined in detail:

1 **Family Consent to Exhume:** The Office of the Prosecutor General requires written family consent prior to any exhumation or examination of purported victims. While the practice shows respect for local custom and family wishes in cases involving individual and consecrated burials, the requirement becomes burdensome and limiting in the case of mass internments, clandestine burials and unidentified remains. Investigations were curtailed in cases of multiple burials because some families agreed to the exhumation while other families withheld consent. Exhumations authorized by one family member would be canceled when another family member withdrew consent. Unidentified remains unearthed during construction projects or in similar circumstances could not be examined by the SCIT Forensic Unit until the victim was tentatively identified or the death could be shown to be from 1999. All forensic and medicolegal investigations, particularly those involving large-scale human rights violations, must be able to operat independently and without constraint in order to produce unbiased results. The family consent requirement in Timor Leste violates this principle.

2 **Monetary Incentives:** Timor Leste is the poorest nation in Asia. Local mortuary customs require elaborate rituals, including village feasts associated with burial, exhumation, and reburial. To assist with the costs associated with the rituals, the United Nations introduced a stipend to families consenting to exhumations. The stipend, originally $40.00 U.S. dollars, has now grown to $150.00. Personal observations include continual family demands for more money and, on one occasion, the family withdrew their prior consent, demanding thousands of dollars to examine the remains. The investigative process relies on families to identify potential victims to the investigative team. In such a harsh economic environment, paying families to exhume their loved ones creates an ethically questionable situation. What began as a well-intentioned practice is now suspect and subject to abuse.

3 **Reliance on Family Identifications:** The identification process in Timor begins and ends with the family of the deceased. While cases exist in which a family member was present when the victim was killed, providing a reasonable visual identification of the remains, a significant proportion of the "identifications" are based on local folk traditions. Personal observations include witnessing family members cut themselves and bleed on the bones of their purported loved ones, in the belief that only family blood will be absorbed into the dry remains and the identification of skeletonized remains based on the dreams of the supposed victim's grandmother. As anthropologists, local traditions must be respected; however, as forensic scientists, more must be required. Most troubling are cases in which the biological profile generated at autopsy does not match the family's description of the victim. Given the requirement of family consent and the family's belief that the remains are those of their loved one, there is little that can be done in such cases beyond informing the family of the findings.

4 **The Validity of Applying North American Standards to the Timorese Population:** Even casual observation indicates that the Timorese are significantly smaller than their North American counterparts. A pilot study using presumptively identified individuals was conducted and will be presented in an upcoming article. The sample included 26 individuals, all male, with an age range of 2 to 52 years. All metric forms of analysis were shown to be inaccurate. For example, metric sex determination methods using femoral and humeral head dimensions misclassified 100% of the adult male sample as "unambiguously female." Pubic symphysis aging methods also appeared to be incorrect. The need for regionally specific standards is great, yet would require a test population of positively identified individuals with documented age and stature (a problem in a country where many individuals do not know how old or tall they are). Currently, the ambiguity of family reported data, combined with the knowledge that our anthropological standards are inaccurate for the population under study, results in an identification process fraught with error. When the biological profile and the family description of the victim do not match,

is it because the identification is incorrect, the family is mistaken about the age or stature of the victim, or because our methods are inaccurate?

The cumulative effect of these factors is an identification process that is scientifically unacceptable. DNA testing must be utilized in Timor Leste. There is no other means of addressing issues of victim identification. The current procedure does little more than apply a false veneer of scientific credibility to an otherwise invalid exercise. The complete reliance on families as both the sole source of identification and access to the remains compromises investigative efforts and provides no means of addressing cases where the presumptive identification is incorrect.

Professional standards and practices benefit from review, critique, and reevaluation. This presentation is not intended as an indictment of the current investigation in Timor Leste, but rather as an opportunity to learn from past experiences, to reconsider practices that introduce monetary or resource incentives into forensic investigations, and to identify the need for research into regional standards for all anthropological methodologies.

Personal Identification, Biological Profile, International Human Rights

H118 Personal Identification from Skeletal Remains in Human Rights Investigations: Challenges from the Field

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After attending this presentation, attendees will understand the complexities of personal identification from human skeletal remains in cases of political violence (human rights cases) where traditional antemortem records are rarely available.

This presentation will impact the forensic community by examining some of the problems with presumptive identification techniques and posing questions about reliance on DNA identification methods.

The personal identification of an individual(s) from skeletal remains poses a number of difficulties for forensic specialists. The absence of soft tissue, including skin (with possible tattoos, scars, or birthmarks) and fingerprints, limits the possibility of making a presumptive (e.g., based on visual assessment) or a positive (based on fingerprints) identification, and consequently, augments the role of the forensic anthropologist.

The forensic anthropologist may assist by providing a biological profile (that is, the ancestry, sex, age, and stature of an individual) as well as identifying any skeletal anomalies, defects and/or pathologies. Such information is lead-generating and may narrow down the search. However, even with the formation of a biological profile, an attempt at identification rests on antemortem records being obtainable for comparison with the postmortem data. Adequate antemortem records may not always be available. This is particularly true in cases of political violence (human rights cases), where the affected population rarely visit a dentist or doctor.

While fingerprints, DNA, and dental/medical information are the only evidence accepted in most countries by the legal authority to make a positive identification, other "unofficial" antemortem information may exist. For example, the mother of a victim may remember very well that her son had a missing upper lateral incisor even though no dental records exist. Is this information acceptable for identification? How is such information to be evaluated in the context of a lack of official dental records? Is a fracture in a bone or a pathological change to a limb that produces an unusual gait enough to identify an individual despite the lack of medical reports or x-rays?

And how useful are personal belongings in the identification process? Presumptive identification based on associated clothing and/or personal property has been criticized as being unsystematic and providing high failure rates (Simmons and Skinner 2005; Simmons 2007).[1,2] However, in many contexts the relatives of the missing and/or their friends may recognize clothing and/or property and there will not be funding and/or DNA facilities available to undertake positive identification.

While discussions about acceptable levels of identification are common in contexts where legal and medical standards have not been established and geopolitics dictates international will and funding to investigate the missing, "acceptable" means of identifying deceased individuals need to be rethought and redefined. Does the forensic community have to adapt their practice to fit available resources? The obvious question following this is does such adaptation result in the lowering of standards? Such questions need to be addressed as the families of victims will continue to claim the remains of their loved ones.

References:

1 Simmons T, Skinner MF. The accuracy of antemortem data and presumptive identification: Appropriate procedures, application and ethics. Proceedings of the American Academy of Forensic Sciences; 2005 Feb 20-25; Seattle, USA. 2006. 12;H51:303.

2 Simmons, T. 2007. Presumptive (mis)identification rates for the Balkans. Paper presented at the 9th Indo-Pacifica Congress on Legal Medicine and Forensic Sciences of The Indo-Pacific Association of Law, Medicine and Science 22nd-27th July Colombo, Sri Lanka.

Positive Identification, Standards, Skeletal Remains

H119 The International Commission on Missing Persons and an Integrated, Multidisciplinary Forensic Approach to Identification of the Missing From the 1995 Srebrenica, Bosnia Mass Execution Event

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After attending this presentation, attendees will gain an overview of the mission and role of the International Commission on Missing Persons (ICMP), and an introduction to the integrated forensic sciences that the ICMP has employed in a massive and complex effort to identify and repatriate the victims of the 1995 mass killing associated with the fall of Srebrenica, Bosnia.

This presentation will impact the forensic community by increasing the understanding of the success that can be achieved in large scale missing persons identification, and the range of technical processes and complex considerations that must be taken into account when attempting such an undertaking.

After the breakup of the former Yugoslavia, and the resulting armed conflicts from the period 1992-1995, there were some 40,000 persons missing and unaccounted for, many as a result of severe human rights violations involving civilians. The International Commission on Missing Persons was established in 1996 to ensure the cooperation of governments in locating and identifying those who have disappeared during armed conflict or as a result of human rights violations. Since 2003, ICMP has been active in regions outside of the former Yugoslavia

and has played a substantial role in addressing the issue of persons missing from armed conflict and human rights violations in such countries as Chile, Colombia and Iraq, and in Disaster Victim Identification efforts such as the 2004 SE Asian tsunami, Hurricane Katrina, and the 2008 Typhoon Frank ferry disaster in the Philippines.

In the former Yugoslavia, the ICMP integrates the disciplines of forensic archaeology, forensic anthropology, pathology, high throughput DNA testing and informatics to achieve identifications on a massive, regional scale. Between 2001 and August 2009, the ICMP has made over 14,700 DNA matches between victim samples (recovered mainly from mass graves) and family members of the missing, through comparison with a regionally comprehensive database of over 86,400 DNA profiles from family members of missing persons from this region (representing over 28,700 missing persons). In addition to forensic assistance, a central role of the ICMP is to promote governmental and legal structures to responsibly deal with missing persons issues and to foster justice and civil society initiatives in support of victims' families.

One of the ICMP's biggest forensic challenges in terms of complexity and scale has related to the mass killings associated with the July, 1995 fall of the United Nations' "Safe Haven" in Srebrenica to the Army of Republika Srpska (VRS) forces. This event is the largest mass murder in Europe since World War II and has been designated as genocide by the International Criminal Tribunal of former Yugsolavia (ICTY). Approximately 8,100 men and boys were killed, either during flight from Srebrenica on foot across mountainous terrain, or when separated from a larger civilian contingent and systematically executed. The detainees were taken to various execution sites where the majority of victims died from gunshot wounds and were buried in large primary mass graves within or near the executions sites. In order to hide evidence of the killings and prevent discovery of the remains of the victims, over the ensuing several months the primary graves were crudely exhumed by heavy machinery and the victims reburied in multiple secondary mass graves scattered throughout remote countryside. This caused the remains of the victims to become commingled and fragmented, with the partial remains of many victims being desposited in two or more separate secondary graves. Repatriation of identified mortal remains to families thus also requires re-association of remains, as well as primary identification through a "DNA-led" process. As of August, 2009, the ICMP has provided technical assistance to Bosnian and international authorities in the assessment and excavation of some 250 Srebrenica-related grave sites and established DNA matches for almost 6200 individuals missing from the fall of Srebrenica.

This presentation will serve as an introduction to a following series of presentations that will detail the intregrated forensic sciences which the ICMP brings to bear on the massive and complex undertaking of identification of the missing from Srebrenica, and associated evidentiary analysis and documentation that contributes to an objective forensic and historic record of this event. In addition, this presentation will outline policy issues that arise in large scale forensic missing persons identification from armed conflicts. Also highlighted will be how such a forensic undertaking is dependent on interactions and issues concerning victim families, family organizations, larger society, and legal and governmental structures.

Missing Persons Identification, International Commission on Missing Persons, Srebrenica

H120 The Work of the ICMP in the Detection, Excavation, Documentation, and Analysis of Clandestine Graves Relating to the 1995 Fall of Srebrenica: A Review of Activities and Challenges Encountered

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After attending this presentation, attendees will understand how forensic activities conducted by the International Commission on Missing Persons (ICMP) have contributed to the detection, excavation, documentation, and analysis of clandestine graves relating to the Fall of Srebrenica 1995.

This presentation will impact the forensic community by increasing understanding of how best practices in forensic archaeology and evidentiary recording can be applied to a complex series of mass graves to result in historical documentation and enable the large scale re-association and identification of victims.

Investigations into alleged mass killings related to the Fall of Srebrenica in Eastern Bosnia began in earnest following the release of aerial imagery by the U.S. Government. Evidence collected through humanitarian and judicial inquiries confirmed that several mass executions had occurred in areas surrounding the town of Srebrenica which were at the time under the control of Bosnian Serb forces. Each execution was reported to have involved many hundreds of individuals with an overall estimate of ~8,000. The victims were subsequently buried in various primary mass graves located at or in the near vicinity of the execution sites. The following months saw Bosnian Serb forces return to the primary sites and, in an attempt to destroy any potential forensic evidence, the graves were crudely exhumed using heavy machinery and the victims reburied in multiple clandestine secondary graves in many different locations throughout Eastern and North Eastern Bosnia. This resulted in significant postmortem trauma demonstrated by high fragmentation, disarticulation, and commingling rates amongst the remains and between different graves and deposits.

For over a decade, graves have been located mainly by testimonies provided by survivors, eyewitnesses, and also perpetrators. Technical strategies employed by the International Criminal Tribunal for foramer Yugoslavia (ICTY), the ICMP, and other investigative teams to detect and confirm sites have included the use of invasive techniques such as probing and test trenching, as well as non-invasive techniques such as aerial and satellite imagery analysis. Ground teams have primarily relied on the visual identification of disturbance patterns during systematic ground searches, GIS analyses, and to a lesser degree, the use of selective geophysical techniques such as resistivity and ground penetrating radar.

The excavation of Srebrenica-related graves has enabled the implementation of a significantly standardized yet methodologically flexible set of procedures based on integrated principles of forensic archaeology, forensic anthropology, and crime scene processing. The overall goal of this approach is to maximize the collection and documentation of all human remains, forensic artifacts and site features for the purposes of establishing an objective historical record, supporting the criminal justice process, and contributing to the victim identification process.

Accurate and detailed documentation is critical to the excavation process and is implemented by the ICMP via the application of global positioning systems, 3D surveying, and a suite of tailored recovery and chain of custody forms, supplemented by digital imagery and extensive note taking. Substantial post-excavation data management and analysis, together with computer-generated mapping results not only aids in accountability of the excavation strategy itself but also in the determination of intra- and inter- grave characteristics and variability, and ultimately in event reconstruction. The ICMP has developed a comprehensive forensic database software application (fDMS) which includes a module to manage all data related to field activities.

Despite the significant progress made towards the excavation of all known Srebrenica-related graves over the years, there have arisen a number of political, operational, and technical obstacles and limitations – many of which persist to the present day. Some relate to difficulties inherent in working in an immediate post-conflict environment, with the necessary and desirable involvement of nascent governmental/institutional structures that provide the context of rule of law and applicable jurisdictional standards. Others are based purely on practical aspects of the infrastructure required to excavate and process several thousand sets of remains. It is important to note that in its forensic archaeological work, the role of the ICMP is to provide technical assistance to authorities under whose auspices the excavations are officially conducted.

For the past nine years, the ICMP has provided technical assistance to local and international authorities in the assessment and excavation of over 250 Srebrenica-related sites. This has resulted in the recovery of thousands of partial and complete sets of human remains and artifacts of forensic significance. This presentation will review the sources of background information, utility of detection methods, benefits to standardized yet flexible excavation and documentation strategies, and results of field activities as they pertain to the most complex grave assemblages relating to the Fall of Srebrenica.

Forensic Archaeology, Srebrenica, Mass Grave

H121 The Podrinje Identification Project: A Dedicated Mortuary Facility for the Missing From Srebrenica

Rifat Kešetović, MD, Laura Yazedjian, MSc, Dragana Vučetić, MSc, Emina Kurtalić, Zlatan Šabanović, Cheryl Katzmarzyk, MA, Adnan Rizvić, BSc, and Thomas Parsons, PhD, Forensic Sciences International Commission on Missing Persons, 45A Alipasina, Sarajevo, 71000, BOSNIA-HERZEGOVINA*

The goal of this presentation is to inform attendees of the limitations of traditional identification methods and the importance of a DNA-led system in a large-scale identification project.

This presentation will impact the forensic science community by providing information that will add to the understanding and capabilities of the forensic science field to deal with large scale identification projects.

Exhumations of victims from the Srebrenica massacre began in 1996 by multiple international teams with varying mandates and little coordination. In response, the International Commission on Missing Persons established the Podrinje Identification Project (PIP) in 1999 and built a facility for the systematic examination and identification of recovered mortal remains.

Until the first "blind" DNA match on November 16, 2001, the PIP had achieved only 222 identifications. Fifty-one were classical identifications based on excellent circumstantial evidence and the remaining 171 cases were presumptive identifications with subsequent confirmation through DNA testing by out-of-country laboratories. All of these identifications were virtually complete bodies recovered from primary graves.

Classical identifications were further attempted with the aid of photos of clothing and personal effects presented to the families of the missing. The "Book of Photos II" project collected 2,702 photos relating to 483 exhumed complete bodies from primary mass graves. Two hundred fifty copies of the book were distributed by specially trained teams across the country, and families were requested to view the book for possible recognition of items. In total, 2,767 family members responded, representing about 4,000 missing persons. Of 69 recognized cases, 44 (30%) were excluded based on negative antemortem-postmortem comparison and only 17 (less than 15%) were positively confirmed by DNA testing.

It became clear early in the identification process that classical methods of identification, including the use of dental records, medical records, and biological profiles resulting from the anthropological analysis of remains, were inadequate to determine the identity of the recovered mortal remains. There are several reasons that classical identification of the victims from the fall of Srebrenica is particularly problematic. These include the lack of antemortem information, the lack of associated clothing and personal effects, the similar demographic composition of missing persons, and the very large number of individuals. Moreover, the majority of mortal remains from Srebrenica are disarticulated and/or commingled due to various taphonomic factors, especially as the result of the creation of secondary mass graves in a deliberate attempt to hide evidence. Natural dispersion occurred in many cases when individuals were not buried, which included scattering by weather conditions, rivers, and animal scavenging. These circumstances have proven challenging not only for the identification process, but also in determination of a cause of death. In almost 30% of cases, a definitive cause of death cannot be determined due to missing body parts and/or post-mortem damage.

With the adoption of a large-scale DNA-led identification system, the PIP has identified more than 5,000 missing persons to date. Final identifications are DNA-based but include consideration of all available evidence such as place of last sighting/site of recovery, associated clothing and personal effects and antemortem/postmortem comparison of biological attributes.

The PIP comprises a range of professionals: a project manager, a team leader, case managers, a criminologist, a pathologist, and anthropologists. All of these individuals have specific roles in the identification process, and each case file (representing a missing person) follows a series of stages as different components of the case are completed. This presentation will illustrate the process of identification from receipt of a DNA match report to final identification.

Physical Anthropology Examination, Pathology, Srebrenica

H122 The Lukavac Re-Association Center: A Model for a Multidisciplinary Approach in the Examination of Commingled Remains

Cheryl Katzmarzyk, MA, Rifat Kešetović, MD, Kerry-Ann Martin, MSc, Edin Jasaragić, René Huel, BA, Jon Sterenberg, MSc, and Adnan Rizvić, BSc, International Commission on Missing Persons, 45A Alipasina, Sarajevo, 71000, BOSNIA-HERZEGOVINA; Mark Skinner, PhD; Simon Fraser University, Department of Archeology, Burnaby, BC, V5A 1S6, CANADA; and Thomas Parsons, PhD, Forensic Sciences International Commission on Missing Persons, 45A Alipasina, Sarajevo, 71000, BOSNIA-HERZEGOVINA*

The goal of this presentation is to increase the understanding of the challenges associated with the identification of fragmentary and commingled human remains.

This presentation will impact the forensic science community by increasing the understanding and capability of the forensic science community to deal with the complex challenge of identification in cases of large scale fragmentation and commingling of human remains.

The Srebrenica massacre involved the execution of ~8,100 people, mainly men and boys, who were deposited into primary mass graves, then relocated to numerous secondary graves. The exhumation and relocation resulted in disarticulation, fragmentation, and commingling of body parts within and between multiple graves. In 2005, the International Commission on Missing Persons (ICMP) established the Lukavac Reassociation Center (LKRC), under the auspices of the Podrinje Identification Project, to process the most complex grave assemblages related to the fall of Srebrenica.

To ensure adherence to an evidence-based approach, standard anthropological procedures were defined at the beginning of the effort. In almost every instance, anatomical continuity of the remains was a condition of acceptance of association of skeletal remains. These body parts were confirmed by age consistencies, evaluation of antimeres, and assessment of non-biological evidence supporting the association such as reference to in-situ documentation and consideration of remains found within clothing. Anthropological practices, such as fracture matching and articulation of synchondroses, were used to physically reassociate previously unassociated remains; however, its application was limited due to the high number of remains and the extensive commingling within and between graves. Pair matching of sided elements was used infrequently and articulations of flexion and extension joints were only considered with corroborating evidence. These conservative criteria resulted in a massive amount of isolated skeletal elements, but were necessary to avoid incorrect associations in such a large set of cases.

The ICMP DNA laboratory developed a custom STR multiplex with 7 loci (including sex determination) for cost-effective use in DNA-based re-associations. The LKRC has extensively sampled dissociated remains for this "mini-STR" testing, specifically for the purpose of reassociation. This approach is complemented by the use of Powerplex16© DNA testing for kinship matching to family reference samples to establish identity. DNA sampling guidelines were developed and implemented, and in general, all isolated long bones, relatively complete crania, and dental arcades were routinely tested. The composition of a body part, defined as one or more associated skeletal elements, dictated which optimum bone or tooth sample would be taken, as determined by extensive experience in DNA typing success rates.

This large-scale reassociation effort, based on DNA typing results, requires anthropological expertise to ensure the anatomical consistency of the remains. The development of individual biological profiles, using population-specific standards, allows for comprehensive antemortem/postmortem comparisons as an additional corroboration of identity. The detection and documentation of individualizing characteristics has also played a key role in the acceptance of the identification by families of the missing person.

A massive reassociation effort of highly commingled remains cannot be conducted without the integration of several sources of data. This is particularly important since the Srebrenica massacre is characterized by a high number of first-degree relatives reported missing and, in some cases, family groups representing several generations. At the ICMP, pathologists, anthropologists, and DNA scientists work in tandem to ensure the physical reassociations have a sound scientific basis. This multidisciplinary approach has also allowed the ICMP to address the challenges associated with the use of mini-STRs in bone:bone and bone:blood matching that includes evaluation of allelic dropouts and the possibility of adventitious matches among related victims.

Srebrenica, Reassociation, Integrated Forensic Methods

H123 The Use of Population-Specific Standards in Anthropological Examination and Their Incorporation Into a Multidisciplinary Mortuary Database

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The goal of this presentation is to present an overview of how population-specific standards are incorporated in anthropological examinations and the use of a custom mortuary database module for reassociation and case tracking.

This presentation will impact the forensic science community by illustrating the benefits of population-specific standards and a multi-disciplinary database.

As a result of the high instance of fragmentation and commingling, cases recovered from Srebrenica graves and received by the International Commission on Missing Persons (ICMP) mortuary facilities may include the mortal remains of more than one individual. Standard anthropological practices are applied to sort the skeletal assemblage and a preliminary biological profile is created for each bone, body part, or body. Upon the receipt of DNA match results, a final biological profile is developed for the DNA-identified complete or reassociated skeleton.

In general, the blind-matched Powerplex 16© DNA typing results establish a probable identity for a set of remains. The identity is subsequently corroborated by anthropological data based on the sex, age-at-death, estimated stature, and individualizing characteristics then compared with information provided by the family. The ability to support the DNA identification with anthropological data is directly dependent on the amount and type of skeletal remains presented for examination and the appropriateness of published anthropological standards. In response to the paucity of literature related to Balkan-specific anthropological standards, the ICMP has supported development of such standards to ensure greater accuracy of developed biological profiles.

It is important to note that the Srebrenica graves are characterized by numerous instances of first-degree relatives among the victims, and as such, there is a high incidence of childless brothers reported missing. Thus, independent, evidence-based parameters of age-at-death estimation are necessary to ensure the greatest level of confidence in determining a certain identity. Circumstantial evidence, such as clothing and personal effects is always considered as part of the overall case, but does not stand as a scientifically-based identifier. In many cases involving childless siblings, a final determination cannot be ascertained due to the lack of remains present for examination.

Tracking anthropological reassociations within commingled cases has proven to be challenging and, in response, the ICMP has developed a skeletal inventory and mortuary management database module, within the larger Forensic Data Management System (fDMS). This module allows any bone or associated body part to be accurately inventoried in its original case, and then informatically reassociated to one or more DNA-matched bones or body parts, following the physical reassociation of the skeletal remains. This informatic tool greatly simplifies what otherwise is a challenging and complex case tracking task. This is vital in the mortuary examination of Srebrenica remains as the "building" of individuals involves multiple reassociations, in some situations from twelve different commingled cases, each of which requires a clearly retrievable case history and chain of custody. Furthermore, this database

allows for the addition of appropriate analytic methods, with population-specific standards, as they become available.

Srebrenica, Anthropology, Mortuary Database

H124 High Throughput DNA Typing for Degraded Skeletal Remains and Victim Reference Samples in a Large Scale "DNA-Led" Missing Persons Identification and Re-Association Project: The ICMP Work on the Missing Recovered From Srebrenica Mass Graves

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After attending this presentation, attendees will gain an understanding of the protocols, workflow, and challenges involved in operating a quality-controlled, high throughput laboratory specialized for challenging skeletal remains samples.

This presentation will impact the forensic community by furthering knowledge on the technical details and laboratory management practices that allow DNA typing to be used cost- and time-efficiently on a large scale in missing persons identification casework.

The International Commission on Missing Persons (ICMP) DNA laboratories were brought online in late 2001 to assist authorities in a blind DNA lead identification process in the former Yugoslavia. Since its inception the laboratories have successfully profiled close to 30,000 bone samples and over 85,000 family reference samples resulting in DNA matches to over 15,000 unique individuals.

The laboratories utilize a modular approach in which analysts play a specific role in each part of the process as opposed to processing the sample from start to finish. This approach allows maximal throughput which can process up to 105 bone sample extractions per day. Typically bone samples tested are between 10-17 years old but can range up to 65-years-old in other projects. For most cases performed over the years, an extraction protocol involving overnight digestion in protease K, followed by a silica-based purification has been used. The results of multiple thousands of DNA tests have permitted a detailed evaluation of the relative preservation of DNA in various skeletal elements. The overall success rate on the >15,000 skeletal and tooth samples submitted from Srebrenica-related graves has been 83%.

Recently, the DNA laboratories have validated a new extraction protocol based on a complete demineralization of the bone sample, coupled with silica based clean up. This new protocol requires significantly less starting material, and requires fewer manipulations throughout the procedure, and provides higher DNA yields. The purification portion of this new protocol has the potential to be automated.

Typing of bone/tooth sample extracts is primarily done with the Promega PowerPlex© 16 STR multiplex. Amplification conditions for optimal success with degraded samples, as well as profile interpretation criteria will be discussed. Additionally, the ICMP has developed a series of short-amplicon multiplexes, one of which (6 loci plus amelogenin) has been widely applied for cost-effective DNA-based re-assocation of dissociated body parts from Srebrenica-related graves. Other multiplex kits and Y-chromosomal testing are also applied as needed to resolve family relationships.

The ICMP DNA Laboratory system is accredited to ISO-17025 and ILAC standards, and the role of key elements of the ICMP Quality Management System in assuring accuracy and chain of custody in such a large scale system will be discussed.

DNA Typing of Skeletal Remains, International Commission on Missing Persons, Mass Grave

H125 The ICMP Identification Coordination Center: A Sample Accessioning and Blind DNA Matching System for Missing Persons Identification on a Regional Scale

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After attending this presentation, attendees will have learned how a centralized DNA matching, sample, and information coordination facility can assist in making missing persons identifications on a large scale.

This presentation will impact the forensic community by increasing the knowledge base of how large scale missing persons identification programs may be structured efficiently.

The International Commission on Missing Persons (ICMP) conducts large scale missing persons identification using an integrated, multidisciplinary approach that is anchored by a "DNA-led" blind DNA matching system that compares DNA profiles from victims (usually skeletal remains from mass graves) to a database of DNA profiles from family members of the missing. At the heart of this system is the ICMP Identification Coordination Center (ICC), where victim and reference samples are received and accessioned, distributed to the DNA laboratory system, DNA profiles are received back from the laboratory, and DNA matching and reporting are performed. In the former Yugoslavia, as of August 2009, the ICC has collected over 87,000 family reference blood samples representing 28,783 missing persons, and maintains a database of 29,748 DNA profiles obtained from victim bone or tooth samples. DNA database comparisons have resulted in issuing 24,741 DNA match reports representing 14,741 different individuals. Many match reports involve reassociation of dissociated body parts which are common among remains recovered from the secondary mass graves associated with the 1995 Srebrenica mass killing event.

The ICC is responsible for the collection of blood samples from family members of the missing, and recording relevant information on both the missing person and the family members to permit establishing a DNA match. Antemortem information on the missing person is recorded, and informed consent is established to assure participants of genetic data protection and the use to which their sample will be made. Participants may indicate their willingness to have their sample used for the purposes of war crimes trials or other such criminalistic proceedings. Large scale family reference collection efforts by the ICC involve public information campaigns, and have been conducted throughout the former Yugoslavia and globally.

Victim samples, usually bone or teeth, are obtained by the ICC either from ICMP field or mortuary teams, or by other contributors. Both victim and reference samples are accessioned at the ICC in strict accordance with chain of custody, and are immediately assigned bar codes which remain their sole identifier throughout the DNA testing procedure. A complete lack of information regarding sample origin or presumption of identity during DNA testing contributes to the objectivity of the process.

Once DNA profiles are obtained from the DNA laboratory, they are entered into a central database and candidate matches to any existing profiles are determined using internally developed DNA Matching software. The DNA Matching module conducts pairwise comparisons,

outputting results based on direct match, half allele share (maternity or paternity indices), or sibling indices. Once candidate matches are discovered, final kinship statistics involving all family reference samples are generated using the commercial software DNAView. DNA match reports are issued by ICC when the final surety of identification exceeds 99.95%, with prior probabilities ascribed based on the number of individuals missing in a particular region or event. Statistical comparison reports are also generated to report possible DNA associations of lower surety, which can be used in combination with over evidence under well defined policy.

All data storage and analysis functions of the ICC are managed by an internally developed forensic data management system (fDMS). In this system, missing persons information, family reference information, the DNA Matching Module, and DNA report generation and tracking functions are efficiently integrated to result in a fast, flexible, and user-friendly system.

ICMP, Missing Persons Identification, DNA Matching

H126 An Innovative Software Solution for Large Scale Forensic Identification Efforts

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After attending this presentation, attendees will learn how integrated informatics systems can be developed and used to greatly facilitate complex forensic identification efforts.

This presentation will impact the forensic science community by increasing the understanding and capacity of the forensic science community to deal with large scale identification projects.

More than 40,000 persons went missing as a result of the conflicts in former Yugoslavia from 1992-1995. The International Commission on Missing Persons (ICMP) was established in 1996 with a primary goal to assist local governments to resolve the matter of missing persons. As part of its technical assistance, the ICMP applies an integrated approach involving advanced forensic disciplines, such as forensic archeology, forensic anthropology, forensic pathology, and DNA matching. This generates and utilizes vast amounts of data, which much be archived, tracked, accessed, and reported. Due to the limited availability of suitable software solutions, ICMP has committed itself to development of a software solution to support all its forensic activities.

A group of software engineers started with development of an integrated software solution now known as Forensic Data Management System (fDMS) in the beginning of 2006. As a result of interaction and cooperation with ICMP and other forensic experts in their respective fields of expertise, the team analyzed, designed, developed, tested, and deployed a set of applications for support of all forensic activities. The fDMS enables DNA-led identification process in the large scale.

Each application can be used as stand-alone individually or as a part of integrated system. The fDMS supports entering, storing, and processing data about missing persons, relatives, field activities, and forensic archaeology, anthropological examination and skeletal inventory process, chain of custody, DNA analysis, DNA matching, and identification. This presentation will present an overview of both the development and capabilities of the fDMS system and illustrate how the integrated database and software package facilitates the effective conduct of forensic sciences in a large scale identification system.

Data Management, Forensics, DNA Identification

H127 Mapping Forensic Evidence Onto the Stor of Srebrenica: Augmenting the Historical Record Through Analysis of Archaeology, Anthropology, and DNA

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After attending this presentation, attendees will understand how forensic activities, conducted by the International Commission on Missing Persons (ICMP) since 2001, are integrated to augment the historical record relating to war crimes and human rights violations resulting from the fall of Srebrenica

This presentation will impact the forensic community by serving as an example of multi-disciplinary amalgamation of data to objectively reconstruct a large-scale genocidal event within a post-conflict setting.

By July of 1995, over 25,000 Bosnian Muslim refugees had overwhelmed the United Nations designated “Safe Haven” in Srebrenica, Bosnia and Herzegovina (BiH). On July 11, the United Nations controlled zone fell to the Army of Republika Srpska (VRS) forces, resulting in the largest mass murder in Europe since World War II. According to many witnesses, investigative reports and accumulated lines of evidence – and as detailed in multiple war crimes/crimes against humanity indictments – approximately 8,100 men and boys were killed, either during flight from Srebrenica on foot across mountainous terrain or when separated from a larger civilian contingent and systematically executed. The detainees were taken to various execution sites and killed, mainly by gunshot. The victims were buried in large primary mass graves within or near the executions sites. In order to hide evidence of the atrocities and prevent discovery of the remains of the victims, the primary graves were crudely exhumed, over several months, by heavy machinery and the victims deposited in multiple secondary mass graves scattered throughout remote countryside. This caused the remains of the victims to become fragmented and commingled, with the partial remains of many victims being deposited in two or more separate secondary graves. These actions significantly confounded the detection and recovery effort and have necessitated an integrative approach in the detection of mass grave locations and the determination of linkages between graves.

The ICMP has provided technical assistance to the BiH and international authorities in the assessment and excavation of some 250 Srebrenica-related grave sites since 2001. This has resulted in the recovery of thousands of partial and complete sets of human remains and artifacts of forensic significance. Furthermore, the ICMP has provided technical assistance in the application of a DNA-led process towards identification that integrates pathology, anthropology, DNA, and circumstantial evidence (such as personal effects). As of August 2009, the ICMP has revealed the identity of 6,186 persons missing from the fall of Srebrenica, by analyzing nuclear DNA profiles extracted from bone samples of exhumed mortal remains and matching them to the DNA profiles obtained from blood samples provided by relatives of the missing.

The complex nature of the Srebrenica graves has defined all aspects of the search, recovery, and identification efforts. Since the remains of single individuals may be scattered amongst numerous locations, there are profound consequences for reassociation of body parts, with concurrent repercussions regarding legal case closure, family notification and acceptance of the identification, repatriation, and dignified burial. Thus, analysis of evidentiary linkage between graves is important not only in establishing a historical record, but in prioritization of grave excavation, so that series of interconnected graves are completed together to enable closure of individual cases.

This presentation will outline the patterns of evidentiary connections within and between Srebrenica-associated graves that have been documented as a result of the ICMP's work, and summarize how this evidence contributes to and fits with the larger reconstruction of the events associated with the fall of Srebrenica that comes from a variety of sources. More detailed analysis of selected grave assemblages will be highlighted as examples with focus on DNA-matched body parts recovered from specific deposits within graves to assist in reconstructing the sequence of events. These links have served in criminal justice proceedings as supplementary evidence supporting the scale and organization of the executions and the subsequent attempts to conceal the evidence.

Srebrenica, Event Reconstruction, Integration of Forensic Sciences

H128 Identifying the Missing From Srebrenica: Family Contact and the Final Identification Process

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The goal of this presentation is to inform attendees of the importance of communicating with family members in complex identification projects relating to armed conflict/human rights abuses.

This presentation will impact the forensic science community by emphasizing the role of family members in the identification process.

The Podrinje Identification Project (PIP) was established by the International Commission on Missing Persons (ICMP) as a centralized effort for the identification of victims of the mass killings associated with the fall of the United Nations "Safe Haven" in Srebrenica. From the beginning of the project, the families of the missing were involved in the identification process. The participation of families is vital at the outset, in order to obtain information about the missing person and obtain genetic samples from relatives to permit DNA matching. In these activities, the PIP staff members work closely with teams from the ICMP Identification Coordination Division to ensure that family members are properly informed of the identification process. To this end, the ICMP conducts public information campaigns, sponsors and meets with numerous family organizations to explain the identification process and informs them of the particular challenges associated with identifying the victims from the fall of Srebrenica. On an individual level, the PIP case managers communicate daily with family members providing information on the progress of specific cases.

Most importantly, the case managers interact with families during the process by which identifications are finalized and the identified person is repatriated for burial. This is a stressful process for families. Confirmation of their loved one's death represents terrible news, though the recovery of their loved one's remains has been anxiously awaited. To these surviving family members, the case manager is a combination of a social worker and grief counselor.

The first contact with family members informing them of identification does not occur immediately when a DNA report is received, as a case file must be prepared. Initial contact, and any subsequent contacts, can take place either at the PIP office or at the home of the family member. There are several circumstances, related to the nature of the Srebrencia event, which are particularly difficult to present to family member, including when fragmentary and commingled remains are recovered and may result in a final case that consists of incomplete remains or a small body part. In situations where further graves remain to be exhumed or examined, it is necessary to explain that there is the possibility of locating additional body parts. Alternatively, families must be informed when no further remains are expected to be recovered, such as in situations of surface recoveries or a completed series of graves despite that the final case consists of an incomplete skeleton.

The final disposition of the identified person is exclusively the family's decision. The vast majority choose to bury their loved ones at the annual commemoration at the Potočari Memorial, which takes place in July each year. However, a few families choose to bury their relatives in family cemeteries.

A case study of a family with multiple missing first-degree relatives will be presented.

Srebrenica, family contact, case managers

H129 The Social Effects of Recognizing Srebrenica's Missing

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After attending this presentation, attendees will gain insight into how the successful identification and reburial of victims of the Srebrenica genocide have affected the lives of surviving families and influenced the political discourse in postwar Bosnia and Herzegovina.

This presentation will impact the forensic science community by demonstrating the interface between science and society through the example of the DNA-based identification efforts developed to counter the devastating effects of the July 1995 genocide at the United Nations "Safe Haven" of Srebrenica.

For the Srebrenica victims whose remains have been unearthed, examined, sampled, and stored by forensic experts over the past fourteen years, identification has been the primary goal—that is, re-attaching individual identity to a set of previously unrecognizable remains. Yet the biotechnological innovation that has successfully returned names to remains and coffins to grieving families involves layers of recognition, from the instant of the "blind" DNA match to the moment a relative spies a still familiar piece of clothing. Identifying the missing thus encompasses both scientific and social recognition.

Nowhere is this more apparent than at the culmination of the identification process: the annual commemoration ceremony and mass burial held at the Srebrenica-Potocari Memorial Center on July 11 of each year. Once complete, the results of identification, namely individual coffins placed in individual plots, enable families and friends to care for the souls of their loved ones, knowing at long last where their bones rest. At the same time, the effects of identification, of recovery and reburial, radiate beyond the most intimately connected, entering into the political discourse of postwar Bosnia as recognition of social identity is demanded in the prayers and political speeches that preface the mass burials. Indeed, individual identity at times becomes subsumed in the ceremony's rhetoric of collective victimhood and, by extension, collective responsibility. In response, Bosnian Serbs in the region counter the scientifically-backed evidence of the scale and intensity of the Srebrenica genocide by tabulating their own losses and erecting their own memorials, chief among them the commemorative site in the village of Kravica at which Bosnian Serbs gather on the very next day, July 12.

Drawing on ethnographic research conducted in eastern Bosnia since 2003, this paper examines the sociopolitical significance of the DNA-based identification process developed to recognize the Srebrenica missing, juxtaposing the expectations and responses of surviving families with those of Bosnian political and religious leaders, both Bosniak (Bosnian Muslim) and Bosnian Serb. Three arguments emerge: (1) for the surviving relatives of the missing, the identification process succeeds in bridging painful gaps of knowledge and in reconstituting families (if only metaphorically) torn asunder by mass violence through sanctified, witness burial; (2) tempering conventional assumptions that identification brings about social repair, an analysis of the multivalent meanings of the Srebrenica-Potocari Memorial Center and its rapidly

expanding cemetery illustrates that political manipulation of the identification efforts has often exacerbated rather than assuaged tensions in postwar Bosnia; and, (3) the intervention of forensic science into the missing person issue, manifest in the capacity of the DNA-based identification system to identify Srebrenica's missing, has raised the stakes of facticity, forcing both Bosniaks and Bosnian Serbs to document their losses in increasingly quantifiable terms. Thus when indicted war criminal Radovan Karadzic attempts to discredit the numbers and types of victims of Srebrenica July 1995 he must do so—however problematically—through the language of DNA. These three outcomes of the identification process remind us that the scientific and the social cannot be separated out from one another, just as individual identity cannot exist apart from social identity. In these ways, postwar Bosnia and specifically the case of Srebrenica's missing reveal the powerful role genetic science has come to play in grappling with the devastating effects of mass violence.

DNA Identification, Social Repair, Commemoration

H130 Lessons and Challenges From Srebrenica: A Summary and Future Perspectives

Thomas Parsons, PhD, Andreas Kleiser LLM, Adnan Rizvić BSc, and Kathryne Bomberger MA, Forensic Sciences International Commission on Missing Persons, 45A Alipasina, Sarajevo, 71000, BOSNIA-HERZEGOVINA*

After attending this presentation, attendees will gain information and perspectives relating to the large and complex undertaking of the ICMP in the application of integrated forensic sciences to the identification of the missing from the 1995 fall of Srebrenica.

This presentation will impact the forensic community by increasing an understanding of the success that can be achieved in large scale missing persons identification, and the range of technical processes and considerations that should be taken into account when attempting such an undertaking.

This presentation is intended as a conclusion to a series of presentations in a multidisciplinary symposium highlighting the integrated forensic sciences that the International Commission on Missing Persons (ICMP) has employed in a massive and complex effort to identify and repatriate the victims of the 1995 mass killing associated with the fall of Srebrenica, Bosnia and Herzegovina. Discussion will focus on some of the central and ongoing challenges of the undertaking, and attempt to draw lessons that may be more widely applicable in other contexts.

The nature of the Srebrencia "event"—the mass killing of ~8,100 men and boys that occurred in July 1995 as result of the fall of the United Nations "Safe Haven" in Srebrenica to the Army of Republika Srpska, and the subsequent distribution of the mortal remains throughout a large series of secondary mass graves—poses a formidible challenge in an attempt to scientifically identify the victims. Elements adding to the challenge include: the very large number of victims, of a relatively uniform demographic; a systematic lack of antemortem medical or dental records; the relative lack of distinctive clothing and personal effects among the refugee victims; the distribution of fragmented and commingled remains in either secondary graves and surface environments; and the clandestine nature of the graves that complicates full recovery.

It is through the novel use of DNA typing on a very large scale, and blind DNA matching in a "DNA-led" identification process, that the ICMP has been able to, as of August 2009, establish a named DNA match on over 6,100 individuals missing from the Srebrenica event. More than 4200 of these cases have been closed, with repatriation to family members. The discrepancy between these numbers is again due to the nature of the event, with many cases awaiting recovery of additional portions of the mortal remains prior to case closure. This underscores some of the policy challenges that will be discussed in this presentation, and that become more acute as the number of remaining known un-excavated Srebrenica graves dwindles.

While Srebrenica is in many ways unique, each of the component challenges involved are present to one extent or another in almost any large scale forensic identification undertaking. This presentation will discuss how the approach used to achieve large scale success in the case of Srebrenica is applicable elsewhere, and the variables that condition such considerations. Other policy issues that are of general relevance relate to personal data protection in various contexts, and the presentation of forensic identification casework in the support of criminal justice proceedings.

Srebrenica, ICMP, Missing Persons Identification

I1 Intimate Partner Violence: Tracking the Development of a Killer Through Love Letters

Helen M. Farrell, MD, The University Hospital of Cincinnati, 260 Stetson Street, 3200, Cincinnati, Ohio 45219; and Scott Bresler, PhD, Department of Psychiatry, UC Medical Center, Box 670559, 260 Stetson, Cincinnati, OH 45267-0559*

By attending this presentation, attendees will be provided with a comprehensive review of scientific research on Intimate Partner Violence which will educate them on its importance as a major world health organization concern. Attendees will also be provided with a description of a well-known female athlete in Ohio, who married her high school sweetheart, and was later murdered while sleeping at home. Details of this case, including the arrest and conviction of her husband, will be provided; a forensic analysis of love letters from this murderer to his wife will be given. Audience members will have the rare opportunity to view these letters through visual aids. This in-depth analysis, which follows a teenager into young adulthood, uniquely portrays the development of an abuser; it correlates the stages of development of an intimate-partner-violence relationship through literature review and comparison with the murderer's love letters to his wife. A video interview given by the parents of the victim will be shown, so that audience members better can understand the development of this murderer, identify warning signs of intimate partner violence relationships, and review risk assessment literature, which forensic specialists may utilize in practice to identify perpetrators and prevent victimization of individuals in abusive relationships.

This presentation will impact the forensic science community by providing comprehensive scientific research about Intimate Partner Violence and educating specialists about risk assessment tools and their clinical and forensic use. The forensic community will have the unique opportunity to view portions of hundreds of love letters that clearly outline the development of an abuser and murderer.

Intimate partner violence (IPV) is a major, preventable public health crisis. "Battering" is a term reserved for physical violence experienced in intimate relationships. The battering often begins during the dating relationship and continues into marriage, sometimes leading to murder.

In this presentation, the stages of development of IPV have been correlated with the analytic review of love letters written from a murderer to his wife throughout their courtship. This relationship ended dramatically with the murder of the abuser's pregnant wife. Forensic specialists can play a pivotal role in the prevention of complications from IPV by using objective psychological screening tools and semi-structured interviews to identify IPV in suspected abusive perpetrators.

Violence, Murder, Risk Assessment, Intimate Relationship

I2 Women Victims of Violent Partners The Italian Situation Between Culture and Psychopathology

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By attending this presentation, attendees will understand social, cultural, and psychopathological factors that could explain the phenomenon of women as victims of inter-family violence, physical and sexual, in Italy.

This presentation will impact the forensic science community by presenting a hypothesis of insanity in violent men that have killed their female partners. This is especially important now that the Italian judiciary has ruled that personality disorders can be considered in trials involving such crimes.

For some time, criminological investigations have noted an elevated number of women who have been victims of violence perpetrated by their partners.

In Italy, a complete forensic psychiatric examination is conducted only in cases of homicide. From the cases observed, it is clear that a psychopathological perspective alone cannot explain the multiplicity of factors involved in violent behaviors toward women.

Two studies conducted in Italy – the first involving all inter-family homicides (EURES, 2003-2007) and the second involving family abuse (ISTAT, 2007) – have shed light on how vast (though hidden) this phenomenon has actually become. The ISTAT conducted an anonymous questionnaire on a nationwide, representative sample of women which demonstrated that 31.9% of women had been subjected to violence, perpetrated by their partner or ex-partner, during the course of their life. Despite this fact, the number of actual formal police reports was very low (3-8%). This figure may be explained by considering the fact that these episodes were considered "true offenses" in only 18.2% of cases.

By reviewing Italian homicide cases from recent years, the studies conducted by EURES show that there has been an increase in inter-family homicide cases from 20% in 2002 to 31% in 2006. In 2006, more than 50% of these homicides were committed by partners or ex-partners; most of the perpetrators (84%) were male. Furthermore, in only a small percentage of such homicides (11%) were the culprit reported to have a clear mental disorder.

Therefore, it is almost certain that social and cultural aspects interact with psychopathological aspects of the criminal. It has been rare to find serious mental disorders in individuals allegedly perpetrating these homicides or attempted homicides; instead, it is common to find that many of these individuals have narcissistic traits or characteristics. However, it was rare for these individuals to meet criteria for Narcissistic Personality Disorder.

The research has often seen male adults with little cognitive and emotional ability to deal maturely with a relationship. In these immature relationships, partners tend to react to real or perceived "loss" in a violent manner. It is hypothesized that this increased narcissism can affect men who lack a "cultural anchor," which might otherwise protect them. For example, the title "head of the family" guarantees a man a precise and relatively prestigious position within the couple or family. It is a model, which though unacceptable, is able to provide a sense to their

male being, either intellectual or characterological. It is a model which though abandoned has not been substituted with something equally "strong" and able to support psychological fragile personality.

To further this view, women declare their rights - as if trying to distance themselves physically or psychologically from their partner. This declaration; however, is purely verbal; many young male adults appear "frightened" of a (negated) fragility, though being only structural, regarding their role in identity, and the only response they then find themselves able to enact is that of aggression.

The court expert will have to bear all this in consideration when called upon to express the ability to intend and want regarding the accused. Above all now that the Italian judicial order has accepted the hypothesis that even personality disorders could be considered relevant when taking into account proposed insanity.

Inter-Family Violence, Social Pressure, Psychopathological Factors

I3 The Psychopathic Mother: Identification, Characteristics, Prognosis, and...Treatment?

Vivian Shnaidman, MD, Jersey Forensic Consulting, LLC, 181 Cherry Valley Road, Princeton, NJ 08540; and Karen B. Rosenbaum, MD*, Einstein College of Medicine, Bronx Lebanon Hospital Center, Department of Psychiatry, 1276 Fulton Street, 4th Floor, Bronx, NY 10456*

By attending this presentation, attendees will understand that psychopathy is not a condition limited to men and will learn about special characteristics of psychopathic women (with an emphasis on mothers), who are in the position to do the most harm to their most vulnerable victims. The topics of family reunification versus termination of parental rights will be addressed, as will the controversial topic of treatment of psychopathy.

This presentation will impact the forensic science community by: (1) acknowledging that psychopathic women exist outside of fiction; and, 2) describing characteristics that the forensic evaluator can identify in order to help determine which abusive mothers can be conventionally treated, and which mothers are psychopaths (whose victims include their own children).

Abusive mothers fall into one of four groups. These groups are: the substance abusers, the mentally ill and personality-disordered, the mentally retarded, and the psychopathic. Psychopathy in women has been overlooked by researchers for many years, although the new Hare PCL-R II now has been normed for use in women. However, social biases tend to work against identifying women as psychopaths. Sadly, it is these rare psychopathic women who tend to be misunderstood and excused by the criminal justice system.

Current research will be covered, which focuses on the psychopathic mother – how to identify her, what interventions are commonly utilized (if any), and what interventions should be utilized in dealing with families in which abuse is the result of psychopathy.

To date, there has been little research on this question. Existing relevant literature will be reviewed. Data will be presented on a cohort of 100 women who have been documented to be abusive to their children, whose children have been removed by the court, and who have been referred for psychiatric/evaluations and disposition recommendations.

The results of the data will be discussed. If time permits, specific cases will be discussed and the audience will be asked to categorize the mothers using the four-pronged system. In addition, some individuals who have received extensive media coverage will be discussed; the audience will be asked to help categorize these individuals using the aforementioned four-pronged system.

The data will show that although psychopathic mothers are rare, they are some of the most dangerous parents in our society and that properly identifying them is critical.

Psychopathic Mothers, Abusive Mothers, Psychopathy

I4 The "Schizopath" Revisited: The Forensic Implications of the Co-Occurrence of Schizophrenia and Antisocial Personality Disorder

David S. Rad, MD, University of Southern California Institute of Psychiatry, Law, and Behavioral Science, PO Box 86125, Los Angeles, CA 90086-0125*

By attending this presentation, attendees will have a better understanding of the special issues involved in the psychiatric-legal evaluations and treatment of individuals with both schizophrenia and antisocial personality disorder.

This presentation will impact the forensic science community by promoting more accurate psychiatric-legal evaluations of individuals with both schizophrenia and antisocial personality disorder. It will also promote more appropriate treatment of such individuals.

The occurrence of antisocial behaviors in individuals with schizophrenia has been examined by multiple investigators. While there is heterogeneity in the etiology of such behaviors, with some stemming from psychotic symptoms and others from the effects of downward social drift, a subset of such individuals meets the additional diagnostic criteria for antisocial personality disorder (APD), independent of the diagnosis of schizophrenia. This co-occurrence previously has been described by such names as *heboïdophrenia*, *pseudopsychopathic schizophrenia*, *schizoid psychopath* and *schizopath*. Yet, such notions never gained wide acceptance. However, recent large-scale epidemiological studies (which suggest a high co-occurrence of schizophrenia and APD) as well as advances in neuroscience have led to researchers' taking a closer look at the nature of this co-morbidity. While the data are still preliminary (and in many instances anecdotal), there is some indication that the co-occurrence of these disorders results in a condition that is more complex than the mere combination of symptoms of each illness. Consequently, this presents unique challenges in forensic settings and requires special consideration. This presentation will describe how this co-occurrence presents clinically and its importance in psychiatric-legal evaluations and treatment.

Individuals with schizophrenia without APD usually engage in antisocial behavior in the context of psychotic symptoms; however, those with both schizophrenia and APD tend to present with more enduring antisocial behaviors independent of psychotic symptoms. While there are no evident differences between the two populations in terms of the onset and severity of psychotic symptoms, there is growing evidence of more consistent and frequent criminal behavior, violence, homelessness, substance-related disorders, and recidivism throughout the lives of individuals with both schizophrenia and APD. In addition, there is growing evidence of higher premorbid levels of functioning, lower levels of anxiety, and less overall cognitive dysfunction among individuals with both schizophrenia and APD. Neuropsychiatric studies correlate with these observations and indicate distinct differences between individuals with schizophrenia alone and those diagnosed with both schizophrenia and APD. Those with both diagnoses appear to have less severe general brain pathology, better executive functioning, and more impulsivity.

When translating these findings to the forensic setting, such cases present challenges in both the psychiatric-legal and clinical arenas. Special care should be employed in evaluating such individuals for legal

purposes. Given their higher cognitive functioning, lower levels of anxiety, familiarity with psychotic experiences, and antisocial tendencies, they may malinger more convincingly, thereby allowing themselves to avoid or mitigate the legal consequences of their antisocial actions. Similarly, such individuals may be more successful in minimizing active symptoms of psychosis, which may result in premature release from court-mandated hospitalization or prison. In terms of assessing for dangerousness, the forensic practitioner should be adept at distinguishing between violent behaviors stemming from typical symptoms of schizophrenia and violence associated with co-morbid APD. The individuals exhibiting the former behaviors may be more amenable to pharmacological and psychological treatment than individuals in the latter group. Therefore, it may be easier to lower the risk of future dangerous behavior in these individuals as compared to individuals with co-morbid APD. The same considerations extend to clinical settings, where the management of violent and other antisocial behavior is a common challenge. It is of paramount importance for the forensic practitioner to be aware of this co-morbid presentation and its clinical features, so that s/he may render more accurate opinions and recommendations regarding mental health/legal issues and clinical treatment.

Schizophrenia, Antisocial Personality Disorder, Schizopath

I5 Old Men Gone Bad: Frontotemporal Dementia and Its Potential Criminal Consequences

Michael Yoo, MD, MPH, University of Southern California Institute of Psychiatry, Law, and Behavioral Science, 2020 Zonal Avenue, IRD #714, Los Angeles, CA 90033*

By attending this presentation, attendees: (1) will receive an overview of frontotemporal dementia (FTD); (2) will examine the pathophysiology of acquired sociopathy; and, (3) will explore its significance related to criminal responsibility.

This presentation will impact the forensic science community by increasing the awareness of frontotemporal dementia, demonstrating how biological processes causally may impact behavior, and exploring how advancing neuroscience research may impact the criminal justice system, particularly with regard to criminal responsibility.

FTD is an insidious and progressive neurodegenerative disorder characterized by the development of neuropsychiatric symptoms which are strikingly different from premorbid behaviors. It is the second most common cause of non-vascular dementia, (only Alzheimer's Dementia is more common). In contrast to Alzheimer's, which produces a decline in memory and/or other cognitive deficits, behavioral symptoms are more prominent in FTD. FTD results from frontotemporal lobar degeneration, which includes both gross atrophy and histopathological changes in the frontal lobes and/or anterior temporal lobe regions.

The prefrontal cortex (PFC), the anterior region of the frontal lobes, is responsible for higher level cognitive processes that include the ability to strategically organize information, plan, and make judgments (i.e., "executive functioning"). The PFC mediates moral reasoning and socially-appropriate behaviors. It does this in part by functioning to promote and individual's delaying immediate gratification in order to gain a larger reward at a later time. The PFC is also critical in regulating emotions and processing regret. Damage to this structure can produce impulsive and disinhibited behavior, can decrease capacity for empathy or remorse, and can cause deterioration in social behaviors. The anterior temporal lobes are part of the limbic cortex. This region is important in processing emotions; lesions here may cause alterations in mood, aggression, and even violent behavior. In patients with FTD, antisocial behaviors are frequently seen. Stealing, reckless driving, physical assault, unethical job conduct, indecent exposure, inappropriate or offensive speech, and public urination/masturbation have been reported.

A diagnosis of FTD is made by clinical history, neuropsychological testing, and neuroimaging, which may include magnetic resonance imaging (MRI), single photon emission computerized tomography (SPECT), and/or positron emission tomography (PET). Diagnosis is often difficult and frequently delayed by as much as three to four years, because symptoms may be confused with other neurological and psychiatric disorders.

The legal implications of FTD are numerous. Sociopathic behavior seen in FTD will make contact with the legal system much more likely. In cases of older adult defendants with no history of sociopathic behavior and a reliable ancillary history suggesting a recent dramatic personality change preceding the instant offense, FTD can be considered as a defense and an expert can be consulted. Neuropsychological tests and neuroimaging can be ordered if there is a strong clinical suspicion for FTD.

If FTD has been diagnosed, what would be the defendant's level of legal responsibility? It is uncertain if a defendant with FTD would meet a cognitive insanity standard (i.e., one that assesses for knowledge of wrongfulness). Because more global cognitive processes are largely spared in the early stages of FTD, an individual with FTD often can understand still the legal and moral wrongfulness of his actions. S/he simply cannot keep from acting on his/her impulses. Therefore, it is possible that a defendant with FTD could meet the "impaired volition" prong of the American Law Institute (ALI) standard for insanity. Diminished capacity could also be a relevant partial defense for defendants with FTD and the finding of this mental state could lead to more appropriate sentencing and/or treatment planning.

As neuroscience research progresses and begins to provide more compelling evidence for biological explanations for behavior, should those better explanations diminish criminal responsibility? This raises some controversial issues. For example, there is evidence to suggest a higher prevalence of structural PFC abnormalities in death row inmates. What if new evidence emerges that individuals with certain genetic constitutions can acquire structural PFC abnormalities if involuntarily exposed to neglect or abuse in developmentally critical periods? Would this also diminish responsibility in the same manner as would FTD? Where does biological determinism begin and free will and accountability end?

Antisocial, Dementia, Violence

I6 Prevalence of Asphyxial Games in Sadomasochists and Nonsadomasochists

Mark Benecke, PhD, International Forensic Researching & Consulting, Postfach 250411, Cologne, NRW 50520, GERMANY; and Ewelin C. Wawrzyniak, MSc*, County Hospital for the Mentally Ill, Clemens-August-Str. 49, Dorsten, 46282, GERMANY*

By attending this presentation, attendees will understand that asphyxial games are often practiced among consensual sadomasochists but also among non-sadomasochists (at a rate of 6.5%). Nevertheless, one must take care to distinguish between consensually acting and non-consensually acting sadomasochists; a current case example (involving first degree murder) will demonstrate why.

This presentation will impact the forensic science community by showing that asphyxial games are performed relatively often in some communities but are only a danger if performed alone or in a non-consensual manner.

In a large questionnaire study (n = 1627, age 13—80 years, mean age 31.2 years), correlations between different styles of sadomasochistic behavior and personality traits consistent with experience-seeking were

checked (among other items). Experiences the respondents had with asphyxial sexual games were also checked, which include using hands or ropes to compress the neck, wrapping plastic bags around the head, obstructing the mouth and nose, etc. Seventy percent of the participants were sadomasochists, 30% were non-sadomasochists. The participants were recruited in German-speaking parts of Europe (Germany, Austria, and parts of Switzerland). Sadomasochists were recruited through Internet-based, specialized newsgroups and chat rooms related to sadomasochism; non-sadomasochists were contacted through general interest groups on the Internet.

More than half of the female sadomasochists reported experiences with asphyxial play (54%), whereas only 4.8% of non-sadomasochistic females had such experiences. Forty percent of male sadomasochasists reported experiences with asphyxial games compared with only 8.3% of the male non-sadomasochists.

There was a significant correlation between experience-seeking and sadomasochistic behavior. This correlation was strongest in "switchers" (persons switching between active and passive roles), followed by masochists (switchers: OR 6.8; masochists: OR 6.6). Sadists had lower scores (OR 6.5); compared to non-sadomasochists (OR 6.1); these were; however, not significant (ANOVA).

Persons with higher scores in experience-seeking also had a significantly higher number of sexual partners ($p > 0.01$) and of diversity of sexual practices, such as needle play, asphyxial play, bondage, and different types of penetration ($p > 0.01$).

The levels of neuroticism were lowest in switchers (1.8) and sadists (1.5; significant), and highest in masochists (2.0) and non-sadomasochists (2.0). This suggests that sadists are in significantly better control of their emotions than all other groups.

These results are relevant because, to our knowledge, there were no accidents ever reported during such games (except if performed alone or non-consensually). One must therefore distinguish between consensually acting and non-consensually acting sadomasochists. A current first-degree murder case (offender: German scientist; victim: sadomasochistic photo model; final verdict pending) will illustrate this concept.

Asphyxia, Strangulation, Sadomasochism

I7 The Use of Actuarial Risk Assessments Instruments in Sex Offenders: Research and Practice

Amy Phenix, PhD, PO Box 325, Cambria, CA 93428; Doug Epperson, PhD*, PO Box 642630, Pullman, WA 99164-2630; Mohan Nair, MD*, 133 North Promenade, Suite 108, Long Beach, CA 90802; and Fabian M. Saleh, MD*, Law and Psychiatry Service, Massachusetts General Hospital, Boston, MA*

By attending this presentation, attendees will gain an understanding of the principles of instruments used in sex offender risk assessment and the criticisms/limitations thereof. Future directions, alternatives, and evolving science will be reviewed.

This presentation will impact the forensic science community by attempting to provide a balanced review of actuarial instruments and how they may have relevance to mental health professionals, law enforcement personnel, and members of the legal community who work with sex offenders.

Most first-world countries have instituted programs aimed at the identification and preventive detention of individuals perceived to be at high risk for violent sexual recidivism. Research in this area has shown that predictions based on actuarial instruments are consistently superior to predictions based on clinical interviews. A number of actuarial tools have been developed over the last decade for the purpose of predicting sexual and non-sexual violence. While there are limitations on these instruments, predictive accuracy has improved with their continued use. In the field of sex offender risk assessment, research continues to develop instruments that are more comprehensive and can be used in more different types of populations. The Static 99 is "one of the best single predictors that our science has to offer in the area of sex offender risk assessment (Vincent, 2008)."

Amy Phenix, PhD has served as Consulting Psychologist for the California Department of Mental Health Sexual Offender Commitment Program from its inception in 1996 to 2008. She has been responsible for state-wide training of all clinical staff who perform Sexually Violent Predator (SVP) Evaluations in California (the training program is largest program of its kind in the U.S.). An overview of the actuarial tools currently in use will be presented, including the Static 99, the Static 2002, the SORAG, and the Minnesota Sex Offender Screening Tool – Revised (MnSOST). Attendees will be educated about sex offender risk assessment, report writing, and court testimony issues. The rapidly evolving research related to changing norms of the Static-99 and the MnSOST will be discussed. Strategies on interpreting and effectively communicating the implications of actuarial risk scores will also be presented. Recommendations will be made related to using these instruments in pre-treatment, parole, and civil commitment settings. Doug Epperson, PhD is the lead author of the MnSOST-R and the Juvenile Sexual Offense Recidivism Risk Assessment Tool – II (JSORRAT-II) and will discuss these instruments.

Drs. Saleh and Maram will educate the audience on current practice and new research related to risk assessment instruments for adolescent sexual offenders. The elements of a comprehensive forensic assessment, data gathering strategies, and the use of risk assessment instruments such as the PCL: Youth Version, ERASOR, and the J-SOAP-II will be covered.

Actuarial Instruments, Static 99, MnSOST

I8 Evidence-Based Forensic Psychiatry

Park Dietz, MD, PhD, Park Dietz & Associates, Inc., 2906 Lafayette Road, Newport Beach, CA 92663*

By attending this presentation, attendees will have a better understanding of the importance of the scientific method in forensic psychiatry, will recognize that it is essential to seek to videotape examinations, and will learn the value of transparency and consultation for improving the standards of the discipline.

This presentation will impact the forensic science community by combating incompetence, dishonesty, and distortion in forensic psychiatry.

The most important tools for ridding forensic psychiatry and psychology of incompetence, dishonesty, and distortion are: (1) the application of the scientific method in the collection, analysis, interpretation, and presentation of data and in the cross-examination of opinion; and, (2) improvements in the transparency of evaluations and reasoning and in the use of consultation to guard against confirmation bias.

Forensic psychiatry and psychology are branches of the forensic sciences, which, like other sciences, require objective observation, measurement, and reproducible results. Videotaping of examinations has been a practical option for 30 years, during which time no example has arisen of videotaping having harmed the search for truth. Yet even today there are those who conduct unrecorded examinations, concealing from scrutiny their examination technique, the utterances of the examinee, and any "evidence-tampering" that may have occurred through the use of suggestive or leading questions, the sharing of investigative information or witness statements, coaching on the relevant legal standards, or coaching on the symptoms of a particular diagnosis. Without verbatim recording, subsequent examiners and the trier of fact have only the selective reporting of the examiner on which to judge what

transpired and how the evaluee or the evaluee's story may have changed as a result of the examination.

The need for forensic mental health professionals to contribute to the collection and preservation of evidence during investigations and to base their analysis, interpretation, and presentation of evidence in both reports and testimony on reliable and valid observations, properly recorded, with reference to the applicable scientific literature will be addressed. This requires a different method of interviewing and a higher standard of practice than clinical diagnosis or opinion formation because of the higher incentives for malingering, distortion of facts, and concealment of evidence and motives.

Forensic mental health professionals are as susceptible to confirmation bias as other forensic scientists and can take steps to address this universal phenomenon by greater transparency in the evaluative and analytic processes and through more frequent use of consultation.

Forensic Psychiatry, Evidence, Videotaping

I9 Parental Alienation: Past, Present, and Future

William Bernet, MD, Vanderbilt University School of Medicine, 1601 23rd Avenue South, Suite 3050, Nashville, TN 37212-3182; Joseph N. Kenan, MD*, 436 North Roxbury Drive, #201, Beverly Hills, CA 90210; and James S. Walker, PhD*, Vanderbilt University School of Medicine, 1601 23rd Avenue South, Suite 3050, Nashville, TN 37212-3182*

By attending this presentation, attendees will understand the long history of the concept of parental alienation, the difference between "parental alienation" and "parental alienation syndrome," and reasons why parental alienation should be included as a mental condition in DSM-V and ICD-11.

This presentation will impact the forensic science community by helping to clarify to meaning of "parental alienation," a very important concept that has been immersed in controversy and misunderstanding.

Parental alienation is a serious mental condition in which a child – usually one whose parents are engaged in a hostile divorce – allies himself or herself strongly with one parent and rejects a relationship with the other parent without legitimate justification.

James S. Walker, PhD, will present "Parental Alienation *Past:* A Brief History of the Concept of Parental Alienation." Parental alienation was described in legal documents in the 18th century and in psychiatric and psychological professional literature since the 1940s. The prevalence of parental alienation increased in the 1970s when it became more common for fathers to seek custody of their children. In the 1980s, the phenomenon of parental alienation was "discovered" and described independently by six researchers, one of whom was Richard Gardner, MD. It is important to understand the difference between "parental alienation" and Gardner's concept of "parental alienation syndrome."

Joseph N. Kenan, MD, will present "Parental Alienation *Present:* Typical Clinical and Forensic Presentations of Parental Alienation." Two clinical vignettes will be presented, one representing the clinical practice of psychotherapy and one that was identified in a forensic evaluation. The typical attitudes and behaviors of the family members (the preferred parent, the alienated parent, and the child) will be described.

William Bernet, MD, will present "Parental Alienation *Future:* Parental Alienation in DSM-V, ICD-11, and Beyond." Considerable research – primarily in the Grounded Theory Method – has established that parental alienation is a valid concept, and that it causes serious psychological symptoms for many children and their families. The prevalence of parental alienation in the United States is about 1%, and the condition occurs throughout the developed countries of the world.

The speakers and the audience will discuss: Should "parental alienation disorder" be considered a mental disorder in DSM-V? If not a full-fledged diagnosis, should "parental alienation disorder" be included in the appendix of DSM-V, Criteria Sets and Axes for Further Study? If not a mental disorder, should "parental alienation relational problem" be a V-code in the chapter of DSM-V, Other Conditions That May Be a Focus of Clinical Attention?

Parental Alienation, Divorce, DSM

I10 Update on the Neuroscience of Traumatic Brain Injury

Robert Granacher, MD, Lexington Forensic Psychiatry, 1401 Harrodsburg Road, Suite A400, Lexington, KY 40504; Manish Fozdar, MD*, Triangle Forensic Neuropsychiatry PLLC, 1109 Chilmark Avenue, Wake Forest, NC 27587; and Mohan Nair, MD, PO Box 849, Seal Beach, CA 90740*

By attending this presentation, attendees will be educated about the advances in the neuroanatomy and neuropathogy of Traumatic Brain Injury (TBI).

This presentation will impact the forensic science community by assisting physicians, nurses, and lawyers, both military and civilian, who treat or conduct disability evaluations on those suspected to have a traumatic brain injury.

Disorders related to traumatic brain injury are the second-most common neurological disorder (behind only headaches). There are roughly 1.4 million cases of traumatic brain injury in the United States, 75% of which are deemed "mild TBI." Every year, about 90,000 individuals are left with some level of chronic disability as a result of TBI. About 300,000 American servicemen and women may be suffering from TBI; sports-related injuries result in another 300,000 cases of TBI. Between 2.5 and 6.5 million Americans live with the long-term sequelae of TBI.

The understanding of the neuroanatomy and pathophysiology of these injuries is continuing to evolve. Significant mechanical forces on the brain initiate a cascade of events, the clinical impact of which may not be obvious in the short term. Diffuse axonal injury, which can occur even in the absence of loss of consciousness, may be a factor in the persistent emotional, behavioral, and cognitive problems experienced by victims of mild TBI. High-pressure shock waves, such as those experienced by individuals exposed to IEDs (Improvised Explosive Devices) at close range, can result in cerebral bruising, bleeding, torn nerve fibers, and destroyed neurons, even in the absence of skull-related injury. These injuries may be unreported by the victim but result in emotional, behavioral, cognitive, interpersonal, and occupational dysfunction, which may be noted weeks or months after the event.

The goal of this presentation is to educate the audience on the advances in the neuroanatomy and neuropathogy of TBI.

TBI, Neuroanatomy, Diffuse Axonal Injury

I11 Pitfalls in the Forensic Application of Functional Neuroimaging to Traumatic Brain Injury

Manish Fozdar, MD, Triangle Forensic Neuropsychiatry PLLC, 1109 Chilmark Avenue, Wake Forest, NC 27587; Mohan Nair, MD, PO Box 849, Seal Beach, CA 90740; and Robert Granacher, MD*, Lexington Forensic Psychiatry, 1401 Harrodsburg road, Suite A400, Lexington, KY 40504*

By attending this presentation, attendees will understand how SPECT imaging can be misused in Traumatic Brain Injury (TBI) cases.

This presentation will impact the forensic science community by informing attorneys and psychiatrists that the misuse of brain SPECT imaging is a concern in both criminal and civil forensic psychiatry.

"The frequencies of mild TBI, the increasing clinical availability and application of SPECT, and a litigious environment have united to produce an atmosphere in which the introduction of evidence involving the interpretation of SPECT images is inevitable (Wortzel, 2009)."

Although most survivors of mild TBI fully recover within one year of their injury, a minority have ongoing, mostly subjective disturbances of cognition, emotion, and behavior, which is characterized as poorly-defined "post-concussive syndrome." Because the majority of these subjects have no demonstrable abnormalities on either conventional diagnostic electrophysiological or structural neuroimaging studies, SPECT imaging, a (relatively) affordable and available functional imaging modality, has become popular with litigants.

Juries' increasing expectation of visual aids in the courtroom reinforces the use of such evidence. The Society of Nuclear Medicine has cautioned that such use may be unethical, stating that it can lead to unsupportable conclusions if introduced as "objective evidence." The color-coding of statistical data can create an illusion of lesions where none exists. There is no generally accepted standard for the diagnosis of mild TBI and there are no published standards for pathognomonic lesion determination using either PET or SPECT after mild traumatic brain injury (Granacher, 2009). SPECT imaging does not meet the *Daubert* or *Frye* standards for presentation of scientific evidence in legal settings.

The goal of this presentation is to help the audience understand key elements of this important forensic area.

Brain SPECT, Mild TBI, Post-concussive Disorder

I12 Malingering, Deception, and Abnormal Illness Behavior in Traumatic Brain Injury (TBI)

Mohan Nair, MD, PO Box 849, Seal Beach, CA 90740; and Daniel A. Martell, PhD*, Park Dietz & Associates, 2906 Lafayette, Newport Beach, CA 92663*

By attending this presentation, attendees will obtain the tools to conduct a systematic assessment for malingering in cases of purported traumatic brain injury (TBI) and learn about the current research in this area.

This presentation will impact the forensic science community by helping evaluators distinguish between those who are truly affected by TBI and those who are feigning symptoms related to TBI. Neuropsychological testing is an important tool in making this distinction.

The medical literature suggests that litigants claiming mild traumatic brain injury (MTBI) have a high likelihood of magnifying symptoms or exaggerating the duration of symptoms purportedly related to MTBI merely for compensation. The actual prevalence of persistent cognitive deficits in individuals with MTBI is unknown. In one recent study, the base rate of malingering of MTBI symptoms in more than 30,000 neuropsychology examinations was reported to be 39%. In contrast, a prospective study in Scotland (where adversarial litigation is uncommon) found that almost half the subjects who experienced mild head injury experienced moderate to severe disability.

The assessment of malingered TBI remains difficult and there is no credible research-based "profile" for genuine cases. While much of the literature on MTBI has focused on cognitive impairment, many individuals with genuine MTBI may manifest primarily emotional and behavioral problems. Abnormal illness behavior other than malingering also must be considered by the forensic evaluator.

This presentation will provide the attendee with the tools to conduct a systematic assessment for malingering, including detecting false complaints of memory, executive, motor/visuo-spatial/sensory function deficits, and poor effort. The role of personality testing (e.g., MMPI-2, PAI) and forced-choice tests (e.g., Portland) will also be discussed.

The Digit Recognition Test, the Test of Memory Malingering (TOMM), and neuropsychological batteries will be reviewed. Attendees will learn practical ways of obtaining multiple streams of data and how to integrate these into evidence-based opinions.

TBI, Malingering, Neuropsychological Testing

I13 Healthcare Serial Killers: Helper or Hunter

Dean De Crisce, MD, 41 Schermerhorn Street, #325, Brooklyn, NY 11201; and Martha E. Vargas, RN*, Borough of Manhattan Community College-Department of Nursing, 41 Schermerhorn Street, #325, Brooklyn, NY 11201*

By attending this presentation, attendees will be able to discuss serial killer typology, particularly as it applies to healthcare professionals.

This presentation will impact the forensic science community by adding to the body of knowledge on a unique, alarming, and yet poorly studied phenomenon.

A New Jersey nurse was sentenced to 18 consecutive life sentences for the murder, over many years, of over 50 patients. An English nurse assaulted 13 children over a period of two weeks, leading to the deaths of at least three of the children. An English family doctor killed over 200 of his patients, making it appear that they had died of natural causes. These are rare events. Serial killings comprise a very small proportion of murders, yet are fascinating to the public. There is particular interest in individuals, working in "helping professions," who purposely harm, rather than help others. It is a phenomenon that is incomprehensible to many.

In the last 40 years, approximately 50 identified healthcare professionals, mostly nurses, have killed over 2,000 patients; the exact number of deaths and the extent of these types of killings are unknown. The actual cause of death might be easily obscured, appearing as the natural course of events or as adverse reactions to appropriate interventions. Perpetrators have been caught and prosecuted, often when epidemiological evidence uncovered multiple unexpected deaths correlated with a specific healthcare provider. FBI estimates have suggested, however, that as many as 500 - 1,000 patient deaths per year go unnoticed as crimes of malice.

Various typologies have been put forth to explain the motives of healthcare serial killers. The "hero" is one type of serial killer. When assuming this role, the health care professional creates a crisis and then comes to the patient's "rescue," thereby gaining accolades for his or her actions; patients die "by mistake," rather than by design. The "angel" is a healthcare professional that kills to relieve the perceived suffering of a patient. The "god" is a type of serial killer who kills to exercise the "power of life and death." The "hedonistic" killer murders simply for the excitement and thrill. There are also other proposed types of healthcare serial killers.

Healthcare serial killers differ from more typical serial killers in their demographic characteristics, characteristic behaviors, and the typology used to describe them. Healthcare serial killers are frequently women, infrequently use overtly violent methods, and generally do not have a sexual component to their behavior.

This presentation will explore the various types and characteristics of the healthcare serial killer, using examples from prosecuted cases in recent years, in an attempt to understand these unusual events. Comparisons will be made against common theories regarding more "typical" serial killer subtypes, demographic characteristics, and psychological profiles.

Psychiatry, Serial Killers, Healthcare

I14 The Investigation of Burnout and Job Satisfaction Levels in Jail Guardians in Ceyhan M Type Jails

Özgür Özdemir, MD, PhD, Mus State Hospital, Kültür Mah. Bahar-2 Sitesi B Blok, Kat:4 No:7, MUS, 0 49100, TURKEY; Esin Özdemir, MSc, Çukurova University, Institute of Health Sciences, Kültür Mah. Bahar-2 Sitesi B Blok, Kat:4 D:7, MUS, MUS 49100, TURKEY; and Mete K. Gulmen, PhD, MD, Cukurova University, School of Medicine, Department of Forensic Medicine, Adana, 0 01330, TURKEY*

By attending this presentation, attendees will learn about "burnout," job satisfaction levels, and positively influencing these factors in custody staff.

This presentation will impact the forensic science community by presenting information relevant to burnout and job satisfaction of custody staff who work with prisoners.

In this study burn-out, job satisfaction, and ways of coping with stress in jail workers in Ceyhan M Type Jail were investigated. The study included 87 participants. A sociodemographic data form prepared by the researchers, the Maslach Burnout Inventory (MBI), was utilized. This rating scale measures burnout in three dimensions: depersonalization (D), emotional exhaustion (EE), personal accomplishment (PA). The Job Satisfaction Inventory (JSI) was also administered to the sample. Burnout and job satisfaction in individuals with varying educational levels, numbers of children, working periods, specific positions in the detention setting, working conditions (day or night), satisfaction with salary, satisfaction with their profession, and satisfaction with the institution (in which they worked) were compared.

Number of children, working conditions, satisfaction with profession, and satisfaction with the institution showed a positive correlation with depersonalization. Job position, satisfaction with profession, and satisfaction with institute showed a positive correlation with personal accomplishments. Educational level, specific position in the detention setting, working conditions and satisfaction with their position, satisfaction with their profession, and satisfaction with the institution were significantly correlated with emotional exhaustion.

Overall, job satisfaction level was positively correlated with job position, working conditions, satisfaction with position with their profession, satisfaction with their salary, and satisfaction with their institution.

Burnout, Job Satisfaction, Jail

I15 The Rights of Minors to Refuse Antipsychotic Medication

Leanne M. Stoneking, MD, University of Southern California, Institute of Psychiatry and Law, PO Box 86125, Los Angeles, CA 90086*

By attending this presentation, attendees will learn: the legal basis underlying minors' ability/inability to refuse antipsychotic medication; the rights of parents in the process of consenting to/dissenting from the administration of antipsychotic medication to their children; the California *Riese* hearing process and its applicability to minors.

This presentation will impact the forensic science community by addressing whether or not minors are afforded the same rights as adult to refuse antipsychotic medication.

Involuntarily medicating psychiatric patients has been an issue of considerable debate in psychiatry and the law. Currently, California law requires a "*Riese* hearing" (from the 1989 California Supreme Court case *Riese v. St. Mary's* Hospital) to determine if a patient has the capacity to refuse psychiatric medications. Patients who are judicially determined to lack to this capacity may be involuntarily medicated in non-emergent situations. It is not clear whether or this standard applies to both minors and adults.

This presentation will also address the ethical implications of minors' ability or inability to understand, while on an inpatient setting, the basis for recommended antipsychotic treatment. The differing rights of minors under dependency or delinquency court jurisdiction (compared with those residing with custodial parents) will also be discussed. These differences could have an impact on the current psychotropic medication authorization process in California.

This presentation will attempt to answer the following questions:

1. What is a *Riese* hearing?
2. Are minors entitled to a *Riese* hearing?
3. Can inpatient psychiatric treatment facilities involuntarily medicate minors with antipsychotic medications against their will in non-emergent situations?
4. What happens in inpatient treatment facilities when minors refuse antipsychotic medications?

There are non-emergent circumstances under which antipsychotic medication is required to decrease mental suffering and improve functioning. How are inpatient treatment facilities or juvenile justice facilities to proceed with care of the minor if he/she orally refuses antipsychotic medication? What if the parent refuses consent? These are situations which occur in the many inpatient treatment facilities. Is it ethical for the patient to remain untreated until they become self-injurious, dangerous to others, or "gravely disabled" (i.e., unable to provide for their food, clothing, or shelter)? There is considerable variability in state law with regard to procedures for involuntarily hospitalizing minors and adults. Does state law vary with regard to minors' rights to refuse antipsychotic medication?

Antipsychotic Refusal, Minors Rights, Riese and Minors

I16 Association Study Between the SNAP-25/STX1A Genes and Alcoholism

Duarte N. Vieira, PhD, National Institute of Legal Medicine, Largo da Sé Nova, Coimbra, 3000-356, PORTUGAL*

By attending this presentation, attendees will learn about the SNAP-25 and STX1A genes, which do not appear to be associated with alcoholism in a Portuguese population.

This presentation will impact the forensic science community by identifying genes that were postulated to predispose Portuguese individuals to alcohol dependence.

Excessive alcohol consumption contributes to numerous health problems, such as high blood pressure, heart attacks, obesity and suicide, and also increases the frequency of traffic accidents. In Portugal, alcohol is estimated to be the fourth most common cause of death. Epidemiological studies suggest that alcohol dependence has a genetic component and some evidence suggests that changes in exocytotic machinery may be involved in this disorder. However, to date no genetic studies have been performed in order to investigate the relationship between "exocytotic-machinery" genes and alcoholism. The aim of this study was to investigate the association (or lack thereof) between polymorphisms of the SNAP-25/STX1A genes and alcoholism in the Portuguese population.

Genomic DNA was extracted from peripheral lymphocytes by using enzymatic methods. Genotyping of the SNAP-25 and STX1A genes was performed using conventional PCR methods. The statistical analysis was performed by c^2. We found no evidence of an association between SNAP-25/STX1A genes and alcoholism.

Although it will be important to extend the present study to a larger sample, our preliminary results do not suggest any association between

SNAP-25 and STX1A genes and alcoholism in the Portuguese population.

Alcoholism, Genetics, Exocytotic Machinery

I17 Genetics and Suicide: Gene GABAA Gamma 2

Duarte N. Vieira, PhD, National Institute of Legal Medicine, Largo da Sé Nova, 3000-213 Coimbra, 3000-213, PORTUGAL*

By attending this presentation, attendees will learn how polymorphisms in the gabaergic system, namely GABAA gamma 2, do not appear to be correlated with completed suicide.

This presentation will impact the forensic science community by identifying genes that may predispose Portuguese individuals to completed suicide.

Every year worldwide, one million people commit suicide and at least ten million more attempt suicide. Epidemiological studies suggest that suicide attempts and completed suicides have a genetic component. These phenomena may share a common genetic underpinning which is independent of the genetic transmission of other psychiatric disorders or symptoms that are causative of or comorbid with suicidal behavior (e.g., Major Depressive Disorder). Alterations in gabaergic neurotransmission and GABA receptors long have been postulated to play a critical role in the etiology of completed suicide. Therefore, we investigated the potential association between the GABAA gamma 2 gene and suicide.

Peripheral blood was collected from alcoholics and controls. Genomic DNA was extracted from blood lymphocytes using a standard method. The polymorphism of the GABAA gamma gene was investigated by RFLP-PCR. There was no statistical difference in the allelic and genotypic frequency of the polymorphism of GABAA gamma 2 in individuals who committed suicide. In conclusion, no evidence was found for an association between the GABAA gamma 2 gene and completed suicide in this sample.

Suicide, Genetics, Gabaergic System

I18 Forensic Aspects of Fetal Alcohol Syndrome

William J. Collins, MD, Monroe Correctional Complex, PO Box 514, Mail Stop: NM-84, Monroe, WA 98272*

By attending this presentation, attendees will learn the extent to which adults with fetal alcohol spectrum disorders (FASDs) impact our legal system with respect to types of crimes committed, sentencing, prevalence in prison populations, and possible reasons for under-diagnosis or misdiagnosis.

This presentation will impact the forensic science community by describing the challenges and potential medicolegal ramifications facing mental health experts who identify, diagnose, and/or treat individuals with FASDs, and generally will endeavor to shed some light on what happens to the myriad of FASDs children who grow up to interface with the criminal justice system.

Little is known about the extent to which adults with FASDs impact our legal system. Since 1973, when researchers at the University of Washington first reported that alcohol was indeed a teratogen, most of the research, clinical description, and treatment of FASDs focused on children and adolescents. The notion of fetal alcohol syndrome (FAS) in adults made a rather dubious entrance onto the national stage in 1993 with the well-publicized execution of convicted double-murderer Robert Alton Harris in California. His final death row appeal for clemency based on FAS became known as the "abuse excuse," and many argued that it made a mockery of the criminal justice system.

Through a search of the literature and relevant case law since the Robert Alton Harris case, some garnered from decades of research conducted by the Fetal Alcohol and Drug Unit at the University of Washington School of Medicine, this presentation will present an overview of FASDs: how they are viewed generally within the legal system in criminal and civil contexts, and potential forensic ramifications. It will also present an overview of the Robert Alton Harris case and other relevant cases since that time, clinical aspects such as pathophysiological, behavioral, and cognitive abnormalities, and epidemiology and psychological testing results, which often show low-normal IQs. The aim of this presentation is to convey an overall sense of the magnitude of the problem of FASDs in terms of cost to society, sentencing, disposition and treatment challenges, and explore whether there is a legitimate argument for reduced criminal responsibility in individuals with FASDs.

Aspects, Fetal, Alcohol

I19 Treating Disruptive Behavior Disorders in Correctional Settings: To Treat or Not to Treat?

Christopher R. Thompson, MD, 10850 Wilshire Boulevard, Suite 850, Los Angeles, CA 90024; Charles L. Scott, MD*, University of California, Davis, Division of Psychiatry and the Law, 2516 Stockton Boulevard, Suite 210, Sacramento, CA 95817; Gregory Sokolov, MD*, University of California, Davis, Division of Forensic Psychiatry, PO Box 389, Davis, CA 95817; and Steve Wu, MD*, 550 S. Vermont Avenue, JJMHP, 3rd Floor, Los Angeles, CA 90020*

By attending this presentation, attendees will: (1) Know the rates of ADHD and domains of impairment in afflicted individuals in juvenile justice and adult correctional settings; (2) Learn techniques and sources of information to corroborate a self-report of ADHD symptoms (self-report scales, psychological testing, computerized testing, and collateral sources of information); and (3) Learn techniques to minimize abuse or diversion of ADHD medications in correctional settings.

This presentation will impact the forensic science community by demonstrating how treating some individuals with Disruptive Behavioral Disorders (DBDs) pharmacologically is important and may improve outcomes; however, the medications most frequently and effectively used can also be abused and diverted. Therefore, medications must be used in a prudent fashion.

DBDs (e.g., ADHD) are overrepresented in individuals in correctional settings and cause significant morbidity in impacted individuals. Frequently, these individuals have difficulty following instructions, adhering to the jail/prison/juvenile detention facility routine, and their education (particularly for juveniles) is adversely impacted.

DBDs and Substance Use Disorders (SUDs) increase the risk for antisocial behavior, both in juveniles and adults. Fairly recent data have shown that treating DBDs (particularly ADHD) can lead to a reduction in antisocial behavior and SUDs in adolescents. However, treating DBDs in a correctional population presents special challenges for clinicians. Diversion and abuse of medications (e.g., stimulants, bupropion, quetiapine) can be problematic and, in both juveniles and adults, illicit substance use may be ongoing, even in detention/correctional settings. Organizational treatment philosophies for SUDs often vary from detention/correctional setting to the community, giving rise to problems with consistency and continuity of care. This presentation will focus on "mental health demographics" of the juvenile justice and adult correctional populations, ways to minimize diversion and abuse of psychotropic medications (particularly those designed to treat ADHD), different treatment interventions' efficacy in

treating SUDs, and the importance of consistency of treatment philosophy as individuals transition from detention/correctional facilities back into the community.

ADHD, Jail, Stimulant

I20 Pornography and Sexual Violence: Is There a Connection?

Mohan Nair, MD, PO Box 849, Seal Beach, CA 90740; Rob Friedman, JD*, 301 South Monroe Street, Suite 401, Tallahassee, FL 32301; and Wesley Maram, PhD*, Orange Psychological Services, 1234 West Chapman Avenue, Suite 203, Orange, CA 92868*

By attending the presentation, attendees will understand the connection (or lack of connection) between pornography and sexual violence. Presenters will explore whether a causal link exists between child pornography and pedophilia.

This presentation will impact the forensic science community by providing the forensic scientist, law enforcement personnel, and judicial officers techniques to differentiate legitimate science and "junk science" related to this topic.

In 2005, the Department of Justice (DOJ), under then-Attorney General Alberto Gonzales, created the Obscenity Prosecution Task Force (OPTF) and the Child Exploitation and Obscenity Section. The theoretical basis for the creation of these entities was the belief there was a strong link between pornography, violent sex crimes, and the sexual exploitation of children. The DOJ websites gave direct links to anti-pornography organizations such as www.obscenitycrimes.org, a website of Morality in Media (MIM). Robert Peters, president of MIM, raised concerns that while pornography was widely accepted as harmless, "common sense, anecdotal evidence, and social science research all point in the opposite direction." Hearings on pornography were conducted on Capitol Hill, where experts on pornography such as Dr. Judith Riesman (Scientific Advisor, California Protective Parents Association) and Mary Anne Layden (Co-Director, Sexual Trauma and Psychopathology Program, Center for Cognitive Therapy, University of Pennsylvania) testified before the United States Senate's Subcommittee on Science on "The Brain Science Behind Pornography Addiction." Dr. Riesman informed that August body, "Thanks to the latest advances in neuroscience, we now know that emotionally arousing images imprint and alter the brain, triggering an instant, involuntary, but lasting biochemical memory trail. Pornography triggers a myriad of endogenous, internal, natural drugs that mimic the 'high' from a street drug." Those testifying highlighted the "grave consequences" of pornography's being available 24/7 and how it resulted in an epidemic of sexual violence toward women and children. This testimony appeared to be a significant influence on the Bush administration's "War on Porn." The only problem with Dr. Riesman's elegant "erototoxins" theory was that facts stood in the way of her opinion and testimony. The overwhelming scientific evidence is that the increasing availability of pornography has been inversely related to the number of sex crimes committed.

This presentation reviews the current social and scientific literature on pornography and its impact on both adults and children. The connection (or lack of connection) between child pornography and pedophilia will be reviewed; the case of *United States vs. Ira Isaacs* will be discussed; and, the legal issues involved in obscenity cases will be discussed.

Pornography, Sex Crime, Child Exploitation

I21 Current Status of Clinical Research in Correctional Settings – A Review

Lakshmi Savitala-Damerla, and Hanumantharao Damerla, MD*, 636 West Wistaria Avenue, Arcadia, CA 91007*

By attending this presentation, attendees will understand some basic principles of clinical research in correctional settings. The presenters will elaborate on the encumbrances involved in the informed consent process and the obstacles encountered in conducting research in such settings. This presentation will also describe some potential advantages and gains to the subjects and society in general.

This presentation will impact the forensic science community by pointing out the ramifications and implications of conducting biomedical and psychological research on inmates. The research community will benefit by gaining ample understanding of variations in research procedures, current trends and thinking in conducting research, and IRB governance for this population that is considered to be vulnerable. Incarcerated individuals have a very high incidence of drug abuse, alcoholism, HIV, hepatitis, and mental illness. By conducting research in this population, we hope to learn more about new diagnostic and treatment modalities.

Research in correctional settings has always been considered controversial. On one hand, this is a set of individuals who have lost their liberty and, therefore, are deemed unable to give informed consent; on the other hand, there is a wealth of potential clinical information that could be discovered if research is done appropriately. Inmates in correctional settings can be surprisingly agreeable and amenable to clinical research, for a variety of reasons. Additionally, there are several diseases (such as Hepatitis C, HIV) and conditions (such as alcoholism and substance abuse) that are overrepresented in this population; extensive research on this population is indeed sorely needed.

In general, clinical research requires voluntary informed consent. Dealing with inmates in a correctional setting brings up several ethical and legal dilemmas. Because we are dealing with individuals who have lost their freedom, some have commented that any consent offered for clinical and experimental research is inherently coerced and involuntary.

While there are many potential rewards for conducting research in a correctional setting, one cannot underestimate the importance of having extensive and special safeguards in place to achieve the potential benefits. For example, a specialized IRB, which understands and is sensitive to protecting the rights of the incarcerated population, is extremely important. The IRB should consist of experienced personnel who are able to evaluate the protocols and, at the same time, assure that protections for patient rights and safety are present. The formation of such a committee is vital to eliminate any form of coercion during the informed consent process.

Clinical Research, Correctional Settings, Patient Safety

I22 Developmental Immaturity as a Basis for Juvenile Incompetence to Stand Trial

Philip C. O'Donnell, PhD, University of Southern California, 2020 Zonal Avenue, Interns and Residents Dorm #714, Los Angeles, CA 90033; and Bruce H. Gross, PhD, University of Southern California, Institute of Psychiatry & Law, PO Box 86125, Los Angeles, CA 90086-0125*

By attending this presentation, attendees will learn about the core principles of child and adolescent development relevant to the understanding of juvenile competence to stand trial and the legal status of developmental immaturity as a basis for incompetence to stand trial across jurisdictions. Attendees will also learn about the practical

implications that arise in assessing juvenile competence to stand trial and providing recommendations for restoration of competence.

This presentation will impact the forensic science community by raising awareness of the unique developmental issues that affect juvenile competence to stand trial and by increasing practitioners' understanding of how these issues are being addressed in competence proceedings.

In recent years, juvenile adjudicative competence has received increased attention from legal and mental health practitioners. As youthful offenders increasingly face serious sanctions in the juvenile court system and are more frequently subject to prosecution in adult criminal courts, their ability to rationally understand and participate in their trial has become a pressing concern.

The test of competence to stand trial, articulated by the United States Supreme Court in *Dusky v. United States* (1960), is, generally speaking, whether the defendant can rationally consult with his attorney and rationally understand the proceedings against him. For adult defendants in most jurisdictions, incompetence must be based upon a predicate mental disease or defect; however, many children and young adolescents who are free of mental illness may nonetheless fail to meet the standard set forth in *Dusky.*

In assessing juveniles' competence to stand trial, evaluators should have adequate training in the principles of child and adolescent development. Several specific social, emotional and cognitive aspects of their development have a potential effect on a juvenile's ability to rationally participate in his or her adjudicative process. These include the still-developing abilities to act autonomously, weigh the risks and benefits of alternative courses of action, and consider the long-term consequences of their choices, among others. The authors will discuss how these factors should be assessed and addressed in a comprehensive evaluation.

The standards for juvenile competence to stand trial vary across state jurisdictions. Therefore, forensic mental health evaluators must be familiar with the laws in their jurisdiction. Based upon a review of case law and state legislation, the authors will discuss several states' approaches to developmental immaturity and juvenile competence to stand trial to illustrate important cross-jurisdictional differences.

Developmental immaturity as a basis for incompetence to stand trial presents a conundrum for the restoration of incompetent youth. Forensic experts are often asked what interventions will help restore a defendant to competence (e.g., medication, therapy, court competence training). However, normative developmental differences that affect juveniles' competence, by their very nature, will only be addressed with maturation and the passage of time. Thus, options for short-term psycho-educational restoration training are limited.

It is concluded that a comprehensive approach to assessing juveniles' competence to stand trial requires forensic evaluators to consider normative child and adolescent development as well as the presence of mental illness and developmental delay. Evaluators must also be aware of state laws regarding developmental immaturity as a basis for incompetence and should know about local resources for competence restoration services.

Adjudicative Competence, Developmental Immaturity, Juveniles

I23 The Etiology and Taxonomy of Adolescent Antisocial Behavior

Christopher R. Thompson, MD, UCLA Department of Psychiatry and Biobehavioral Sciences, 10850 Wilshire Boulevard, Suite 850, Los Angeles, CA 90024*

By attending this presentation, attendees will be able to understand the difference between the etiology and course of "life-course persistent" and "adolescence-limited" antisocial behavior and to understand the ramifications (ethical, legal, and societal) of differentiating (or not differentiating) between these subtypes of individuals.

This presentation will impact the forensic science community by exploring how incarcerating individuals for lengthy periods imposes a tremendous cost on society, both directly (e.g., cost to house inmate) and indirectly (e.g., institutionalization and loss of employment opportunities because of a criminal record). These costs may be justified in order to protect society or serve other legitimate penological interests. However, it is questionable whether indiscriminately incarcerating minors for extended periods serves these penological interests.

It is important to note that some degree of adolescent antisocial behavior is normative. Arrest rates for violent and non-violent crime peak around age 16 or 17, decrease quickly and linearly until age 30, and then continue to decrease each year thereafter, albeit more slowly. What does this mean? Adolescent antisocial behavior generally does not persist into adulthood and is, by definition, "adolescence-limited." As contingencies change and neurological maturation progresses, the vast majority of adolescents are able to desist from their criminal behavior. However, there is a small subset of individuals who engages in "life course persistent" antisocial behavior.

Is severe, inflexible punishment (i.e., retribution) a legitimate penological objective if the actor is less blameworthy (or, in extreme cases, not culpable at all)? Is incapacitation necessary if the antisocial behavior is likely to cease even without specific interventions? These and other questions will be explored during the course of the presentation.

Adolescent, Antisocial Behavior, Life Course Persistent

I24 Life Without Parole for Adolescents: Controversies and Current U.S. Supreme Court Cases

Robert Weinstock, MD, 1823 Sawtelle Boulevard, Los Angeles, CA 90025*

After attending this presentation, attendees will be able to distinguish special characteristics of adolescents relevant to their culpability and punishment.

This presentation will impact the forensic science community by calling attention to the U.S. Supreme Court cases involving adolescent punishment and heightening awareness of adolescent developmental considerations in future cases.

The U.S. Supreme Court, in its *Roper v. Simmons* (2005) decision, recognized that juveniles are not as culpable as adults because of their developmental immaturity and should therefore not be eligible for the death penalty. Their personality characteristics are not fully formed and are subject to change as adolescents mature. Similar issues arise in the context of sentencing juveniles to life without parole. In its 2009-2010 term, the U.S. Supreme Court is considering whether sentences of life without parole (meted out to juveniles as young as 13 in some states, sometimes for crimes short of murder) violate the 8th Amendment's prohibition of cruel and unusual punishment. The United States may be the only country in the world to have sentences this severe for adolescents. The American Psychiatric Association and American Psychological Association have submitted a joint amicus brief in the case at hand.

There is some question regarding the level of proof needed for professional organizations to cite evidence in amicus briefs. For example, in the area of neurobiological development, there is evidence of developmental immaturity in particular areas of the brain. These areas have some role in planning and decreasing impulsivity. Neuroimaging data support other types of evidence of adolescent immaturity, which are reflected in psychological studies showing limitations in their thinking

and a decreased ability to control impulses and behavior. However, neuroimaging data do not provide any direct evidence regarding blameworthiness. There are few studies correlating brain maturity directly to traits such as impulsivity and "behavior control," subjects in which the law is most interested. Existing studies also do not examine the extent to which brain development has occurred in any particular adolescent and correlate that with other psychological measures of maturity or behaviors relevant to legal issues. Therefore, the possibility cannot be dismissed that these are unrelated, concurrent processes.

Nonetheless, the evidence lends support to other common-sense understandings of adolescent immaturity, illustrated by society's denying privileges such as drinking, driving, and voting to adolescents under age 18. If adolescents continue to be given sentences of life without parole for actions committed at an age at which their personalities are still fluid and their brains still developing, questions of due process and fundamental fairness would certainly persist. "Brain science" still is relevant, so long as its implications are not overstated and its limitations made clear. Although relevant legal questions may not be fully answered by neuorimaging studies, they do lend support to the conclusions of other extant data. Also, psychological studies of adolescents provide important relevant data.

There is also a debate as to whether psychopathy can be validly and reliably identified in a subgroup of adolescents. If such identification were possible, it may be reasonable to sentence such adolescent offenders to life without parole. Although there are certainly adolescents who will become adult psychopaths, current instruments, including the PCL:Youth Version, are not yet capable of long-term predictions regarding recidivism or institutional infractions, particularly in girls and ethnic minorities. Additionally, to date, any predictive power that has been demonstrated by these instruments has been related to Factor 2 traits (i.e., behavior) and not Factor 1 traits (i.e., affective/interpersonal traits thought to be central to the concept of psychopathy). Obviously, we are far from being able to utilize these instruments as effectively in adolescents as we do in adults. Therefore, current jurisprudence needs to recognize the limitations in our knowledge base, the implications of adolescent immaturity, and the "changeability" of juveniles as a group, including repeat offenders.

Adolescent, Parole, Punishment

I25 Maladaptive Sexual Behaviors in Children and Adolescents With Pervasive Developmental Disorders

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By attending this presentation, attendees will become familiar with the existing literature regarding adaptive and maladaptive sexual behaviors in children and adolescents with Pervasive Developmental Disorders (PDD), and will learn approaches to the evaluation and treatment of these individuals.

This presentation will impact the forensic science community by raising awareness of the conditions that may result in problematic sexual behaviors in children and adolescents with PDD and of the approaches to their evaluation, risk management, and treatment.

Pervasive Developmental Disorders, a group of psychiatric conditions that includes Autistic Disorder and Asperger's Disorder, are characterized by impaired social skills, atypical communication patterns, and stereotyped behaviors. Individuals can also present with maladaptive sexual behaviors, such as public masturbation or indecent exposure. These individuals may also present with co-occurring paraphilic disorders. This presentation will review the existing literature regarding the differential diagnosis of problematic sexual behaviors in children with Pervasive Developmental Disorders. Approaches to assessment (including risk assessment) and treatment of these individuals will be discussed.

Pervasive Developmental Disorders, Asperger's Disorder, Paraphilias

J1 The Use of Microscopy-FTIR-ATR Technique to Determine the Sequence of Crossed Lines

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After attending this presentation, attendees will be briefed on a Microscopy-FTIR-ATR method for the determination of the sequence of crossed lines.

This presentation will impact the forensic science community by providing a efficient method for the determination of the sequence of crossed lines.

The determination of the chronological sequence of crossed lines has been a difficult problem in document examination. The similarity of physical and chemical properties of printer toners and pen inks make the work of forensic experts more difficult, because only determinations of minor differences can lead to an identification. In relation to ransoming, anonymous or threatening letters, discrimination and identification of printers or pens is often required. In cases of fraud, it must be determined whether the document has been additionally altered. In the case of counterfeit documents, one needs to determine the sequence of crossed printer and pen ink lines to answer the very frequent question, was "signature or printed text first on the document?" Up until now, solution to these problems required experts to run time demanding investigations and the results were more or less subjective. Microscopy-based infrared ATR technique as opposed to optical microscopy techniques is a simple, fast, non-destructive method, which does not require sample preparation and provide an objective result, while also leaving the documents intact.

In this experiment, spectra were collected using a Bruker Vertex 70 infrared spectrometer equipped with a 20x ATR objective Bruker Hyperion microscope. Before the analysis the measurement spot on the document is defined, while the ATR objective has to be made in the visual mode. During the examination the documents contact with the surface of the Ge crystal at 100 mm diameter. Through principle of measurement, infrared spectral information is gathered from ~1 mm depth layer of the surface. In connection to questionable documents, the most common and indistinguishable samples are the black printed and black handwriting lines. In our experiment we investigated black toners of laser printers and black pen inks because examination of these samples by other optical analytical methods has serious difficulties.

Polymer resin, the main component in dry black printer toners, creates a millimeter thin, black surface layer on the paper. Printed matter can be investigated in situ by its infrared spectrum without any disturbing effect, because the penetration depth of the infrared radiation is smaller than the thickness of the printed layer. The liquid pen inks penetrate into the micro fibers of the paper, so much so that, the upper sides of the cellulose fibers are saturated entirely with pen ink. Because of this fact the disturbing effect of cellulose fibers of paper cannot be removed from the spectrum. For determination of the sequence of crossed lines, the exact definition of line crossing points of document is provided (when ATR objective works in the visual mode), so the chemical composition of the surface layer can also be examined at this point based on the spectrum. By analyzing the upper layer, the sequence of crossed lines of printer toner and pen ink is determined.

The microscopy FTIR-ATR method is a very suitable technique for the examination of printed and handwritten documents. Using this technique different types of printer toners and pen inks can be distinguished by their chemical fingerprints. The sequence of crossed lines can be determined by measuring the surface layer at the line crossing point. Additionally, the measurement neither destructs the document nor does it require sample preparation. This analytical method is objective and easy to interpret. Application of the method makes an easier comparison of questioned documents for forensic experts in criminal cases.

Document, Crossing-Lines, FTIR

J2 Hyperspectral Imaging of TLC Plates: A Novel Approach to Ink Discrimination

Cara A. Plese, Sara E. Nedley, BA, MS, and Rebecca Schuler, BS, ChemImage, 7301 Penn Avenue, Pittsburgh, PA 15208*

After attending this presentation, attendees will understand how hyperspectral imaging can be applied to the visualization of Thin Layer Chromatography (TLC) plates and aid in ink discrimination.

This presentation will impact the forensic science community by introducing a novel approach to TLC plate visualization and ink discrimination.

Hyperspectral imaging (HSI) is a proven, versatile technology, allowing for the analysis of many types of samples, including a variety of questioned document samples. Previous studies have shown HSI to be highly discriminatory in the analysis of black ballpoint inks. Although HSI is able to differentiate black ballpoint inks in cases where other optical imaging methods cannot, there remain samples that cannot be differentiated by any method.

Forensic document examiners use a variety of techniques to determine the chemical properties of ink samples, including spectral analysis, fluorescence imaging, and various forms of chromatography. Using TLC, a sample is separated into its various constituents that are displayed as colored or fluorescent spots on a silica gel coated plate. The plate, with its resultant "spots" can be further visualized for ink components not readily visible to the naked eye. The plate can be evaluated using visible reflectance, near-IR reflectance, and/or fluorescence hyperspectral imaging to visualize the spots and therefore ascertain additional chemical information.

This study will demonstrate that combining HSI and TLC provides document examiners with increased discriminatory power and analytical versatility in determining differences between various black ballpoint ink samples. Preliminary data indicates that HSI is capable of discriminating black ballpoint ink samples, previously found to be indistinguishable, through the analysis of prepared TLC plates. By performing hyperspectral imaging of TLC plates and comparing the resulting data, certain inks that were previously categorized as indistinguishable by a number of investigative methods are now categorized as different.

Hyperspectral Imaging, Thin Layer Chromatography, Ink Discrimination

J3 The Determination of Authorship From a Homogenous Group of Writers

Marie E. Durina, BBA, San Diego Sheriff's Department, Crime Laboratory, 5255 Mt. Etna Drive, San Diego, CA 92117*

After attending this presentation, attendees will learn the history and development of the Palmer system of handwriting and learn to identify certain class characteristics associated with that system.

This presentation will impact the forensic science community by teaching how handwriting systems provide a foundation upon which people learn to write the language of their culture.

This presentation is based on a research project where samples of writing were obtained from over 50 writers who grew up in the same neighborhood, were taught the same copybook style (the Palmer system of handwriting), at the same Catholic elementary school, by the same teachers, approximately four decades ago. Knowledge of class characteristics of a particular handwriting system is important because these characteristics have a significant influence upon how a person writes.

Handwriting systems provide a foundation upon which people learn to write the language of their culture. Each person's writing contains a combination of class and individual characteristics. The extent of these combinations depends upon the individual. This is one of the basic reasons why handwriting is identifiable. For the forensic document examiner, knowledge of forms dictated by a particular handwriting system provides a reference point from which writers may deviate, and it is these deviations that document examiners must discern when performing examinations to attempt to identify or exclude writers as authors of questioned documents. Understanding of the influence of a particular handwriting system on those providing writing samples can help forensic document examiners evaluate features that make handwriting identifiable, and can aid in the performance of handwriting examinations and comparisons.

The presentation will cover the challenges encountered by forensic document examiners when they were asked to render conclusions of authorship on handwriting obtained from an homogeneous writing population, and will discuss possible sources of errors during the examination of such writings. Potential pitfalls involved in examining large groups of writing that may appear to be similar due to common class characteristics will also be discussed.

In this research study, the submitted specimen writings obtained from former students and teachers from the same school were subsequently examined and compared by a group of 49 forensic document examiners throughout the world. The examiners rendered conclusions of authorship on the writings and submitted them for grading.

The study sought to find supporting evidence that:

1) There is a high degree of inter-writer variation among writers, even in populations where the driving forces for variation are low; and
2) Among these homogeneous writing populations, forensic document examiners would still be able to extract features from the writing samples that would enable them to attribute authorship.

The research also hopes to answer criticisms that earlier studies on the individuality of handwriting did not include populations from "homogeneous writing communities," and relied on computer analysis of handwriting, rather than on human examiners.

Overall results of the study of handwriting from an homogeneous group of writers will be discussed, including how well human examiners performed as a group in making distinctions among the writing specimens. Effects on results that will be discussed include factors such as examiner experience level, peer review, geographic location of the participating examiners, and the length of the questioned documents submitted for examination. Potential sources for error in certain problematic samples will also be discussed.

Handwriting Systems, Homogenous, Palmer System

J4 A Comparison Between Different Likelihood Ratios for Assessing Handwriting Evidence

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After attending this presentation, attendees will understand how sometimes subtle changes to the prosecution and defense propositions can have a large effect upon the corresponding likelihood ratio. These impacts will be illustrated using an automated handwriting system developed and applied to handwriting samples collected by the FBI laboratories.

This presentation will impact the forensic science community by illustrating the effects of modifying the prosecution and defense propositions when interpreting handwriting evidence.

The ultimate goal of the court (and/or jury) is to make a decision concerning a specific suspect's guilt given the evidence, which in the likelihood ratio paradigm for presenting evidence is usually expressed as the posterior odds in favor of the suspect's guilt. In this paradigm, the court (and/or jury) is usually responsible for prior beliefs about guilt while the forensic scientist is responsible for providing the likelihood of the evidence when the suspect is guilty (the prosecution proposition) vs. when the suspect is not guilty (the defense proposition).

In this presentation, various sets of prosecution and defense propositions (and the resulting likelihood ratios) which have appeared in the literature will be compared and contrasted. The goal in performing these comparisons is to illustrate the effect that subtle modifications of these propositions can have on the resulting likelihood ratios. In addition, the practical and logical implications of each variation will be discussed.

This study will be performed using a dataset of bank robbery notes and a reference database composed of writing samples from over 400 writers.

Handwriting Evidence, Likelihood Ratios, Evidence Interpretation

J5 New Results for Addressing the Open Set Problem in Automated Handwriting Identification

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After attending this presentation, attendees will be updated on the current development status of a powerful tool for automated open set handwriting identification. Forensic document examiners will be more aware of the handwriting identification tools that are being developed to assist them in their practice.

The presentation will impact the forensic science community by increasing awareness of substantial advances being made in adding scientific underpinnings to the practice of forensic document examination.

The Open Set Problem involves making a two-stage decision when attempting to ascertain whether a questioned document was written by some individual in a reference collection (for which training material exists for each writer in the reference collection). The first step is to decide whether the document was written by any writer in the reference collection and the second step is to decide which writer in the reference collection is the most likely writer of the questioned document (or to give a "short list" of likely writers), presuming that the decision is that some writer in the reference collection was the writer of the questioned document. At theAAFS 2009 Annual Meeting, results were presented for this problem that were generated using the FLASH ID software system. Those results used the difference between the aggregated score (totaled over all graphemes in the questioned document) for the first place writer and the aggregated score for the second place writer as the basis for the "in the reference collection" decision. In this paper, results will be given for an improved open set decision based on a combination of the original criterion with a new criterion based on a "Vector of Counts" (VOC) methodology described below.

The VOC methodology is a way to obtain categorical type feature data by using the FLASH ID system with continuous feature data. It works in the following manner. First, a "base set" of writers is obtained, who are not in the reference collection or likely to be among writers of any questioned documents we observe. Writing samples, from these individuals and using FLASH ID create a trained system of the same sort as is used for the reference collection. This base set is used to analyze any document by recording for each grapheme in that document, which writer in the base set is most likely to have written that grapheme. In this way, a vector of counts for the document can be developed by counting how many graphemes are assigned to each writer in the base set.

Next, the training writings is taken for each writer in the reference collection and obtain a VOC for each of those writers. When a questioned document is analyzed, its VOC is obtained as well. Then, the VOC can be compared for the questioned document with the VOC for the first place writer when writers in the reference collection are assigned questioned document scores by FLASH ID. One way to do this comparison of VOCs is using a chi-squared statistic. Since large values of chi-squared would indicate a relative mismatch between the questioned document and the first place writer and since small values of the previously used difference of first and second place writer scores would also indicate a poor match, taking the ratio of these two criteria can be an effective tool for improvement of the open set decision. Numerical results are given based on extensive simulations to illustrate the improvement.

Handwriting Identification, Open Set Problem, Vector of Counts

J6 On the Conclusions of Handwriting Examination

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The objective of this presentation is to compare the current practice for interpreting handwriting evidence utilizing the Bayesian framework that is commonly recommended for other domains of forensic science. After attending this presentation, attendees will be made aware that their current practice for interpreting the results of handwriting examinations requires great care in the application of the underlying logical framework. Examples taken from another traditional field of forensic science (fingerprints) will demonstrate to the audience that it is possible to use a probabilistic framework to handle the uncertainty associated with forensic evidence, even in fields concerned with pattern matching.

This presentation is aligned with Recommendation #3 of the recent National Academy of Sciences (NAS) Report and this presentation will impact the forensic science community by asking for more fundamental research in the scientific validity in forensic science. Forensic document examiners, and more generally forensic scientists, need to be fully aware and comfortable with the scheme that they use to interpret and report evidence.

Among the recommendations of the recent report from the National Academy of Sciences is the need to establish the scientific bases of forensic techniques. The interpretation of the results of the examination of a particular evidence item, or in other words, the interpretation of the meaning and value of the evidence in the context of a case, is a critical part of any forensic technique.

Unfortunately, a majority of the fields in forensic science have not fully developed the proper theoretical framework allowing scientists to handle the uncertainty associated with forensic examinations. The weak understanding of the theoretical foundations of the interpretation of forensic evidence renders the assessment of the value of a given evidence item in the context of a case more difficult. As a result, the value of forensic evidence is either overstated for some evidence types, or does not realize its full potential for some other evidence types.

This paper reviews the current framework used by forensic document examiners to interpret the results of their examinations. More specifically, the reporting scheme and the conclusions currently proposed by the ASTM 1658 will be discussed with respect to the underlying logic of evidence interpretation that is proposed by forensic scholars over the past decades, namely the Bayesian framework.

After describing in simple and concrete terms the application of the Bayes' Theorem to handwriting examination, this paper will show that the Bayesian framework is not incompatible with current practice. However, the comparison of the current scheme and the Bayesian framework will highlight elements that require particular attention from documents examiners when reporting their conclusions based on the current scheme. At present, these elements may not satisfy the needs for transparency and for the support by empirical data recommended by the NAS report.

The final part of this paper will present how the proposed Bayesian framework is currently being implemented in other traditional fields of forensic science, such as fingerprints.

Handwriting Reporting Conclusion, Handwriting Interpretation, Probabilistic Framework

J7 Optimal Variables for Handwriting Identification

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After attending this presentation, attendees will understand the difference between human pattern recognition and computer based superposition in handwriting identification. Attendees also will understand the availability of the human pattern recognition to handwriting identification.

This presentation will impact the forensic science community by demonstrating the variety and the flexibility of the human pattern recognition in the field of handwriting identification.

A document examiner examines handwriting mainly by a qualitative method based on his/her knowledge and experiences. The qualitative examination, compared with the quantitative examination, possesses less objectivity and is believed to be less reliable. However, an examiner's opinion is, in fact, highly reliable. This is because the examiner has much knowledge about the handwriting and chooses the strategy and variables that are most appropriate to his/her case. So, an analysis of the strategies and variables an examiner uses and the quantification of them will contribute to the establishment of the objectivity in the examination.

Classification of handwriting samples was done following the procedure below. Six people wrote two kinds of Japanese Hiragana characters six times in square style. Both characters were written in one stroke. One character has a curvature stroke and the other has a linear stroke. There were 36 handwritten samples (6 subjects x 6 times) per character and all the samples collected were 72, that is, 2 kinds of characters x 6 subjects x 6 times. Coordinates of handwritten samples were measured at 21 points such as the starting point and the stroke terminal defined beforehand. Coordinates were standardized as for the origin and the character size. Then, handwritten samples were reconstructed by connecting standardized coordinates. Three kinds of classification experiments were done. Experiment 1 - Cluster analysis: Thirty-six data sets of standardized coordinate data of thirty-six handwritten samples were classified into 6 groups using cluster analysis. Cluster analysis finished at the stage where clusters were merged into 6. Experiment 2 - Classification of the reconstructed samples by the visual examination: One subject, who was an active forensic document examiner, classified 36 reconstructed samples into 6 groups according to the similarity of the samples. The subject was instructed the samples to be geometric figures, not characters. The subject was interviewed about the variables used for the classification after the experiment. Experiment 3 - Classification of the original handwritten samples by the visual examination: This was similar to a case work. One subject, who was the same subject as the subject participated in Experiment 2, was instructed to classify 36 handwritten samples into six groups according to the similarity of the samples. Experiment 3 was done one month after Experiment 2. The subject was interviewed about the variables used for the classification after the experiment. Three experiments were done to two kinds of characters respectively. Correct classification ratio of the three experiments was calculated and compared. Correct classification was defined as follows: A cluster was defined to be equal to the subject whose samples were contained in the cluster most. That is, if a cluster had four samples of the writer No.1, one sample of the writer No.2 and one sample of the writer No.3, the cluster was defined as the writer No.1's. After labeling each cluster to the writer, correct classification ratio was calculated. Correct classification ratio was defined as the ratio of correct writer's samples to the whole samples (=36 samples).

Average correct ratio of the two characters was the highest in Experiment 3 (87.5%). Experiment 1 showed 48% and Experiment 2 showed 44%. The subject's answer showed that the hooked shape in the stroke initial was weighted in Experiment 2, while stroke initial was ignored in Experiment 3. The terminating manner in the stroke was weighted in Experiment 3. The condition of the stroke termination highly correlated to the kinetic aspect of writing. These suggested that the knowledge on characters and the kinetic information while writing were important to the correct identification.

Handwriting Identification, Cluster Analysis, Human Pattern Recognition

J8 Forensic Stylistics: Strengths and Limitations

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The goals of this presentation are to briefly introduce the theory and practice of Forensic Stylistics (FS) as a viable linguistic approach to questioned authorship, then to focus specifically on real and perceived limitations of theory or method as related to its application.

This presentation will impact the forensic science community by informing attendees of the nature of FS and the ways in which it is being applied in cases of questioned authorship. It will then focus on actual limitations of the approach as well as unfounded objections sometimes raised in the judicial context.

Authorship identification is an important area of Forensic Linguistics based on the theory and practice of forensic stylistics as a technique that utilizes the linguistic analysis of writing style for the purpose of authorship identification. Such analysis is known as linguistic stylistics and is briefly summarized here: *Language* is the internal system human speakers and writers develop and use to communicate. *Style* is seen as that part of human behavior that reflects individual variation in activities that are otherwise invariant. While style in spoken language is linguistic variation that is directly related to the social context of conversation. Style in written language reflects both the writer's conscious response to the requirements of genre and context as well as the result of his or her unconscious and habituated choices of grammatical elements acquired through the long term, experiential process of writing. *Written style* is (in part), then, the sum of the recurrent choices the writer makes in the writing process. Finally, *stylistics* is a broad approach to the study of style in language, and *linguistic stylistics* is the scientific interpretation of style-variables as observed, described and analyzed in the language of groups and individuals.

Various case examples of style variables will be provided to demonstrate the nature of writing style and how it is used in authorship cases.

Linguistic limitations to the theory and practice of FS have been identified in recent years and have long been studied in authorship attribution research. Directly confronting such limitations provides direction to the ongoing development of stylistic analysis and of forensic authorship analysis. Specific concerns presently center around four principal issues, each of which will be considered in turn: selection of stylistic variables; objective statistical analysis of style-variable occurrence; analytical need to reference difficult-to-access linguistic norms to assess reliability of style variables; and significance of style variables relative to level of conscious use by the writer.

Questioned Authorship, Forensic Stylistics, Limitations

J9 Study on the Physical Measurements of Hangul Final Consonant

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After attending this presentation, attendees will learn how the alteration of individual handwriting and handwriting changes according to the measurement program and visual methods in handwriting identification were studied.

This presentation will impact the forensic science community by exposing attendees to the examination of Hangul writing.

Handwriting is a personal biometric that has long been considered to be unique to a person. When a child first begins to learn the art of handwriting, penmanship books of the different characters are placed before them. Their first step is one of imitation only, by a process of drawing. Handwriting is influenced by physiology, psychological effect, training, environment and other behavioral factors. Once the forms of the characters and their manual execution have been crystallized by long usage and graphic maturity, identifying characteristics will undergo only slight, if any change as times goes on. Formation of letters is unquestionably the most important and comprehensive in handwriting identification. Handwriting identification is usually based on empirical knowledge of a professional and valued mostly through visual examination from a professional rather than physical measurement and standardized handwriting measurements. Based on measurements of inside angles and external angles by a computer, the objectivity of

handwriting examinations and its and efficiency through automation can be improved.

Hangul is a phonetic alphabet, not an ideograph, as some may think it is. Hangul has 24 basic characters, 14 basic consonantal characters, and 10 basic vowel characters. Each Hangul syllable is composed of an initial consonantal character, a syllable-peak vowel character, and an optional final syllable consonantal character. Because handwriting is different and individual, position of character with individual handwriting characteristics can be identified by comparing external shapes. Ten people's Hangual handwriting samples were measured, specifically using the Hangul final consonant. Visual methods which include the direction of an initial stroke, stroke bond, and terminal stroke were measured by empirical knowledge of a professional. The writing was classified according to constancy (specific and characteristic handwriting features that were repeated) and scarcity (fixed handwriting features of an individual) by calculating measured values from inside angles, external angles, and ratio of the lengths of letters. The features of Hangul final consonant were analyzed by various methods and could be used to identify handwriting as coming from the a particular handwriting sample.

Handwriting, Identification, Hangul

J10 The Quantitative Analysis of Ballpoint Pen Inks Solvents on Paper

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After attending this presentation, attendees will learn ink dating methodologies.

This presentation will impact the forensic community by alerting them to new changes in ink dating methodology.

In the field of forensic document examination, forensic ink chemists face the task of classification and discrimination between the different brands of inks and accurate dating of ink entries. For characteristic profiles of inks, non-destructive methods such as physical and optical, as well as microscopic and spectroscopic techniques, are primarily applied. Theses methods provide color, infrared reflectance, luminescence, absorption of radiation, and Raman scattering characterization. But it is necessary to determine sample kinds and components using chemical methods. Chemical examinations of an ink used are the solubility test, thin-layer chromatography (TLC), ultraviolet fluorescence, high-pressure liquid chromatography (HPLC), and gas chromatography/mass spectrometry (GC/MS). Forensic document examiners have been focusing on the aging processes of the components in ink such as dyes (colorants), solvents (vehicles), and resins. Aging processes have been recently influenced by environmental conditions and effective abstraction of ink components. Ballpoint pen inks are mainly composed of dye, organic solvents, resin, and additives. Among these components, organic solvents are 50-95% by weight based on the weight of the ink such as benzyl alcohol, phenoxyethanol, phenoxyethoxyethanol, ethoxyethoxyethanol, 2-ethylhexanol, *N*-methylpyrrolidone, dipropylene glycol, propylene glycol, monophenyl ether, polyoxypropyltrial, triethylene glycol mono butyl ether, triethylene glycol monoethyl ether, 1-octanol, and/or 2-octanol.

The aim of this study was to investigate the aging process of ballpoint pen inks, determined by the disappearance of solvents from the stroke after deposition on paper. The components present in black ballpoint pen by GC-FID were evaluated. Examinations were performed for fifty-nine samples of black ballpoint pen with various brands and manufacturers, commonly available in South Korea. Ballpoint pen entries drawn on office copy paper(80 g/cm^2) with a writing force of 300-400 kgf using load cell with a ruler and stored at room condition(darkness, 25, 50 % relative humidity). Small paper disks were cut from ink entries with a micro-punch (plug size about 0.5 mm in diameter). To determine calibration curves, reference solvents were pure ethoxyethoxyethanol, 2-phenoxy ethanol and dipropylene glycol and etc. Extraction of solvents from ink entries was made using dichloromethane. Changes in quantity of solvent were investigated for entries over 1-year-old. It was detected that in some ink a significant decrease of solvent was noticed within several hours and up to several months. This research could aid the forensic document field by providing an alternative to current ink analysis techniques

Questioned Documents, Ballpoint Pen Ink, Ink Dating

J11 Risk Management in Forensic Document Examination: The Role of Formal Training

Karen S. Runyon, BA, 400 South 4th Street, Suite 505, Minneapolis, MN 55415*

After attending this presentation, attendees will learn more regarding research literature on expertise and expert performance, as well as receive an understanding of the application of these research findings to forensic science and specifically the field of forensic document examination. The presentation will review various approaches to expertise and delineate best practices based on research in the study of expertise.

This presentation will impact the forensic science community by improving training and education practices in forensic science and in-training specific to forensic document examination. Awareness of practices among traditional and self-promoting professional affiliations will impact the users of forensic document examination and allow greater reliability of the results of analysis.

The identification, characterization, and management of risk is a standard exercise within professions and industries. The forensic science industry historically has employed a dedication to formalized introductory training following academic degree achievement as a reliable foundation for expertise development. This formal training has been widely accepted as an elementary foundational mechanism for managing risk by those who claim expertise in evaluating forensic science evidence. This is not a unique model of introduction into a profession. Abundant research exists related to development of expertise and expert performance and is inherently applicable to the forensic sciences. The recent popularity of forensic science coupled with the lack of industry regulation has led to risky behavior, largely authorized by the broad, encompassing language of Federal Rule 702. In light of expert performance research findings, this presentation discusses the history of training in the forensic document examination profession, the application of findings concerning expert versus novice behavior, and reviews the practice of this expertise by various traditional and self-promoting organizations.

Training, Expertise, Forensic Document Examination

J12 Status of Graduate Studies in Forensic Document Examination at Oklahoma State University Center for Health Sciences

Charles L. Eggleston, MFS, 41590 Road 757, Cozad, NE 69130*

After attending this presentation, attendees will be aware of the current status of graduate studies in forensic document examination at Oklahoma State University Center for Health Sciences including a Graduate Certificate and Master of Science in Forensic Science degree.

This presentation will impact the forensic science community by presenting the Oklahoma State University Center for Health Sciences initiative to academically support the next generation of forensic document examiners.

In the academic year 2003-04, Oklahoma State University Center for Health Sciences launched an online graduate studies program in the forensic examination of questioned documents and added a track in questioned documents to a master's degree. The goal was twofold: academically support traditional forensic document examination training regimens, and further academic acceptance of forensic document examination as a forensic science discipline. In the ensuing five academic calendar years, 26 individuals have successfully completed a total of 150 credit hours in courses specific to document examination, and six individuals have completed a master's degree with a specialization in the field.

Improvements to the program have brought about several changes, including a Graduate Certificate in Forensic Document Examination, awarded upon completion of four online academic courses specific to the discipline; a substantial tuition waiver for participating governmental employees; an additional online course covering historical aspects of forensic document examination; the establishment of forensic document examination as an academic track in the Master of Science in Forensic Sciences degree; and course revisions to reflect the latest published texts, articles and empirical studies in the discipline.

All courses are offered entirely online and require no attendance on campus. The Graduate Certificate consists of 12 credit hours and can be completed in 3 to 4 semesters. The certificate courses are: Forensic Examination of Questioned Documents; Forensic Handwriting Examination; Technical Aspects of Forensic Document Examination; and Historical Aspects of Forensic Document Examination. The Master of Science in Forensic Sciences degree with an option in forensic document examination consists of 39 credit hours including the certificate courses and can be completed in 7 to 13 semesters. A comprehensive examination is required. Applicants must meet minimum qualifications for admission to the Graduate College at Oklahoma State University, which include a grade point average of 3.0 or above. Participation also requires associated training or experience and the approval of the lead instructor for forensic document examination courses.

Students who are employees of city, county, state, and federal agencies with the United States can receive a partial tuition waiver. Verification of employment is required. Students enrolled in the Master of Science in Forensic Science degree with the forensic document examination option who reside in the Academic Common Market (ACM) States may qualify for in-state tuition. ACM States besides Oklahoma are: Alabama, Arkansas, Delaware, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Texas, Virginia, and West Virginia. Permission from the governing college board in those states is required.

Education, Forensic Document Examination, Graduate Studies

J13 Error Rates - Limitations and Realities

Jane A. Lewis, MFS, Wisconsin State Crime Lab-Milwaukee, 1578 South 11th Street, Milwaukee, WI 53204-2860*

After attending this presentation, attendees will appreciate the compexites of applying error rates to forensic science disciplines.

This presentation will impact the forensic science community by creating an appreciation for difficulties of applying error rates to each forensic science discipline.

How do you define error rate? This is the first question on a forensic science survey and one of the five flexible *Daubert* factors considered in the admission of scientific evidence. The American Academy of Forensic Sciences (AAFS) Section officers were sent a brief survey exploring error rates – what they are and how they use them. The eleven sections of the AAFS were asked to apply questions about establishing error rates to each forensic specialty area. These eleven AAFS sections include: Criminalistics, Digital & Multimedia Sciences, Engineering Sciences, General, Jurisprudence, Odontology, Pathology/Biology, Physical Anthropology, Psychiatry & Behavioral Science, Questioned Documents, and Toxicology. The 2010 AAFS Annual Section Program Chair, AAFS President, and several persons outside the forensic science world were also surveyed. Responses varied, but none of the AAFS respondents had a personal error rate. AAFS section officers returned 12 of 22 surveys sent out. Several sections refused to participate in the project. Most who responded stated that it was not possible to establish error rates for each examination method used in their profession. The surveys explain the limitations and realities of attempting to apply error rates to a disparate group of forensic scientists.

Error Rate, Forensic Sciences, Forensic Document Examination

J14 An Examination of Sources and Content to Root Out Faked Photos and Methods of Presenting Pictures to Maximize Their Impact

Cecilia Bohan, BA, The New York Times, 119 Tappan Landing Road, Tarrytown, NY 10591*

After attending this session, attendees will understand some principals of image fakery and detection and will learn how pictures are selected to illustrate news articles.

This presentation will impact the forensic science community by identifying means of analyzing photos and will offer examples of how and why manipulation can occur, sometimes without malice of intent and other times to purposefully direct perception and opinion. By evaluating how pictures are analyzed and presented in the newspaper, the forensic document examiner will gain useful information that can be applied to his/her own examination and presentation of photographs.

The presentation will cover methods of determining the authenticity of a photograph, which include critically considering the sources of the photos, and by comparing a photo in question with other relevant news photos. It will also describe how picture editors might present a particular set of images to be most persuasive. Some pertinent examples of images which were discovered to be outright fakes include: a doctored image of an Iranian missile launch, which was identified upon submission to *The Times* to be bogus, but was erroneously published in other publications as an accurate depiction of events; and a doctored image of heavy smoke over Lebanon, which was discovered to be a fake only after publication. Other forms of manipulated imagery are staged situations in Myanmar, for example, that allow outsiders access to clean refugee areas in the aftermath of the typhoon, while denying access to devastation. There are also so-called "set designers," or people who stage photos to maximize impact in the press. These are prevalent in war zones when one side stands to benefit from depicting themselves as being either victimized, or to be a stronger power. In these kinds of cases, it is often not the scene in the photo that is the biggest problem, but that meanings can be changed depending on the caption. Anyone who provides pictures for publication and has an interest in promoting or creating a public image could manipulate an image. Because it is in the newspapers interest to portray events as accurately as possible, uncontrolled photographs of all kinds are regarded carefully. Government handouts or even handouts from a performance fall into this category. Whether a photo is a hard news photo or a soft feature photo, the goal is the same - how to best convey a story and how to persuade the finder of fact that the story they have of the event is the correct one.

The presentation will stress the scrutiny of photographs on many levels – for content, caption, and for what they might not be showing. Knowing the source and what might motivate that source is also critical. The final vetting process at *The Times* involves selecting the few which tell the story best. How they are presented can make the difference between getting the point across or not.

Photographs, Manipulated, Faked

J15 Evidential Value of Adhesives in Questioned Document Examinations

Douglas K. Shaffer, MS, Immigration and Customs Enforcement, Forensic Document Laboratory, OI FDL STOP 5116, DHS/ICE Forensic Document Lab, 8000 Westpark Drive, Suite 200, McLean, VA 20598-5116*

After attending this presentation, attendees will better understand the role and evidential value of adhesives in the examination of questioned documents.

This presentation will impact the forensic science community by alerting questioned document examiners to the evidential importance of detecting and identifying adhesives in the materials (e.g., inks, papers, substrates) of questioned documents cases.

The presence of functional adhesives in questioned document materials is widespread, although these components are often overlooked as useful diagnostic evidence for authentication and linking purposes. Adhesive formulations are found, in one form or another, in written and printed inks, paper substrates, applied laminates, envelope gums, stamps and packaging labels, photographs or security features attached with a glue, and various other document constituents. It is often of probative value to the questioned document analyst to chemically characterize the adhesive formulation for authentication or linking purposes and to understand possible mechanisms by which counterfeiters can chemically remove, alter, or replace an adhesive material in the production of fraudulent documents.

Adhesion can be defined as the tendency of a material to bond to another material. The strength of adhesion, or attraction, between bonded materials depends on many factors, including the means by which the bonding occurs – e.g., by mechanical means, in which the adhesive works its way into small pores of the substrate, or by one of several chemical mechanisms. In some cases, an actual chemical bond is formed between the adhesive and the substrate. In others, electrostatic forces hold the substances together. A third mechanism involves the *van der Waals* forces that develop between molecules, while a fourth means involves the diffusion of the glue into the substrate, followed by hardening.

In the case of written or printed inks, formulations require chemical and mechanical forces to hold their multiple constituents together as a single entity and to bond tightly to the substrate after application. The vehicle system of the ink largely determines its adhesive properties. On absorbent substrates, such as paper, adhesion is influenced by the degree of vehicle penetration into the matrix, while on non-absorbent substrates such as films or foil, adhesion is primarily controlled by the film-forming ability of the resin and the molecular affinity for the substrate. Inkmakers often use adhesion promoters in small amounts to enhance the compatibility between substrate and ink to provide improved chemical bonding.

Binders such as starch act as adhesives in the production of paper by increasing the strength of the inter-fiber bonding. The fiber-to-starch link is stronger than the fiber-to-fiber bond, which translates directly to the strength of the paper fibers, with the greatest percentage gain in strength noted in cotton fiber content papers. Applied laminates, or films, which are added to one or both sides of a printed document (e.g. passports, identification cards, photo badges) to protect the document from degradation due to handling and exposure, are available as either self-adhesive films, cold (or *tape*) laminating films, or hot (or *thermal*) laminating films, depending on the intended application. The adhesives contained in envelope gums, stamps, packaging labels and various glue-based document features also consist of resin formulations which can be analyzed by questioned document examiners.

Various types of adhesives that are used in the production of document materials (inks, papers, laminates, et al) will be described, including heat set, solvent and pressure sensitive adhesives, and will discuss analytical techniques that are available to characterize the adhesives to provide diagnostic forensic information. A basic description of the principles of adhesion, and how adhesives are developed and incorporated into document materials, in particular, will also be covered in this presentation.

Adhesives, Documents, Bonding

J16 Examination of Fraud Documents by Microscopy Raman Spectroscopy Method

Tamas Gal, Agnes Karoly, and Judit Sandor, MSc, Institute for Forensic Sciences, 1903 Budapest, PO Box 314/4, Budapest, HUNGARY*

After attending this presentation, attendees will learn a new method for the determination of the sequence of printed text and signatures in questionable documents with no intersecting areas of pen ink and toner lines.

This presentation will impact the forensic science community by improving its capabilities in fraudulent document investigations.

In recent years, due to the widespread availability of laser printers and photocopiers, offenses in connection to document alterations have become more frequent. Crimes and illegal acts related to document manipulation include fraud, counterfeiting, blackmail, anonymous letters, and acts of terrorism among others. Following the trend of the increasing number of document fraud cases, efficient investigation techniques of printed materials have come into the focus of forensic research.

In cases with suspicions that the content of a signed legal document has been subsequently altered, the determination of the order of crossing lines is an appropriate investigation approach. If the printed text overlaps or intersects with the signature on the document, the alteration may be investigated by examining the areas of intersections. In these cases a number of techniques are available to determine the order of crossing lines. They include standard optical microscopic techniques and some special types of microscopy for example SEM and AFM. Recently a new analytical method was published, the microscopy FTIR-ATR method, which is a suitable technique to determine the sequence of the crossed lines. This can be done by measuring the surface layer at the areas of intersection. In the visual mode of the ATR objective, the exact definition of line crossing points is provided, so the chemical composition of the surface layer can be examined at this point based on the spectrum. Analyzing the upper layer, the sequence of crossed lines of printer toner and pen ink can be determined. However, if there was no intersecting area the sequence order of the toner and pen ink layers could not be determined with the application of the above standard methods.

In this paper a new method is presented that is applicable for the determination of the order of different ink layers even if there is no visible intersection of printed lines. The microscopy-based Raman technique is an eligible method for the determination of the chemical structure of printer toners and pen inks directly on the document. This new method is based on the features of the printing process used by the copiers and laser printers. During this electro-photographic process, dry toner particles of size 6-8 mm diameters are melted and flattened by pressure onto the surface of the document. The polymer resin, the main component of dry printer toners creates a few mm thin surface layer that

forms the characters and further thousands of discrete toner particles contaminate the full surface of the paper. These microscopic toner spatters are evenly distributed over the whole document, approximately 100 spatters/ cm^2. Such particles can almost surely be found in the critical area of the signature or other lines of high importance. As the chemical structure of these particles is the same as the toner material, these micro-sized toner particles are suitable for the sequencing examination.

This new method helps to investigate the chronological sequence of two writing media in both possibilities: document with and without intersecting lines. This is a simple, fast, non-destructive method, which doesn't require sample preparation and provides an objective result leaving the documents intact.

Document, Fraud, Raman

J17 Hyperspectral Imaging vs. Video Spectral Analysis: A Continued Comparison of Ink Discrimination Capabilities

Derek L. Hammond, BA, U.S. Army Criminal Investigations Lab, 4930 North 31st Street, Forest Park, GA; and Sara E. Nedley, MS, Cara A. Plese, BS, and Rebecca Schuler, BS, ChemImage Corporation, 7301 Penn Avenue, Pittsburgh, PA 15208*

After attending this presentation, attendees will understand how hyperspectral imaging compares to video spectral analysis for the discrimination of black ballpoint inks.

This presentation will impact the forensic science community by providing information for alternative, nondestructive methods of ink analysis and discrimination.

Forensic document examiners have a need for reliable and nondestructive methods for discriminating between handwritten entries made by different writing instruments. Traditional methods of analysis for the nondestructive differentiation of inks include the use of dichroic filters, ultraviolet lighting, digital imaging, and video spectral analysis. Of these, video spectral analysis may be the most commonly used nondestructive method of analysis used today to discriminate between visually similar inks.

In a previous study[1], 44 different black ballpoint pens were used to make 990 pen-pair samples for discrimination analysis comparing two nondestructive techniques: digital imaging[2] and video spectral analysis[3]. At least 187 pen-pairs could not be discriminated through the use of video spectral analysis methods.

A blinded study was performed on a subset of the 990 pen-pair samples, including some of the 187 pen-pairs which were previously found to be indistinguishable through video spectral analysis methods. This study will expand upon the data acquired from the initial subset of 99 pen pairs by continuing to assess the discriminatory power of hyperspectral imaging technology[4]. A comparison of results between hyperspectral imaging (operating in the visible/NIR reflectance and NIR luminescence modes) and traditional video spectral analysis will be presented. Current data indicates that hyperspectral imaging is capable of discriminating black ballpoint pen-pair samples previously found to be indistinguishable through video spectral analysis.

References:

1 Hammond, D. L., Validation of LAB Color Mode as a Nondestructive Method to Differentiate Black Ballpoint Pen Inks, *J. For. Sci.*, Vol.52, No 4., pp. 967-973, July 2007

2 L*A*B* Color Mode using Adobe® Photoshop®

3 RIR and IRL using a Foster & Freeman VSC4C

4 ChemImage's HSI Examiner 100 QD hyperspectral imaging system

Hyperspectral Imaging, Ink Discrimination, Questioned Documents

J18 The Need for Research Into the Analysis of Pigmented Printing Inks

Joel A. Zlotnick, MSFS, and Douglas K. Shaffer, MS, DHS-ICE Forensic Document Lab, 8000 Westpark Drive, Suite 200, McLean, VA 22102*

The goals of this presentation are to contrast dye-based and pigment-based inks and toners, and describe why these two types of materials are most effectively analyzed by different methods. This presentation will further describe how the ICE Forensic Document Laboratory plans to address this need with the development of a new printing ink analysis program geared toward the analysis of pigmented printing inks and toners.

Ultimately, development of a printing ink analysis program will impact the forensic science community by making available a resource at the proposed scale which does not exist in the United States at the present time.

Analysis of inks has historically been centered on dye-based writing inks, primarily ballpoint pens. Thin-layer chromatography (TLC) has unquestionably been the method of choice, though research has been done in many other areas of analytical chemistry to compliment TLC. Additionally, TLC methods used for ballpoint pens have been adapted to the analysis of other materials containing dye colorants, including non-ballpoint writing instruments as well as inkjet inks. However, TLC requires extractability of the ink components from both the substrate and from the rest of the ink matrix as a prerequisite to effective separation, and does not perform well when used to analyze pigments that cannot dissolve in the extraction solvent due to their intrinsic chemical properties, or their encasement in binders within the ink vehicle. Printing materials such as impact printing process inks, toners, water- and light-fast pigmented inkjet inks, and even some specialty writing inks (such as gel pens) all fall into this category and are difficult to analyze by TLC. Accordingly, it is necessary to identify appropriate instrumental analysis methods that can be applied to pigmented ink samples, and validate them for court admissibility and casework. This is important for analysis of forensic samples such as counterfeit documents, including identity documents and packaging, which are produced using pigmented inks and (for example) traditional printing processes like offset lithography.

To accomplish this, the ICE Forensic Document Laboratory is in the process of developing a library consisting both of raw materials, including pigments, resins, oils and additives, and finished ink samples appropriate for a variety of printing processes, including offset, typographic, screen and intaglio. It is anticipated that collection of these samples, and construction of a database to document their properties, will be an ongoing process that will require several years and extensive cooperation with industry partners. Characteristics of these materials will be studied by a variety of instrumental analysis techniques, to include Fourier transform infrared spectroscopy (FT-IR), Raman spectroscopy, laser-ablation inductively-coupled plasma/mass spectrometry (LA-ICP/MS), pyrolysis gas chromatrography/mass spectrometry (py-GC/MS), scanning electron microscopy (SEM), and other techniques as required. Of equal importance, various modes of sampling of the documents will be studied, not only because the pigmented materials in question are not easily solubilized, but also to minimize destruction to questioned documents for future court purposes. It is also expected that method selection, method development and validation of the chosen instrumental techniques will require several years to complete.

Printing Ink, Toner, Pigment

J19 Analysis of Writing Inks by Time of Flight Secondary Ion Mass Spectrometry (ToF-SIMS) - A Case Study

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After attending this presentation, attendees will learn about the ToF-SIMS instrumentation, its advantages and disadvantages, and its applicability to the analysis of writing inks, as well as, other items of forensic interest. Information and data will be provided that will illustrate the abilities of the ToF-SIMS methodology to solve the "line crossing" problem through the illustration of an actual case example.

This presentation will impact the forensic science community by introducing a unique, surface sensitive, mass spectrometry, ToF-SIMS, and illustrating its application to the solving of a forensic problem.

The analysis of writing inks has garnered extensive interest by the forensic community in regards to differentiation, dating and the solving of problems such as line crossings and obliterations. Various assorted scientific methodologies have been employed such as near infrared imaging, thin layer chromatography, chemical spot tests, high performance liquid chromatography, gas chromatography/mass spectrometry, raman spectroscopy and capillary electrophoresis.

This work will evaluate the capabilities of surface mass spectrometry and especially Tof-SIMS in the analysis of writing inks. Tof-SIMS has several advantages besides the surface sensitivity that will be elucidated, including superior mass resolution, minimal sample destruction, surface analysis, and imaging capabilities. Because of the limited destruction and superior mass range the ToF-SIMS technique is a desirable examination methodology in those instances where the evidence is either extremely limited, as in the case of trace evidence, or extremely valuable, as in the case of antiquities or historical documents. The imaging capabilities of the ToF-SIMS also allow this examination methodology to be used in a court setting where examination results can be easily demonstrated to the trier of fact. One such instance where this circumstance arises is that of a "line crossing." The term "line crossing" refers to an instance where two lines, prepared by either writing or printing, intersect. Historically, microscopic examination has been the technique of choice for this problem, but high instances of inconclusive results and lack of ability to illustrate results has caused continuous research for a better solution. This work will illustrate a series of differences detected by ToF-SIMS among a group of ink formulations. These differences in mass spectra, combined with the ToF-SIMS' surface analysis capabilities, allow for points of comparison that can be used to determine the sequence of application in a "line crossing" problem.

Ink Analysis, ToF-SIMS, Line Crossing

J20 The Characterization of Black Inkjet Computer Printer Inks Using Chromatographic and Spectrophotometric Techniques

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After attending this presentation, attendees will understand how various analytical techniques can be used in the analysis and identification of black inkjet computer printer inks. Through the analysis of black inkjet computer printer inks using both spectrophotometric and chromatographic techniques a characterization of the various manufacturers, and the differences between the manufacturers, will be identified. In addition, a classification scheme will be developed, and tested using a blind study, that will aid in the identification of unknown black inkjet ink samples.

This presentation will impact the forensic science community by providing a mechanism for the analysis of inkjet generated documents. This research will provide key information on the differences between, and within, the various inkjet ink manufacturers that will aid in the examination of questioned documents. Once the differences between, and within, the various inkjet ink manufacturers is known, it will be possible to identify unknown ink samples, which can aid in an investigation.

Documents are prevalent in every aspect of daily life and hardly a day passes without using some sort of document. Problems arise; however, when the authenticity of these documents is raised. Forensic science has long been involved in the investigation and examination of suspect documents. One of the steps in the examination of questioned documents is for the examiner to analyze the type of material used to create the document. This could involve the analysis of the paper substrate and/or the medium used to create the written word, namely pen ink, typewriter ink or photocopied documents.

This is the age of the computer, and as a result new challenges are facing the questioned document examiner. With more and more individuals using computers to produce their documents, and with the advancement of more sophisticated computer and printer systems, it has become harder for the analyst to distinguish and individualize a suspected document based on physical appearance alone. Once again, the forensic scientist must focus on the material used to produce the document, namely the computer printer ink. An examination of these ink samples may allow for the differentiation between the many manufacturers, as well as within the products of a specific manufacturer. In time, it may also be possible to date a computer printer generated document based on the drying and decomposition rates of the different computer printer ink components. Unfortunately, this is still just a theory. There have been few studies on the different types of computer printer inks and how, or if, they differ from each other. The identification of the various black inkjet computer printer ink manufacturers, and the creation of a classification procedure, is the first step in the analysis of a questioned inkjet produced document.

The goal of this study is to produce a detailed document on the forensic identification of black inkjet computer printer inks. The analysis of black inkjet computer printer inks by the various analytical methods will result in the production of data that will aid in the establishment of a classification procedure that can assist the forensic scientist in the examination, identification, and discrimination of the different inkjet computer generated documents they receive.

Results obtained through the analysis of the ink samples on Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Pyrolysis Gas Chromatography/Mass Spectrometry (PyGC/MS) and Attenuated Total Reflection Fourier Transform Infrared Spectrophotometry (ATR-FTIR) will be presented. In addition, the results of the blind study, which was conducted to test the accuracy of the classification scheme that was developed will be presented.

Inkjet, Chromatography, Spectrophotometry

J21 New Perspectives in the Interpretation of Ink Evidence

Cedric Neumann, PhD, Forensic Science Service, 2920 Solihull Parkway, Solihull, B37 7YN, UNITED KINGDOM*

After attending this presentation, attendees will understand why the current ASTM standards on ink analysis unnecessarily limit forensic ink examiners in their contribution to the criminal justice system.

Furthermore, attendees will realize that it is possible to improve the profession through the development of adequate quality assurance (QA), data collection, and theoretical frameworks.

The theoretical framework and the results presented during this session will 1) impact the forensic science community by raising the need for the ink examination community to improve their QA; 2) will impact the development of ink examination guidelines for analyzing and interpreting ink evidence; and 3) ultimately will show that the contribution of ink evidence to the criminal justice system can be increased.

The contribution of ink evidence to forensic science is described and supported by an abundant literature and by two standards from the American Society for Testing and Materials (ASTM). The vast majority of the available literature is concerned with the physical and chemical analysis of ink evidence. The relevant ASTM standards mention some principles regarding the comparison of pairs of ink samples and the evaluation of their evidential value.

Reviewing the literature and the ASTM standards in the light of recent developments in the interpretation of forensic evidence has shown the potential for some improvements. These improvements would maximize the benefits of the use of ink evidence in forensic casework. More importantly, these improvements will render the field more compatible with some of the recommendations from the National Academy of Sciences report, *"Strengthening Forensic Science in the United States: A Path Forward."*

This paper reviews these potential improvements and presents how a suitable QA process, associated with computer-based pattern recognition and a dedicated theoretical framework for the interpretation of ink evidence, can successfully improve current practices.

Ink Evidence, Interpretation, Quality Assurance

J22 Forensic Analysis of Inks by Laser Induced Breakdown Spectrometry (LIBS) and Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)

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The goal of this presentation is to provide the forensic community with a critical evaluation of the value of using LIBS and LA-ICP-MS for the elemental profiling of writing inks.

This presentation will impact the forensic science community by proposing innovative methods for the forensic examination of writing inks. Advantages and limitations of the use of LIBS and LA-ICP-MS on ballpoint and non-ballpoint inks will be also presented.

Document related crimes are considered a very prevalent form of crime that has a serious economic impact on society. The physical and chemical examination of writing inks has been the focus of many criminal investigations and in routine document examinations, non-destructive analytical methods such as microscopic and optical techniques are applied first. However, these methods are often unable to sufficiently characterize the inks used to prepare the document or to determine attribution between a questioned ink samples to a known source. Moreover, ink formulations are constantly changing to adjust to market requirements. As a consequence, there is an increased interest in finding alternative and/or complementary methods of analysis for writing inks to assist document examiners to overcome analytical challenges that otherwise are difficult to address using conventional methods of analysis. The purpose of the present work is to conduct method development and evaluation of the capabilities of two alternative techniques, LIBS and LA-ICP-MS, for the elemental analysis and comparison of writing inks. Laser sampling (LIBS and LA-ICP-MS) can provide good spatial resolution for the direct removal and subsequent elemental analysis of very small samples on surfaces such as ink deposited on a paper substrate. Some of the recognized advantages of LA-ICP-MS include direct characterization of solids, elimination for the need for chemical procedures for dissolution, minimum consumption of the sample (~nanograms), high sensitivity and high selectivity. Although less mature than LA-ICP-MS, LIBS also shares the benefits associated to laser ablation methods with the added advantage of improved speed, versatility, ease of operation and data interpretation, affordability and portability. An evaluation of the parameters of forensic interest will be investigated in detail including the comparison of the analytical performance of each technique, the homogeneity of the inks at the micro-scale, sampling size requirements, data analysis and interpretation of the results. Another key objective of this presentation consists in the evaluation of the meaning and value of the elemental composition in the discrimination and comparison of writing inks. Sample collections representing ballpoint inks and non-ballpoint inks originating from a known variety of sources will be used to evaluate the discrimination capabilities of the LA-ICP-MS and LIBS methods and to determine type I and type II error rates. The sample sets used for the discrimination studies consist of black gel ink collected from 24 different sources, blue gel ink collected from 22 different sources and black ballpoint ink collected from 18 different sources. The variability of the elemental composition of inks was also studied within ink samples collected from pens originating from the same package. The results show that both the LIBS and LA-ICP-MS methods provide good discrimination between the different inks with very low type I and type II errors and therefore can be useful for the comparison and classification of writing inks and could potentially be optimized for the analysis and identification of other type of inks such as from inkjet printers. The proposed methods can facilitate the chemical analysis of questioned documents by incorporating LIBS and LA-ICP-MS within the analytical strategy.

Inks, Trace Elemental Analysis, LIBS

J23 A Method for Determining the Software Used to Print a Questioned Inkjet Document Utilizing Microscopy and Computerized Imaging

Jordan C. Brough, BS, 5501 Seminary Road, #208, Alexandria, VA 22041*

After attending this presentation, attendees will be introduced to a way in which an examiner can identify the software used to print a questioned document using only the document itself and specimens collected from possible source computers.

This presentation will impact the forensic science community by giving examiners more tools to trace a document to its origins. With only the questioned document itself as evidence, forensic document examiners are often able to determine which printer was used but not which computer sent the file to the printer. This method may aid in such a determination.

This paper reviews a novel way of determining which software application was used to print a document by examining inkjet printing patterns. The source was conducted using only a questioned document and known specimens printed from PDF viewing software such as Adobe Reader® or Apple Preview®. Both Macintosh and Windows based computers were used to print on a common Epson inkjet printer.

A letter sized PDF containing a small gray square was created and used as a print sample. Sample documents were printed from eight software packages on different operating systems.

Great care was made to use all of the same printer settings. A look under the microscope showed initial findings of unique dot patterns that were reproducible. Occasionally, the differences were very small, only a dot or two. An attempt was made to automate the process with a device called the ImageXpert ®. This machine, used by the printing industry for quality assurance purposes, can be calibrated to count the dots with its camera and software. A method was developed to count these dots quickly with a very small standard of deviation.

A blind test was later conducted. Windows versions of Foxit and Adobe Reader 7, 8, and 9 as well as Macintosh OS X versions of Preview and Adobe Reader 7, 8, and 9 were used to print an unknown amount of documents from each software program. Seventy percent of the questioned documents correctly identified the software program used and was able to exclude all but two software options for the other thirty percent. No false associations or exclusions were made.

Questioned Documents, Inkjet Printers, Printing Software

J24 Preconditions for Unsafe Acts in Forensic Document Examination

Karen S. Runyon, BA, 400 South 4th Street, Suite 505, Minneapolis, MN 55415*

The goal of this presentation is to acquaint attendees with the Swiss Cheese model of accident causation and consideration of human factors in risk management, developed by James T. Reason in 1990.

This presentation will impact the forensic science community regarding a safety method by which evaluation can be made as to conditions that may impact analysis and evaluation of evidence.

British psychologist James T. Reason developed a model in 1990 to evaluate accident causation by considering layers of human systems that can contribute to a failure. This model is routinely applied in safety applications. The four levels are comprised of the unsafe act, preconditions for the unsafe act, unsafe supervision, and organizational influences. Acknowledging the ever-present possibility of error in forensic examination of document evidence, preconditions that may lead to a lack of safety in practice are defined and discussed.

Safety, Error, Forensic Document Examination

J25 Statistical Study on the Changing Range of Hangul Signatures

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After attending this presentation, attendees will be familiar with Hangul signatures and various ways to exam them.

This presentation will impact the forensic science community by demonstrating the range of variation present in Hangul signatures.

The purpose of this study was to confirm the range of variation present in Hangul signatures. Ten persons' handwriting were measured the height-width ratio of whole signature, the space ratio of each character, the height-width ratio of each character by CAD (Computer Aided Design) software. These measurements were intended to verify how each signature changes over time and how signatures are different from each other and other writers, reflecting inter and intra writing variations. The results suggest that a signature has individual characteristics; however, the individual characteristics that will be change over time in their signature are not always the same.

Hangul Signature, Hangul Handwriting Identification, Changing Range of Hangul Signature

J26 Expert Witnesses: Lawyers' Ethical Obligations Under the Rules of Professional Conduct

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After attending this presentation, attendees will understand the ethical rules for attorneys that impact their interface with expert witnesses, what attorneys can reasonably expect of expert witnesses and what experts, in turn, have a right to expect from the attorneys with whom they work.

This presentation will impact the forensic science community by serving as a guide for both attorneys and expert witnesses for the ethical preparation and presentation of expert testimony in court, as well as the proper recourse for expert witnesses when ethical violations occur.

In recent years, members of the forensic science community have expressed dissatisfaction over unethical and unprofessional conduct on the part of the lawyers with whom they work. Some commentators have proposed a special Code of Conduct for lawyers when dealing with forensic experts; others have suggested the need for an Expert Witness Bill of Rights.

On February 18, 2009, the National Research Council of the National Academies released a report entitled *Strengthening Forensic Science in the United States: A Path Forward*. While the committee was critical of a number of forensic disciplines, the legal system was also roundly faulted for its shortcomings:

> …the adversarial process relating to the admission and exclusion of scientific evidence is not suited to the task of finding "scientific truth." The judicial system is encumbered by, among other things, judges and lawyers who generally lack the scientific expertise necessary to comprehend and evaluate forensic evidence in an informed manner…

The problems are real. Lawyers often build their cases around evidence they do not understand and put experts on the witness stand without adequate preparation. Some lawyers engage in procedural gamesmanship and attempt to delay or deny their opponents access to the factual and scientific foundation of experts' proffered opinions. Others go so far as to mischaracterize their experts' conclusions and deceive the court and opposing counsel with false or misleading exhibits.

What many in the forensic science community do not appreciate is that existing Rules of Professional Conduct already address these situations. Rather than develop new codes and standards, what is needed is scrupulous reporting and enforcement under existing rules.

The American Bar Association's Model Rules of Professional Conduct serve as the template for the ethics rules adopted in most states. A number of these provisions bear directly on the practices complained of within the forensic science community:

> Rule 1.1 - Competence
> A lawyer shall provide competent representation to a client. Competent representation requires…thoroughness and preparation reasonably necessary for the representation.
> Rule 3.3 - Candor Toward the Tribunal
> (a) A lawyer shall not knowingly:
> (1) make a false statement of fact or law to a tribunal …
> (3) offer evidence that the lawyer knows to be false…

Rule 3.4 - Fairness To Opposing Party And Counsel

A lawyer shall not:

(b) falsify evidence, counsel or assist a witness to testify falsely, or offer an inducement to a witness that is prohibited by law;

(d) in pretrial procedure, make a frivolous discovery request or fail to make reasonably diligent effort to comply with a legally proper discovery request by an opposing party;

(f) request a person other than a client to refrain from voluntarily giving relevant information to another party…

These brief excerpts demonstrate that incompetence and unethical practices are cause for action against the licensure of attorneys under existing professional legal standards. What is lacking is widespread enforcement of the rules. It is the ethical obligation of both legal ***and forensic science professionals*** to report violations. The lawyer who "can't even spell DNA" is no laughing matter; while a phenomenon that is all-too-common, such lawyers represent a serious failure within our system of justice and must be called to task.

Ethical Obligations, Experts, Attorneys

J27 When Good Science Goes Bad - the Good, the Bad, and the Ugly

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The goal of this presentation is to communicate a clear understanding of scientific method and its central role in forensic scientific disciplines.

This presentation will impact the forensic science community by challenging the forensic scientific and legal community to pay closer attention to the methods employed by forensic scientists - not simply focus on the results obtained.

Good science has always been relatively easy to distinguish from bad science – good science is what I do and bad science is what YOU do. Easy – a non-issue! Lawyers perpetuate this *ad hominum* view in forensic contexts: good science is what the expert for MY SIDE does; bad science is what that PSEUDO-EXPERT for YOUR SIDE does. Attack the scientist, ignore the science. We have all been there.

However, such overly dramatic pugilistic approaches to the distinction between good scientific practice and bad scientific practice beg the essential question at issue: what MAKES any scientific practice a good one? And how do we tell the difference between good science and bad science?

In real science, testing eventually leads the scientific community to accept the conclusions that withstand assault and discard those that crumble under critical scrutiny. Real science, then, appears to be identified best by its methods rather than through a body of accepted theories, or the say-so of an educationally ordained priesthood of "legitimate practitioners." But just what are the methods of real science practiced by the so-called scientific community?

"Real natural science" is often methodologically cast as involving orderly and controlled procedures, pristine uncontaminated samples, and general, widely accepted covering laws and theories. From this combination of methodological and sample purity, apparently come reliable predictions, general in nature, confirmable by independent tests.

As an apparent anathema, forensic science is portrayed as using disorderly, uncontrolled procedures, contaminated samples, and specifically designed rules-of-thumb that are neither well accepted, nor general enough to apply outside the specific problem under investigation. Results from this alleged hodgepodge of nonstandard procedures are thought to be unreliable, individual conjectures, unconfirmable by reputable independent testing.

To examine this methodological charge against forensic science, let's consider the relevant individualizing practice of a natural science held by many to be the paradigm of a "real science" – physics. Relevant methods in physics will be compared with three case examples involving the difficult area of pattern evidence assessment.

To this end, cases involving footwear impressions are considered (the Ugly), cartridge case comparisons (the Bad), and pattern injury & bloodstain patterns (the Good). From these examples, we learn that the specialty areas (footwear, tool marks, and bloodstain pattern analysis) have *nothing to do with* what makes for the GOOD, THE BAD, or The UGLY. Instead, through a better understanding of scientific practices involved in the applications of natural science in each case, a distinction between good scientific practice and bad scientific practice, in turn based upon a better understanding of scientific methods, will emerge.

Scientific Method, Science vs. Pseudoscience, Method and Technique

K1 Alcohol Elimination Rate Variability and Subject-Altered General Consumption of Alcohol

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Attendees of this presentation will learn about variability in alcohol (ethanol) elimination rate after alteration, if any, of the general consumption of alcohol claimed by the human test subjects.

This presentation will impact the forensic community by providing a better qualified expert opinion concerning alcohol elimination rate variability and subject-altered general consumption of alcohol beverages to assist in judicial processes.

A decrease in a person's general consumption of alcohol may decrease their rate of elimination of alcohol; conversely an increase in such consumption may increase their elimination rate. Environmental changes in general consumption of alcohol may contribute additional variability to other biological and analytical variability inherent in the alcohol elimination rate of a person.

Test subjects were obtained from a forensic population of motor vehicle drivers under direction of their legal counsel. Informed consent excluded persons seeking, or having received, counseling and/or medical treatment concerning alcohol, and those with limiting physical or mental health. Some subjects consumed a similar light breakfast hours prior to their arrival for testing and initiating alcohol dosing. After consumption of their alcohol beverages on two separate days, suitable breath samples from subjects in the elimination phase were analyzed about every 20 minutes for their alcohol (ethanol) concentration using an Intoxilyzer instrument. Volume and duration of subject breath samples were concomitantly monitored by spirometry. Instrument calibration was confirmed using forensic alcohol standards from different manufacturers with differing concentrations and commercial simulators. The alcohol elimination rate from the second test day was multiplied by the inverse of relative instrument response to that of the first day for further data analysis. Dialogue with test subjects occurred on more than one occasion, with an embedded impromptu query involving change, if any, to their general consumption of alcohol beverages.

Test subjects (65 males and 11 females) had a median age (with range) of 38 years (19–70) and were tested twice with a median of 91 (28–924) days apart. The alcohol elimination rate (mg/210 dL/hr) on the first day had a median of 17.9 (11.6–24.4). For further data analysis, subjects were divided by response to their indicated altered general consumption of alcohol into: group "zero" (51 persons that claimed no change), group "minus" (21 persons claimed decreased consumption), and group "plus" (4 persons claimed increased consumption). Some subjects in group zero were hesitant to inform of a decreased consumption from concern about an adverse inference. One subject who initially claimed a decrease indicated a contrary increase in a later discussion. The alcohol elimination rates (mg/210 dL/hr) for these groups had a respective median of: -0.07 (-3.2–2.4), -2.9 (-5.4–0.7) and 2.3 (0.4–3.2). The relative change in alcohol elimination rate had a range from -23.1% to 27.4%: the subject with the largest relative decrease had an initial high rate of 21.3 in group "minus" and occurred 56 days apart; the subject with the largest relative increase in group "plus" had the lowest initial rate of all subjects and occurred 84 days apart. Adjustments of the alcohol elimination rate for interassay variability had a median of -0.03 (-0.47–0.34). The standard deviation of alcohol elimination rate for group "zero" was 1.38 mg/210 dL/hr, with no correlation between rate variability and delay to second test.

Variability of alcohol elimination rate (mg/210 dL/hr) for subjects divided into no change (0), decreased (-) and increased (+) general consumption of alcohol with the respective group shift of 0, -2.4 and +2.4, with a subject therein with an additional inherent variability of ±3, would describe 96.0% (73 of 76) of test subjects herein: if a decrease in consumption occurred for the two exception subjects in group "zero" and no change for the one exception subject in group "minus", contrary to those subject claims, then all subjects of this study would be described. If additional rate variability of ±2 was alternatively considered, then 86.9% of subjects are described.

Alcohol, Elimination, Variability

K2 Phencyclidine (PCP) in Fatally Injured Drivers and DUID Arrests in Harris County, Texas

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After attending this presentation, attendees will gain knowledge of the incidence of phencyclidine (PCP) in arrested and deceased automobile drivers in a major metropolitan area. Attendees will also be made aware as to how an appropriately broad toxicological analysis can assist in distinguishing between reckless, suicidal behavior and drug-induced intoxication.

This presentation will impact the forensic science community by educating toxicologists on the evaluation of drivers on PCP. Simple analyses for alcohol alone might not have been sufficient to interpret these cases, and observations suggest that a wider screen for drugs of abuse can provide valuable information in understanding the driver's state of mind at the time of a collision or DRE evaluation.

Phencyclidine is a dissociative anesthetic drug that induces an altered mental state at sub-anesthetic doses, where the user may experience a range of sensations from tranquility to detachment and psychosis. Since PCP is a weak base, it is well-absorbed whether it is smoked, injected, or ingested. The onset of intoxication begins within minutes of taking PCP, and can last for several hours. Residual effects may persist for days after the last dose. Its high lipid solubility allows it to accumulate in adipose and brain tissue, with a prolonged excretion interval over several weeks.

The effects of PCP severely undermine an individual's ability to drive safely, and often results in DUID arrests or fatal motor vehicle accidents. Its chemical properties allow it to be easily abused by smoking or swallowing before or during operation of a motor vehicle. An acute 5 mg dose of PCP typically causes drunken behavior with drowsiness, slurred speech, poor coordination, and altered perceptions of time and distance. Moderately larger doses of 10 mg or more produce effects more difficult to predict, such as muscle rigidity, lack of coordination, combative behavior, and auditory/visual hallucinations.

The results of PCP testing in fatally-injured drivers and DUID suspects over a 12-month period in Harris County, Texas. Attendees will learn about the pharmacology and behavioral effects of PCP, as well as modern analytical methods for determining concentrations in forensic specimens. Participants will also learn about the prevalence of PCP in arrested and deceased automobile drivers, and witness some of the characteristics of PCP-related MVA scenes.

In the deceased driver group, PCP blood levels were between 0.09 and 0.20 mg/L. No other drugs, except ethanol, (0.08 and 0.01 mg/dL in two cases) were detected. Typically, the vehicles left the roadway at a high speed, striking fixed objects without any evidence of skid marks or braking. In each of these cases, the collisions resulted in severe damage and almost appeared to be intentional. From a medical examiner viewpoint, this behavior may be interpreted as a suicide in contrast to an accidental collision.

In two of the DUID cases, PCP blood levels were determined to be 0.016 and 0.052 mg/L. In the remaining DUI cases, the presence of PCP was confirmed in urine since it was the only available specimen. Marijuana use was also detected in four of the DUID cases, which points toward the combinatorial use of marijuana and PCP, otherwise known as "fry." Two of these cases were also positive for cocaine and alprazolam.

These cases illuminate the extreme danger of driving under the influence of PCP and also provide support for increased vigilance in apprehending impaired drivers. Simple analyses for alcohol alone might not have been sufficient to interpret these cases satisfactorily. Due to the relatively long half-life of PCP in comparison to other drugs of abuse, the extended excretion interval allows sufficient time to find evidence of consumption that can be correlated to observed actions. Findings suggest that an expanded screen for common drugs of abuse can provide valuable information in the interpretation of motor vehicle fatalities and DRE evaluations.

Phencyclidine, Drivers, Accidents

K3 Comparison of Blood Alcohol Drink-Equivalent From Models and Breath Measurements

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After attending this presentation, attendees will learn about a comparison of blood alcohol drink-equivalent calculated from model equations of Widmark (1932), Watson et al. (1980), Forrest (1986), Urich et al. (1987) and Seidl et al. (2000) with that from breath alcohol testing.

This presentation will impact the forensic community by furthering validation of model calculations of alcohol concentrations applied to breath alcohol testing to assist qualifying some expert opinion that may utilize such calculations to assist in judicial processes.

Model calculations of alcohol concentration may have differing applicability to subjects within a demographic group involving gender, age, weight, height, and body mass index (BMI).

Test subjects (675 male and 100 female) were obtained from a forensic population of motor vehicle drivers under direction of their legal counsel. Informed consent excluded persons seeking, or having received, counseling and/or medical treatment concerning alcohol, and those with limiting physical or mental health. Some subjects consumed a light breakfast hours prior to their arrival for testing and initiating dosing from an alcohol-free state. After consumption of their commercial alcohol beverages (with identified concentration) over a median (with range) of 153 minutes (14–290), suitable breath samples from subjects in the elimination phase were analyzed about every 20 minutes for their alcohol concentration using either an Intoxilyzer 5000 (1 of 7 instruments; 622 subjects) or Breathalyzer 900/900A (1 of 10; 153 subjects). Volume and duration of subject breath samples were monitored concomitantly by spirometry for many cases with Intoxilyzer testing; duration was recorded for a Breathalyzer test and volume from another immediate sample. Instrument calibration was confirmed using forensic alcohol standards from different manufacturers with differing concentrations. Model calculations included weight per volume units using the density of blood (1.055 g/mL) for comparison with breath alcohol concentration (mg/210 dL). The "r" factor in Widmark for females (0.61) used combined results of Österlind et al. (1944). Separate analysis of Breathalyzer and Intoxilyzer data found no significant difference to their combination.

Subjects (male and female) had medians (with range) of: age (yr) 39 (17–77) and 37 (19–74); weight (kg) 81.6 (44.0–144.9) and 64.9 (41.0–132.0); height (cm) 176.5 (155.7–203.2) and 163.8 (149.8–187.1); and BMI of 26.3 (16.5–42.6) and 23.7 (16.2–48.4). Fifteen other persons were excluded for protocol non-compliance. The alcohol dose (g) per body weight (kg) had a median for males of 1.11 (0.58–2.24) and females of 0.98 (0.75–1.77) that generated maximum breath alcohol concentrations (mg/210 dL) with a median for males of 118 (46–216) and females of 124 (57–171). The median experimental alcohol drink-equivalent (mg/210 dL) for males was 24.8 (13.9–37.6) and females was 35.5 (17.8–59.2). Median variation in alcohol drink-equivalent (mg/210 dL) using equations of Widmark, Watson, Forrest, Ulrich and Seidl and breath alcohol testing were for males: 0.92 (-8.7–16.9), 0.30 (-7.7–9.1), 0.23 (-7.4–9.1), -0.64 (-8.7–7.3) and -1.1 (-9.4–7.6), and females: 0.89 (-9.8–13.9), 0.57 (-16.0–13.3), -0.83 (-16.1–13.0), not available, and -0.48 (-16.7–31.4). If the relative factor for females from only Österlind et al. was used (0.637/0.697), then the median variation was 0.20 (-10.7–13.2). Also found were: (1) higher variation (mg/210 dL) for females than males with all models; (2) Widmark for low body weight or BMI tend to overestimate concentration, and (3) Seidl for females with high BMI tend to overestimate concentration. The best fit to breath alcohol testing were calculations for males by Forrest, and females by Seidl. Both gender combined were best fit by Watson, then Forrest, then slightly less by Seidl and Widmark: no model exists for females by Ulrich.

Calculations of alcohol drink-equivalent using models (Widmark, Watson, Forrest, Ulrich, Seidl) agreed with that from breath alcohol testing for mean proportions of subjects at limits (± mg/210 dL) for males: 66.8% (62.1–70.4) at ±2.5, 92.7% (91.0–94.7) at ±5.0, and 98.9% (97.9–99.7) at ±7.5, and females: 65.8% (59.0–69.0) at ±4.5, 93.5% (90.0–97.0) at ±9.0, and 98.3% (97.0–99.0) at ±13.5.

Alcohol, Model, Concentration

K4 National, Regional, and Local Patterns of Methadone and Buprenorphine Seized by Law Enforcement and Analyzed by Crime Laboratories in the United States: 2003-2008

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After attending this presentation, attendees will better understand the trends and geographical variation of drug seizures that inform the U.S. Drug Enforcement Administration (DEA) of the trafficking and potential diversion of methadone and buprenorphine (generic names for two opioid analgesics).

The presentation will impact the forensic community by acknowledging the large contribution of crime laboratory forensic

scientists, as well as the importance of forensic laboratory data. The presentation will also contribute to a clearer understanding of varying dimensions and components of the trafficking, diversion, and abuse of methadone and buprenorphine.

The diversion and abuse of methadone is a key issue for United States drug control agencies, as is the expanding non-medical use of buprenorphine, an alternative to methadone treatment for heroin addiction. The heightened level of concern associated with these drugs is demonstrated in part by the frequency by which methadone and buprenorphine have been obtained by law enforcement agencies and analyzed by our Nation's crime laboratories over the past six years. Data from DEA's National Forensic Laboratory Information System (NFLIS) will be presented on methadone and buprenorphine, two synthetic opioid analgesics. NFLIS data represent instances where these drugs were seized by law enforcement and analyzed by forensic laboratories. From 2003 to 2008, the number of methadone and buprenorphine items reported by state and local laboratories increased significantly in the United States ($p<0.05$). Methadone more than doubled from 4,967 items in 2003 to 10,459 items in 2008, while buprenorphine significantly increased from 25 items in 2003 to 5,627 items in 2008.

Table 1. National and Regional Estimates for Methadone and Buprenorphine, 2003-2008.

	TOTAL	2003	2004	2005	2006	2007	2008
Methadone							
National	48,300	4,967	6,097	7,302	9,022	10,361	10,459
West	7,065	646	892	1,074	1,381	1,611	1,711
Midwest	7,210	859	1,038	1,257	1,424	1,856	1,776
Northeast	12,200	1,525	1,886	1,947	2,403	3,241	2,512
South	22,073	2,036	2,589	3,345	4,451	4,852	4,940
Buprenorphine							
National	11,371	25	252	540	1,009	2,100	5,627
West	427	*	*	*	*	163	264
Midwest	995	1	1	1	127	282	579
Northeast	6,325	21	244	457	1,254	1,746	2,651
South	3,614	3	10	81	386	907	2,133

*The estimate for this drug does not meet standards of precision and reliability.

Highlighted findings will include the prevalence of methadone and buprenorphine items reporting to NFLIS at national, state, and local levels from 2003 to 2008. State and county-level maps will be used to display levels of seized drugs identified in the United States. The exploration of geographically specific information provides timely information on drug trafficking and abuse spatial patterns. This level of understanding is vital as the diversion of methadone presents an increasing threat to public health. For example, methadone-related deaths in the United States increased nearly 600% from 1999 to 2006. As buprenorphine is prescribed more for opioid dependence therapy, impacts on the nation's health may also ensue.

Methadone, Buprenorphine, Prescription Drugs

K5 The Analysis of Oral Swabs by F-SPE/ Fast LC-MSMS for Low Level THC

Jeffery Hackett, MSc, Northern Tier Research, 1300 Old Plank Road, Mayfield, PA 18433; and Albert A. Elian, MS*, 59 Horse Pond Road, Sudbury, MA 01776*

After attending this presentation, attendees will learn how useful oral swabs taken from living individuals can be for the analysis of tetrahydrocannabinol (THC). This situation may arise when other samples are limited or are unavailable. The data presented in this presentation should add another technique for THC analysis in facilities providing toxicological services.

This presentation will impact the forensic science community by demonstrating how useful F-SPE and LC-MS/MS in the confirmation/ quantification of low level THC in oral swabs.

Methods: Over 10 consecutive days, oral swabs were taken from a donor (who used THC) 1 hour after smoking. The swabs were individually air dried, packaged and submitted to NTR/MSPCL. The samples were extracted in a glass tube with 500 µL of methanol (containng THC-D3) by soaking for 30 minutes. Before removal from the tube, each swab was washed with a further 100 µL of methanol. Each sample was evaporated to approximately 200 µL before 5 mL of phosphate buffer (pH 7) was added. This solution was extracted by fluorous solid phase extraction (F-SPE). The columns were conditioned with methanol, deionized water, and pH 7 phosphate buffer (3 mL, 3 mL, and 1 mL, respectively). After washing with deionized water and pH 7 buffer (3 mL of each), the columns were dried and eluted with hexane: ethyl acetate (50:50 v/v) containing 2% acetic acid. The eluates were evaporated to dryness under nitrogen and reconstituted in 50 µL of mobile phase for analysis by fast LC-MSMS using 20µL for injection.

Chromatographic analysis was performed on a 50 x 2.0 mm (5 µm) C_{18} column, with a gradient program of acetonitrile and 0.1% aqueous formic acid that ran for 4.5 minutes. Tandem mass spectrometry was performed in postive and negative MRM mode (to screen for any THC-acid present)

THC / THC-acid calibrators were set up by extracting 0.25, 1, 2, 5, 10, and 50 ng/ mL, controls were set up at 4 and 15 ng/ mL from aqueous buffer samples (5 mL). From the analysis of the calbrators and controls: r^2 value> 0.995, recoveries > 85% were obtained. Limits of detection/ quantification of 0.1 and 0.25 ng/mL, respectively were acheived.

Result: Of the 10 oral swabs where oral swabs taken 1 hour after administration, 9 were found to be postive (THC). The levels of THC ranged from 0.5 ng to 2.5 ng/ mL. None of the swabs contained the THC-acid metabolite.

Conclusions: Based on data presented, the use of oral swabs may be used to extract, confirm, and quantify low levels of THC. The employment of both F-SPE and fast LC-MS/MS shows that this procedure can be performed efficiently and rapidly, which is to the benefit of all scientists in forensic toxicology.

THC, F-SPE, LC-MS/MS

K6 A Retrospective Comparison of Blood- and Breath- Alcohol Results in Wisconsin Impaired Drivers 2001-2007

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After attending this presentation, attendees will better understand the relationship between breath- and blood-alcohol measurements and be better able to assess the validity of breath alcohol results as applied to a population of suspected impaired drivers.

This presentation will impact the forensic community by providing useful data by which to assess claims of breath alcohol testing unreliability as well as providing practical data relating the theoretical blood:breath alcohol ratio in the target population of impaired drivers.

Laws in most jurisdictions define illegal per se alcohol impaired driving offenses in terms of both breath and blood alcohol concentrations. Even so, the relationship between breath and blood alcohol results is still raised as an issue in court cases and a comparison of the two can yield insight into the prevalence of falsely elevated breath alcohol results, as is frequently alleged. In this retrospective study data is compared from drivers arrested for impaired driving offenses in the

State of Wisconsin who had both breath and blood alcohol specimens analyzed. Breath alcohol testing was conducted in the field on EC/IR and EC/IR II (Intoximeters, Inc., St. Louis, MO) breath alcohol analyzers. Breath alcohol results are obtained on duplicate breath samples and must agree with +/- 0.020 g/210L. The lower of the two three decimal place acceptable results is truncated to two decimal places as the reported result. Blood specimens were collected by medical personnel and submitted by the arresting agency to the Wisconsin State Laboratory of Hygiene (WSLH). Blood analysis was performed by direct injection gas chromatography, with 10% done in duplicate per the testing protocol in effect during the study period. All testing was done as part of the routine investigation of impaired driving cases. Only positive breath and blood alcohol results obtained within three hours of each other were included in this study.

During the study period of 2001-2007 there were 1,744 cases that met the inclusion criteria. Of these cases there were 1,545 males with a mean age of 34.9 (16-84) and 199 females with a mean age of 35.8 (16-77). The mean reported breath alcohol concentration (BrAC) was 0.144 g/210L (0.01 – 0.40). The mean of the un-truncated individual BrAC results was 0.1510 g/210L (0.010-0.400). The mean blood alcohol concentration (BAC) was 0.1624 g/100ml (0.010-0.450). The mean difference (BAC-BrAC) between reported BrAC and reported BAC results was 0.018 (-0.046-0.100). There were 869 cases where the BrAC was collected before the BAC with a mean elapsed time of 0.89 hours (0.13 – 2.75). There were 875 cases where the BAC was collected before the BrAC with a mean elapsed time of 0.80 hours and range of 0.05 to 2.27 hours.

BAC results were adjusted for the alcohol elimination occurring between the breath test time and the time of blood collection using a rate of 0.019 g/100ml per hour. After adjustment the BAC – BrAC differences were a mean of 0.019 (-0.029-0.082). The reported BrAC exceeded the adjusted BAC in 105 cases (6.0%). Of these, only 23 (1.3%) exceeded the BAC by 0.010 or more (range 0.010-0.029). There were only five cases where the BrAC was 0.08 and the adjusted BAC was below 0.080. Of these only one differed by more than 0.010. Blood:Breath alcohol ratios were calculated using the time-corrected BAC and reported BrAC. The mean (SD) ratio was 2428:1 (295) (range1622:1 – 6822:1.

The findings of this study are in agreement with others that have found that evidentiary BrAC results generally underestimate BAC in the driving population. The absence of significant overestimations of BAC by BrAC in this study provides strong evidence that alleged significant elevations of BRAC by mouth alcohol, GERD, potential interfering substances, variations in lung capacity, breathing disorders, etc. do not occur in the context of a well-regulated evidential breath testing program.

Forensic Toxicology, Blood Alcohol, Breath Alcohol

K7 Cocaine Detection in Postmortem Samples Following Therapeutic Administration

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After viewing this presentation, attendees will understand the importance of a thorough investigation, medical records review, and interpretation of autopsy and toxicology results in postmortem cases in which controlled substances such as cocaine are detected following administration in a clinical setting.

This presentation will impact the forensic science community by emphasizing that the detection of illicit drugs in postmortem samples is not always indicative of abuse.

Cocaine is a drug which is notorious for its high potential for recreational abuse, and the detection of cocaine in postmortem samples would most often lead toxicologists and forensic pathologists to believe that the drug was abused. However, cocaine is an effective local anesthetic and vasoconstrictor of mucous membranes and has been used clinically in surgeries of the eye, ear, nose, and throat for over 100 years. The persistent popularity of the clinical use of this drug is clearly attributable to its unique ability to simultaneously limit epistaxis and induce local anesthesia. Therefore, it is important to note that the presence of cocaine and its metabolites in postmortem samples cannot always be attributed to abuse and that a thorough investigation and review of clinical records is warranted before an informed conclusion can be made.

Presented here is the case of a 54-year-old male who was involved in an altercation during which he suffered multiple injuries. Three days later, a surgical procedure involving closed reduction of bilateral nasal bone fractures was performed and the man was released from the hospital. Approximately eleven hours post-surgery, the man was found unresponsive in bed and EMS responded and pronounced him dead on the scene. Given the circumstances leading up to the demise, a full postmortem examination was performed in order to elucidate the contribution of external factors such as physical injury, surgical intervention, and/or drug use to his death. In addition to natural disease and injuries documented at autopsy, toxicological analysis revealed the presence of cocaine metabolites in the man's urine. A comprehensive review of subsequently received surgical records revealed that the man was administered cocaine during the procedure to repair his nasal bone fractures.

If not for this review of surgical records, the assumption of cocaine abuse might have otherwise been made and the well-known cardiotoxic effects associated with cocaine considered a contributory factor in certification of cause and manner of death. Additionally, an erroneous presumption of illicit drug use may have significant implications in a legal setting and may cause family members of the decedent undue anguish. Toxicology results, investigative reports, clinical records, and pathologic findings must be collectively taken into consideration to ensure accurate explanations for the presence of cocaine, as well as other drugs that may be administered clinically, in postmortem samples.

Postmortem, Cocaine, Therapeutic

K8 Gastric Fentanyl Concentrations in Fentanyl-Related Deaths: A Study of 11 Cases

Ruth E. Kohlmeier, MD, Werner Jenkins, MS, MPA, Robert C. Bux, MD, Jennifer M. Hoffman, MS, and Christopher B. Clarke, BS, El Paso County Coroner's Office, 2743 East Las Vegas Street, Colorado Springs, CO 80906; and Andrea N. Phelps, and Emily D. Morrison, BS, Univeristy of Colorado at Colorado Springs, 1420 Austin Bluffs Parkway, Colorado Springs, CO 80918*

After attending this presentation, attendees will have a greater understanding of the role that the analysis of gastric concentrations of fentanyl has in fentanyl-related deaths.

This presentation will impact the forensic community by providing toxicological data and insights on potential relationships between gastric fentanyl concentration, blood fentanyl concentration, route of administration, and cause and manner of death.

Given that fentanyl is a short acting and potent narcotic, there is potential risk for abuse and fatalities. Interpreting postmortem

toxicology in suspected narcotic overdoses, including fentanyl, can be difficult for medical examiners due to the variety of drug use and abuse and the development of tolerance in the user/abuser. The unfortunate "creative" abuses of the patch (including snorting, smoking and chewing) only complicate the issue. A strategy utilized in postmortem toxicological evaluation has been to analyze gastric contents for the amount of drug present to ascertain a potential route of administration and/or the cause and manner of death. One would expect that oral consumption would lead to higher levels of gastric concentrations in general. If that were so, would one be able to use the gastric concentrations to determine the route of administration (including inappropriate use of the transdermal patch) as well as the manner of death (intentional versus accidental overdose)? The purpose of this current study was to determine the gastric concentrations of fentanyl and norfentanyl in fentanyl-related deaths and to attempt to relate these levels with blood concentrations, route of administration, and cause and manner of death.

From January 2007 to June 2009, eleven fentanyl-related deaths in which gastric samples were available were identified through routine toxicology testing in the El Paso County Coroner's Office toxicology laboratory in Colorado Springs, Colorado. Routine toxicological testing was performed on all cases. Ethanol and related alcohols were detected using headspace Gas Chromatography/Flame Ionization Detection (GC/FID), urine was screened for drugs of abuse by ELISA and Gas Chromatography-Mass Spectrometry (GC/MS), and GC/MS was used to quantitate the blood and gastric contents after a liquid-liquid basic extraction.

The age of the decedents ranged from 23 to 60 years and consisted of three men and eight women. The blood concentration of fentanyl ranged from 2.1 to 30.7 µg/L (mean 17.5 µg/L) while the total gastric fentanyl concentration ranged from 2.9 to 432.4 µg (mean 85.1 µg). The analytical data for norfentanyl concentrations in the gastric samples were inconclusive as the samples calculated below the detection level of 5 µg/L. The cause of death was acute fentanyl intoxication in six out of eleven cases while five cases were ruled mixed drug overdoses. The manner of death was accidental in eight cases and undetermined in three cases. The route of administration was by transdermal patch in nine cases, oral (by chewing the patch) in one case, and unknown in one case.

In conclusion, there did not appear to be any correlations between the gastric and blood concentrations of fentanyl, the route of administration, or the cause and manner of death. It did not appear to be helpful to determine if the individual had intentionally or accidentally overdosed, nor did it provide insight into the route of administration (e.g. inappropriate use of the patch). Although the case with oral route of administration had the highest gastric concentration of fentanyl, the level was not impressively higher than the next highest concentration, where the route of administration was transdermal application. Additionally, the oral route of administration did not yield the highest total gastric fentanyl concentration. A limiting factor in our study was the small subject number. Perhaps a larger study (e.g., a multi-centered study) focusing on the analysis of gastric concentration of fentanyl would be useful and illuminate any useful patterns or trends.

Gastric Fentanyl, Fentanyl Overdose, Forensic Toxicology

K9 Exposure to Limonene: A Case Report

Zeinab Mohamed Mostafa, BSc, Medicolegal Administration, Ministry of Justice, Egypt, Cairo, 002, EGYPT*

After attending this presentation, attendees will learn the relation between orange oil (Limonene) and respiratory failure.

This presentation will impact the forensic community by providing the relation between orange oil (Limonene) and respiratory failure.

D-limonene (4-Isopropenyl-1-methylcyclohexene) is the chemical name for orange oil. It's a renewable resource and is a by-product of orange juice manufacturing. Orange oil is the oily substance found in the rinds of oranges. Orange oil is used in cleaning solutions, pet shampoos, soaps and perfumes. Limonene and its products are skin and respiratory irritants. Acute exposure to D-limonene has rarely been reported in deaths.

In this case report, we present a case of a previously healthy 30-year-old man who presented to the emergency department with acute respiratory failure. Non-toxicological causes were excluded. The purpose of this work was to demonstrate a toxicological cause of the respiratory failure and to recommend full toxicological screening for clinical and postmortem cases, especially those under suspicious circumstances.

A complete history was taken and a comprehensive clinical examination was performed. Toxicological analysis was performed. For the analysis of limonene in blood, gas chromatography/mass spectrometry (Shimadzu 2010) was utilized in the splitless mode of injection. The initial temperature was 170◦C for 2 min. and then programmed at 16◦C /min. to 270◦C and held for 8 minutes.

The assay was found to be linear in the concentration range of 0.5-20 ng/ml for limonene. Repeatability and intermediate precision were found to be less than 12% for all concentrations tested. Under standard chromatographic conditions the run cycle time would have been 13 minutes. By using fast chromatographic separation conditions, the assay analysis time could be reduced to 7 minutes without compromising the chromatographic resolution.

This developed procedure was also used to determine the limonene concentration levels for more than a hundred real forensic cases. The case was diagnosed as toxic exposure to limonene dissolved in organic solvent. The patient was exposed to limonene at home for many years in air fresheners. The patient survived after supportive treatment. The clinical and laboratory findings are discussed.

Limonene and its oxidation products are skin and respiratory irritants. Inhalation of these chemicals carries the risk of toxicity, which could be missed in diagnosis and hence treatment. This should encourage physicians working in emergency units to analysis for all available chemicals to avoid misdiagnosis.

Forensic, Chemical, GC/MS

K10 Study of the Effects of pH, Temperature, and Time on the Migration of Endocrine Disrupting Compounds From Polyethylene Terephthalate (PET) Bottles

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After attending this presentation, attendees will be informed of an important toxicological topic that has an effect on everyone. The attendees will also be exposed to new optimized extraction and analysis methods of several endocrine disrupting compounds which they can apply to further this aspect of work or use in their own current research projects.

This presentation will impact the forensic community by informing the audience of the constant presence of endocrine disrupting compounds (EDCs) and their possible effects on our health and environment. Although this work is only a start, it may lead to new safety measures to ensure that all levels of EDCs are below the oral reference dose. This work could have an effect on humanity because if these new measures were established, it could affect our everyday lives. Also, several extraction and analysis methods that are commonly used in forensic laboratories, have been used in this study. These methods include solid phase extraction (SPE) and gas chromatography-mass

spectrometry (GC-MS). This presentation may allow the audience to become more knowledgeable about these different techniques which they could possibly apply to their own work. Finally, a major challenge in this work was preventing external contamination. The clean techniques that were utilized in this study could also be useful in a forensic laboratory.

Several toxicological studies have shown that many common endocrine disrupting compounds (EDC), specifically those that display estrogenic properties, could cause toxicity from chronic exposure to levels as low as 20 µg/kg/day. Any compound that has the ability to alter hormonal homeostasis is considered to be an endocrine disrupting compound. Effects of exposure include abnormal cell growth, teratogenicity, liver injury, abnormal thyroid function, and reproductive toxicity. Two types of EDCs, alkylphenols and phthalates, have been found to migrate from plastic containers into the food supply. Recent studies have suggested that phthalates may have a cumulative effect, which has lead to a great interest in studying their presence in the environment. Two different extraction methods, solid phase extraction (SPE) and liquid liquid extraction (LLE), have been performed and compared. LLE has been found to be the most effective extraction technique for studying trace levels of EDCs in water. Gas chromatography- mass spectrometry (GC-MS) was chosen as the analysis method because of the reduced risk of contamination when compared with liquid chromatography- mass spectrometry (LC-MS). Many studies have suggested that LC-MS is not an efficient analysis method when studying EDCs, such as phthalates, because of the use of organic solvents and plastic tubing which can increase the risk of sample contamination. The specific compounds that are being studied include dimethyl phthalate (DMP), dimethyl terephthalate (DMT), diethyl phthalate (DEP), dibutyl phthalate (DBP), butyl benzyl phthalate (BBP), bis-(2-ethylhexyl) phthalate (DEHP), nonylphenol, and octylphenol. Several conditions were established in order to study the effects of temperature, plastic thickness, and pH on migration. When studying the effects of temperature, two plastic bottles were filled with drinking fountain water and were heated to 60°C for six hours. Samples were collected after every two hours. The second bottle had a thickness that was 50% less than the first bottle. Another bottle was filled with fountain water and stored at room temperature. This was used as a control for the temperature experiment and was sampled after three days. The effect of two different pH values was also studied. The two values used were 3.75 and 6.6. These values were chosen because they are comparable to different beverages that are commonly stored in plastic containers. The pH of each sample was adjusted by adding glacial acetic acid until the desired pH value was obtained. A third bottle was filled with fountain water and was not adjusted. This bottle was used as a control for the pH experiment and had a pH value of approximately 7.2. The three pH samples were collected after one day. When heated to 60°C for two hours, five of the eight compounds were detected. These compounds include DMP, DMT, DEP, OP, and DEHP, at concentrations of 2.144, 1.78, 1.258, 0.783, and 1.539 µg/L, respectively. These compounds were found in the control sample at concentrations of 0.619, 0.875, 0.18, 0.475, and 0.483 µg/L, respectively. Therefore, heating plastic to 60°C increased the amount of migration occurring. When the thickness of the plastic bottle was reduced by 50% these compounds were found at concentrations of 1.627, 0.979, 0.779, 0.601, and 1.562 µg/L, when heated at 60°C for two hours. Although lower concentrations were found to migrate from thinner plastics when heated, the migration occurred over a longer period of time when compared to the 50% thicker plastic. Migration was also found to increase as the pH of the water decreased, when stored at room temperature. All reported concentrations were determined using calibration curves prepared from standard solutions. Standard solutions containing all eight compounds were prepared at concentrations of 5×10^5, 5×10^4, 5×10^3, 500, 50, 25, 12.5, and 6.25 µg/L. These standard solutions were also used as controls in order to determine the retention times of each of the studied compounds. A selected ion monitoring (SIM) method was also developed and used to analyze trace levels of these compounds. When compared to a NIST library the highest matches obtained were 80% (DMP), 81% (DMT), 81% (DEP), 73% (OP), and 72% (DEHP). All identified compounds had approximately the same retention times as the standard solutions. The average concentration found from all experiments was 1.046 µg/L. When comparing to the previously reported value of 20 µg/kg/day, a 70 kg person would have to drink approximately 1339 L/day in order to be exposed to this toxic level. Overall, temperature, pH, and plastic thickness have been found to have an effect on EDC migration from PET bottles; however, all concentrations have been below any known toxic level. Further work will be performed in order to study the effect time may have on migration and to test the reproducibility of this method. It is important to understand the effects any of these factors may have on EDC migration because it may or may not suggest that certain safety measures need to be established in order to ensure that all levels are below the oral reference dose (RfD) values set by the United States Environmental Protection Agency.

Toxicology, Endocrine Disrupting Compounds, Gas Chromatography-Mass Spectrometry

K11 Mixed Prescription Drug Death

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After attending this presentation, attendees will become aware of the effects of mixing prescription drugs.

This presentation will impact the forensic community by increasing the awareness of the role of prescription drugs in deaths.

This laboratory has been detecting an increase in the prevalence of multiple prescribed opioid compounds in drug related postmortem cases. In most of our cases, the decedents have histories of addiction to oxycontin and xanax.

A case of postmortem analysis will be presented of a 36-year-old single white male who consumed Oxycontin, Xanax, and Actiq (fentanyl lollipop). The decedent had morbid obesity (BMI of 46) with a long history of lower back pain for at least six years. His clinical work-up for his lower back pain was inconclusive, although a spinal surgery for disc fusion was suggested at one point. He was known to visit various pain clinics and acquired prescription Actiq for at least 18 months. According to multiple co-workers, he demonstrated a typical pattern of opioid compound addition which interfered with his job performance significantly. During his last year, he was admitted twice at a local rehabilitation center for his addition to Oxycontin and Xanax. Of note, per multiple co-workers and family members, the decedent had no prior suicidal ideation or attempt.

The decedent was discovered in his residence with early decomposition after failing to report to work as an accountant. Scene investigation found a fentanyl lollipop inside his shirt pocket as well as crushed pill fragments scattered on the floor and table. Multiple bottles of prescription oxycodone and alprazolam, some empty and others near-full, were located at the scene. Autopsy revealed hypertensive cardiovascular disease and focal bronchopneumonia, and both were not considered to be medically significant. Comprehensive analysis was performed on various postmortem tissues, including femoral blood, urine, stomach content and liver.

All submitted tissues were subject to standard analytical screening and mass spectrometry confirmation protocols. Positive findings of the analysis are as follows:

Blood		
	Oxycodone	1.86 mg/L
	Oxymorphone	0.072 mg/L
	Fentanyl	64 mcg/L
Liver		
	Oxycodone	1.83 mg/Kg
	Oxymorphone	0.12 mg/Kg
	Fentanyl	96 mcg/Kg
Stomach Contents		
	Total weight received: 244 gms	
	Oxycodone	147.30 mg/Kg
	Oxymorphone	0.62 mg/Kg
	Fentanyl	3648 mcg/Kg
Urine		
	Oxycodone	5.82 mg/L
	Oxymorphone	0.36 mg/L
	Fentanyl	890 mcg/L
	a-hydroxyalprazolam	1.60 mg/L
	Alprazolam	0.35 mg/L

Note: Alprazolam and its metabolite were only detected in the urine specimen.

The medical examiner ruled the cause as multiple drug intoxication and manner as accidental.

Oxycodone, Fentanyl, Prescription

K12 Analytical Method Development for Determining the Biomarker, 2-Aminothiazoline-4-Carboxylic Acid (ATCA), in Mice Liver After Cyanide Exposure

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After attending the presentation, attendees will learn about new methods of detecting cyanide exposure and the analytical techniques that are being developed to test the presence in mice livers. The attendees will also learn about 2-Aminothiazoline-4-Carboxylic Acid (ATCA) as a biomarker for cyanide.

This presentation will impact the forensic science community by demonstrating a forensic application being developed to detect cyanide poisoning postmortem. This research will be able to be applied to human remains that are in autopsy under investigation for poisoning. ATCA is a stable biomarker for cyanide so this technique will be able to be applied to cold cases.

The objective of this research was to develop a new analytical technique to determine the chemically stable urinary metabolite of cyanide, 2-aminothiazoline-4-carboxylic acid (ATCA), in mice liver samples. Two extraction techniques, solid phase extraction (SPE) cation exchange and molecular imprinted polymer stir bar (MIP-SB), were tested to determine the efficiency of ATCA extraction from mice liver samples. Mice were exposed to different doses of cyanide, and a method was developed to dissect, preserve organs, and homogenize the livers.

This research will be able to be applied to human remains that are in autopsy under investigation for poisoning. ATCA is a stable biomarker for cyanide so this technique will be able to be applied to cold cases. For forensic casework, a stable and quantifiable marker is needed to determine an accurate level of exposure postmortem. This method will be able to be used in cold cases because ATCA is a stable metabolite that stays in the body after the initial dose of cyanide is depleted.

Endogenous ATCA is always present in the body in low quantity originated from dietary intake of cyanide, smoking, fires or the normal metabolism of amino acids. A selective and sensitive analytical method is needed to determine the endogenous level of ATCA or identify cyanide poisoning. The use of ATCA as a biomarker for cyanide poisoning is promising due to its stability at ambient, as well as freezing temperatures and its production is directly related to cyanide exposure.

The molecularly imprinted polymers (MIPs) are made on the surface of a silica cylinder to serve as a selective stir bar sorption extraction (MISBSE) device. From an external calibration, the capacity of one MISBSE for ATCA was about 31 ng. The data showed that 700 rpm was the optimum stir speed and that sorption plateau was reached after 30 minutes of extraction time. Under the optimal extraction conditions, the MISBSE could selectively extract ATCA from urine samples. The MISBSE has improved the ability to extract lower concentrations of ATCA. Combining MISBSE with Liquid Chromatography Mass Spectrometry (LC/MS/MS), ATCA was detected without the use of any derivatization process. The solid phase extraction cation exchange was preformed with Oasis® MCX (mixed-mode cation exchange) columns and underwent several washes to prepare the cartridges for absorbing the ATCA and then was eluted with ammonium hydroxide with the assistance of a vacuum pump.

An effective method of preparing liver samples from the cyanide exposed mice for extraction will be presented. In additions, the two extraction methods (SPE *vs*. MIP-SB) will be compared. The effectiveness of the extraction techniques will be determined by employing known concentrations of ATCA evaluated by the LC/MS/MS. Liver ATCA contents will be compared to the dose of cyanide mice were given. This new analytical method may serve as great potential benefits for the toxicology field and forensics in general.

Molecularly Imprinted Polymer (MIP), 2-aminothiazoline-4-carboxylic acid (ATCA), Cyanide

K13 Pesticide Intoxications in Cukurova, Turkey: A Three Year Analysis

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The goal of this study is to show the distribution of pesticides in the Cukurova region and alert the forensic toxicologists to notice pesticides in all autopsy cases at this region.

This presentation will impact the forensic science community by demonstrating how organochlorine pesticides are still a serious threat for public health although the WHO has forbidden the use of these substances all over the world.

Cukurova region is one of the most important agricultural areas for Turkey. As a consequence of wide pesticide use, acute pesticide poisoning cases are quite common, in this region. These poisonings are generally suicidal self poisonings, while can be accidental or homicidal as well. In Cukurova, pesticide poisonings still remain as a considerable cause of death, which lead the present retrospective evaluation.

The autopsy records of Adana Group Authority of the Council of Forensic Medicine, between 2006 and 2008, were evaluated retrospectively. Deaths that are attributed to pesticide poisoning included in the scope of the study in order to identify the type of pesticide, as well as the etiology. The frequency and distribution of intoxications were also analyzed in terms of sex and age.

In the studied period, a total of 4,199 autopsies had referred to the forensic toxicology laboratory for pesticide analysis. Pesticide analyses were performed in the Forensic Toxicology Laboratory of Adana Group Authority of the Council of Forensic Medicine, using different biological samples (blood, stomach, liver, lung, and kidney) by chromatographic methods, gas chromatography with electron capture detection (GC-ECD), and gas chromatography with nitrogen phosphorus detection (GC-NPD) and gas chromatography-mass spectrometry (GC-MS).

Seventy-two out of all cases were positive for pesticide analysis. Of these 72 cases, 42 (58.33%) were male and 30 (41.66%) were female, with a mean age of 38.8 ± 20.6 years. Among the inspected pesticides, endosulfan was found to be the most common with 47.2% prevalence, followed by an organophosphorus insecticide dichlorvos with a prevalence of 16.7%. Majority of deaths due to pesticide poisonings (37, 51.38%) were suicidal while (17, 23.61%) of them were accidental. The high ratio of suicidal deaths due to pesticides was a consequence of easy availability and accessibility of uncontrolled pesticides in households at city centers and in villages of countryside.

This report showed that endosulfan, an organochlorine pesticide, is commonly used in Cukurova region. Moreover, frequency of acute and chronic exposure to endosulfan is considerably high in Cukurova region. Recently, strict regulations have been enacted for restricting and controlling the use of endosulfan, of which use was previously allowed. Furthermore, authorities should set more efficient educational facilities for agricultural workers in order to reduce the number of accidental pesticide poisonings.

Forensic Toxicology, Pesticide Poisoning, Cukurova (ADANA)

K14 Identification of GHB and Morphine in Hair in a Case of Drug Facilitated Sexual Assault

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After attending this presentation, attendees will appreciate the importance of an accurate toxicological analysis in sexual assault cases.

This presentation will impact the forensic science community by detailing a unique circumstance of sexual assault and the drug GHB Gamma-hydroxybutyric acid, a substance naturally present in mammalian species, which has been utilized to commit the crime.

Gamma-hydroxybutyric acid GHB is qualified as a "predatory drug." Doses of 10 mg/kg cause amnesia, 20-30 mg/kg induce sleep and doses of 50 mg/kg or higher produce anesthesia. It is attractive for rapists because it can be found easily (on the street, fitness centers, and internet) and moreover because it can be delivered mainly as an odorless, colorless liquid and so it is often assumed unwittingly, mixed in spiked drinks.

Case Report: The case of a 24-year-old girl who was sexually assaulted after administration of Gamma-hydroxybutyric acid (GHB) and morphine will be presented. She had been living in an international college for foreign students for about one year and often complained of a general unhealthy feeling in the morning. At the end of the college period she returned to Italy and received at home some video clips shot by a mobile phone camera. In these videos she was having sex with a boy she met when she was studying abroad.

Materials and Methods: Toxicological analysis of the victim's hair was done: the hair was 20 cm long. A 2 cm segmentation of all the length of the hair was performed. Morphine and GHB were detected in hair segments related to the period of time she was abroad. The analyses of hair segments were performed by gas chromatography/mass spectrometry (GC/MS) and the concentration of morphine and GHB were calculated.

Conclusions: A higher value of GHB was revealed in the period of the criminal event and the presence of morphine was also detected for the same period. According to previous observations our case shows that hair analysis is the only method used to prove repetitive exposure to a toxic substance. This case demonstrates also that a high concentration of GHB in hair reflects an acute overexposure to GHB and can be documented several months after the sexual assault. In general it must be specified that the possibility given by hair analysis should not prevent the victim and the medical examiner from taking urine, blood, and sweat samples as soon as possible after the event. Hair analysis may be a useful adjunct to conventional drug testing in sexual assaults and it should not be considered an alternative to urine analysis, but a complement. It is possible that hair analysis could be a useful addition to conventional drug testing in sexual assault, but it is believed that further studies may confirm the usefulness of this technique and establish the definition of legally defensible cut-off values.

GHB, Hair Analysis- GC/MS, Drug Facilitated Sexual Assault

K15 Death by Potassium Chloride Intravenous Injection and Analytical Detection

Elisabetta Bertol, Lucia Politi, and Maria Grazia Di Milia, Viale Morgagni 85, Florence, ITALY;, and Francesco Mari, Istituto di Medicina Legale, D, Policlinico Careggi, Viale Mor, Firenze, ITALY*

After attending this presentation, attendees will understand the results of the determination of blood potassium in a case of suicide by potassium poisoning. The meaning of the blood potassium concentration is questioned and discussed.

This presentation will impact the forensic science community by demonstrating how potassium concentration resulted to be significantly higher in heart blood in a case of suicide by potassium chloride intravenous injection and, therefore, the general issue of considering potassium poisoning hardly demonstrable by the toxicology needs to be questioned and thoroughly studied in the future.

Potassium chloride intravenous injection is reported as a means in suicide attempts and also in lethal procedures for state-sanctioned capital punishment. Owing to its relatively high concentrations in hemolyzed blood (25-80 mmol/l) as compared to serum (about 4 mmol/l), potassium poisoning has often been considered hardly detectable in postmortem blood specimens.

In considerations of the results of the determination of blood potassium in a case of suicide by potassium poisoning, the meaning of blood potassium concentration is questioned and discussed.

A 41-year-old man, working as a nurse at the local intensive care unit, was found dead at his workplace. A recent injection site was observed on his left foot and a syringe retrieved close to the corpse. At the autopsy no particular signs were noted.

Biological specimens (blood, bile, and urine) were submitted to the screening procedures for drugs and poisons in use in the laboratory, consisting of general unknown screening by solid phase extraction and gas chromatography mass spectrometry for blood and bile, head-space gas chromatography for blood and immunoenzymatic screening for urine. The syringe content was submitted to Feigl spot tests for inorganic ions and, in particular, for potassium. Finally, blood potassium concentration was determined by ion selective electrode measurement (linear over the range 3.0-150 mmol/l).

According to the routine screening procedure, blood was found positive for diazepam at therapeutic level (0.21 mg/l) and urine resulted positive only for benzodiazepines. No other substances were identified in blood and urine and all other samples tested negative. Potassium concentration was found at 160.0 mmol/l in cardiac blood and 87.3 mmol/l in femoral blood (mean of three determinations in both cases). On the other hand, hemolized blood samples obtained from autopsies with no relevant toxicological findings had much lower potassium concentration, i.e., between 32.2 and 43.0 mmol/l (median: 38.6 mmol/l, n=6).

Death by potassium intravenous injection is often considered undetectable by toxicological analyses when only hemolized blood is available, and, consequently, literature is relatively scant. These result show that potassium concentrations were significantly higher in heart blood in a case of suicide by potassium chloride intravenous injection and, therefore, the general issue of considering potassium poisoning hardly demonstrable by the toxicology testing needs to be questioned and thoroughly studied in the future.

Potassium Chloride, Intravenous Injection, Suicide

K16 A HPLC/MS/MS Method for Simultaneous Determination of Three Opiates and Three Benzodiazepines in Postmortem Blood

Shaohan Zhao, PhD, Terry Danielson, PhD, and Ashraf Mozayani, PhD, PharmD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

After attending this presentation attendees will have new knowledge of a Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) method for simultaneous determinations of morphine, hydromorphone, hydrocodone, alprazolam, diazepam, and nordiazepam in postmortem blood using multiple reaction monitoring (MRM) techniques and corresponding deuterated internal standards. Simultaneous analysis of multiple opiates and benzodiazepines has not previously been reported in postmortem blood.

This presentation will impact the forensic community by demonstrating an additional application of LC/MS/MS to the analysis of complex drug mixtures in postmortem specimens.

Analyses were performed with an ABI 3200 Q-Trap instrument operating in a positive polarity mode. For these analyses, one mL specimens of blood were basified by addition of saturated sodium borate buffer, and then extracted once with four volumes of the mixture of 1-chlorobutane and 2-propanol. The organic layer was evaporated and the residue was reconstituted into 0.5 mL of reconstitution solvent (aqueous buffer/acetonitrile; 9:1). Reconstitution solutions were filtered and chromatographed in an acetonitrile/ammonium formate gradient. Instrument parameters were optimized by infusion of solutions of each drug. The chromatographic column was maintained at 25˚C and the run time was 12.5 minutes.

The method was validated by examining selectivity, precision, accuracy, linearity, recovery, suppression, and limits of quantitation and detection. Calibration curves were quadratic for all analytes over the concentration range 10–1000 ng/mL, and correlation coefficients (R^2) were better than 0.999. Intraday and interday precision for all analytes at concentrations of 50, 200, and 500 ng/mL was between 4.1% and 10.6%, intraday and interday accuracy for all analytes at the three concentration levels was between 88% to 114%. Recoveries were between 13% and 52%. Limits of detection and quantitation were 3 and 10 ng/mL, respectively. Selectivity results demonstrate that the precision and accuracy of the analytes were not affected by the presence of 14 other common drugs. Only diazepam showed ion suppression in postmortem blood, and morphine and hydromorphone showed ion enhancement. Four postmortem blood specimens were analyzed by this method. The four specimens were also analyzed by alternate, individual LC/MS/MS opiate, and benzodiazepine methods. The results obtained by this new combined opiate/benzodiazepine method match well with the results run by the individual methods.

A method is described that is applicable to simultaneous determination of at least six opiates and benzodiazepines over a broad range of concentrations. Individual analytes were well separated, suggesting that the method is amenable to addition of other opiates or benzodiazepines.

LC/MS/MS, Benzodiazepines, Opiates

K17 Covalent Protein Adduction by Drugs of Abuse

Kevin J. Schneider, BS, 900 Euclid Avenue, #22, Miami Beach, FL 33139; Anthony P. DeCaprio, PhD, 11200 Southwest 8th Street, Miami, FL 33174*

After attending this presentation, attendees will glean some of the principles of covalent protein adduct formation, previous advances in generating and detecting protein adducts, how drugs of abuse form protein adducts, and the potential importance of protein adducts in the fields of clinical and forensic toxicology.

This presentation will impact the forensic science community by opening a new subset of toxicological analysis for clinical and forensic inquiries. It will allow for the development of new biomarkers of exposure to detect the use of addictive and illegal substances even after the parent compounds and major metabolites have been eliminated from biological samples. These persistent adducts can be employed to expand the range of time a substance can be detected in biological samples; a beneficial advance for both clinical and forensic applications.

Introduction: Protein adducts are formed by the covalent binding of an electrophilic, metabolically activated xenobiotic to nucleophilic sites on endogenous proteins or protein precursors. These permanent covalent bonds remain for the lifetime of the protein. However, not all nucleophilic sites on a given protein are equally reactive to activated xenobiotics. Certain amino acid residues are more susceptible to electrophilic attack, due to both steric and electronic factors. Each xenobiotic will interact with a given protein in a characteristic way determined by the combination of these factors.

While only a few studies have examined protein adduction by drugs of abuse, results suggest that this is a valuable issue to explore further. In this report, initial data is presented on such adducts by evaluating the relative binding affinity of several common drugs of abuse to amino acids known to be reactive under biological conditions. Initial research using a controlled *in vitro* exposure system is required prior to expanding studies into complex matrices and case studies involving biological samples from drug users. This initial step is germane to the understanding of how and where these drugs of abuse covalently bind to endogenous proteins and is imperative to the understanding of *in vivo* formation of protein adducts. This approach involved utilizing HPLC-MS, which allows for the sensitive and discriminating analysis of adducted peptide structure.

Methods: In order to generate protein adducts with drugs of abuse, an *in vitro* metabolic system was used. This system has previously been employed to assess hepatic metabolism of xenobiotics under controlled conditions. The system consisted of purified human cytochrome P450 3A4, human cytochrome b5, and human NADPH cytochrome P450 reductase in conjunction with required lipid cofactors (1,2-dilauroyl-sn-glycero-3-phosphocholine, 1,2-dioleoyl-sn-glycero-3-phosphocholine, and 1,2-dilauroyl-sn-glycero-3-phospho-L-serine). To each mixture, one of three test peptides was added: Ac-PAAHAA-OH, Ac-PAAKAA-OH, and Ac-PAACAA-OH. These short peptides allowed for the analysis of modifications of the reactive amino acid residue (His, Lys, and Cys,

respectively). Each peptide was tested with each of three common substances of abuse: cocaine, morphine, and methamphetamine (each at 200 µM final xenobiotic concentration). Peptides were incubated at 37°C in 200 mM phosphate buffered saline (pH 7.4) for 15 - 60 min to allow for metabolic activation of the xenobiotics and adduction to the peptides. Following incubation, 10 µL aliquots of the mixtures were acidified with TFA and introduced into a Varian 1000 LC-ion trap MS equipped with Polaris C18 column and optimized for the analysis of the individual peptides.

Results: Stable, time-dependent covalent adduction of all three model peptides at varying efficiencies was noted for each drug. Adduct formation was confirmed by the appearance of new peptide peaks with MS molecular ion and fragmentation data consistent with covalently bound drug. MS/MS with *de novo* peptide sequencing results confirmed the location of adduct at the putative reactive site for each peptide. Additional MS studies are currently ongoing to identify the reactive metabolite of each drug and the chemical structure of peptide-bound drug moiety. Data will be presented detailing the relative binding affinities for each tested drug of abuse and peptide.

Conclusions: The data presented in this study demonstrates the ability of metabolically activated cocaine, morphine, and methamphetamine to form viable adducts with nucleophilic residues of model peptides. The analytical detection of these adducts in *in vitro* studies provides the groundwork for further studies of *in vivo* production and analytical detection of these adducts in biological specimens.

Protein, Adduct, Toxicology

K18 Lethal Tachycardia Following a Low Dose of Clozapine

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The goal of this presentation is to report a case of lethal tachycardia that developed in a 99-year-old woman, who mistakenly received a low dose (50 mg) of clozapine.

This presentation will impact the forensic science community by showing how fatal cardiovascular side effect reported in association with clozapine may occur in very elderly patients even at low doses.

Clozapine is a well-proven antipsychotic agent with a wide atypical receptor profile. It is effective against both positive and negative symptoms, with sympatholytic, anticholinergic and antiserotoninergic side effects. It is particularly useful for the management of patients with schizophrenia who are either unresponsive to or intolerant of conventional antipsychotic agent. Use of clozapine is restricted to patients with treatment-refractory schizophrenia because of the drug's association with agranulocytosis, seen in about 1% of patients in the first year of treatment. Additional side effects that may occur with clozapine treatment include sleepiness, dizziness, seizures, pulmonary embolism and respiratory depression.

Recently, attention has focused on cardiovascular complications reported in association with clozapine. Cardiovascular side effects have been less commonly reported but have included orthostatic hypotension, tachycardia, electrocardiogram changes, myocarditis, and cardiomyopathy, which in some cases have resulted in the death of young people with no prior cardiac history.

Clozapine increases heart rate in the majority of patients and around 25% of individuals on therapeutic doses develop a mean increase of 10-15 bpm. Seemingly, the main causes are anticholinergic vagal inhibition and an increase in circulating catecholamines caused by α-1 adrenergic blockade.

Major symptoms in severe clozapine overdose are altered states of consciousness, agitation, confusion, delirium, coma, convulsions, tachycardia, arrhythmias and respiratory depression.

A case will be presented of lethal tachycardia following a low dose (50 mg) clozapine administration, occurred in a 99-year-old woman, after a nurse mistakenly gave her another patient's drug.

Thirty minutes after the administration, the patient was conscious and vital signs were normal. Blood pressure was 118/61 mmHg, heart rate was 85 bpm. One hour later, the patient was still conscious, blood pressure was 108/58, and heart rate was 85 bpm. One hour later, blood pressure was 171/101, heart rate was 101 bpm. Because of deterioration in her spontaneous respiration, the patient was endotracheally intubated and artificial respiration was applied. Gastric lavage could not be performed. All attempts to reanimate the patient did not lead to the clinical improvement and she died due to cardiac arrest after three hours of intensive care. An autopsy was performed at the University Center of Legal Medicine in Geneva. External examination was unremarkable. Internal examination showed congestion of internal organs and pulmonary oedema. Neuropathological investigation was negative. Histological examination showed moderate generalized congestion and broncho-aspiration of foreign material. Toxicological tests included blood ethanol levels and screening for common drugs and illegal substances by gas chromatography and mass spectrometry. Toxicological analysis showed midazolam (blood concentration 40 µg/l), which was administered to the patient at the hospital, and clozapine (blood concentration 140 µg/l), whose level was consistent with the administration of a 50 mg dose of clozapine.

Conclusion: The cause of death was determined to be clozapine intoxication

Adverse Drug Reaction, Clozapine, Tachycardia

K19 Preparation of Oral Fluid for Quantitative Determination of Opiates and Amphetamines by LC-MSMS

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After attending this presentation, attendees will better understand critical issues related to the analysis and quantitation of drugs of abuse in oral fluid.

This presentation will impact the forensic sciences community by expanding the current knowledge on issues related to the analysis of drugs in oral fluid and the distribution of drugs in oral fluid.

Keeping in mind that: (a) substitution therapy policy has recently been implemented in Taiwan; and, (b) oral fluid as an alternate specimen for monitoring drug use has attracted considerable interest, this project was carried out to develop a sample preparation method for effective analysis of opiates and amphetamines in oral fluid by the liquid chromatography-tandem mass spectrometry (LC-MSMS) technology.

Various heating and deproteinization parameters were evaluated for their effectiveness in: (a) removing forth, contaminations, and protein; (b) preserving original drug composition in the specimen; and, (c) carrying out direct electrospray LC-MSMS analysis. Oral fluid specimens were first processed by the sample preparation protocol, then analyzed by a LC-MSMS system (Agilent 6410 Triple Quadrupole Mass Spectrometer with an electrospray interface and an Agilent 1200 RRLC System) using an Agilent Zorbax SB-Aq (2.1 mm ´ 150 mm, 3.5 µm

particle) analytical column operated at 40 °C. The mobile phases adapted for gradient elution are: (A) methanol and (B) 0.1% (v/v) formic acid in water.

The established protocol achieved 1 ng/mL as the method's limit of detection for amphetamine, methamphetamine, 6-acetylmorphine, 6-acetylcodeine, morphine, and codeine. The method's limit of quantitation was 1 ng/mL for the first four compounds listed above and 2.5 ng/mL for morphine and codeine. The method was also successfully applied to the analysis of 34 oral fluid specimens collected from patients participating in the substitution therapy program following the institution's IRB guidelines. Data generating by the "sample preparation/direct LC-MSMS" protocol were superior to those obtained by portable testing devices and gas chromatography-mass spectrometry approaches. For example, one portable testing device could only identify 3 amphetamines and 1 opiates positives, while this method hereby developed quantitated the presence of methamphetamine, amphetamine, morphine, 6-acetylmorphine, and codeine in 20, 17, 7, 3, and 1 specimens. With the limited size of specimen available, the GC-MS approach could not detect the presence of the drugs of interest in many of the specimens that were found (by the newly developed methodology) to contain these dugs at low ng/mL concentration levels.

Oral Fluid, Drugs of Abuse, Liquid Chromatography-Tandem Mass Spectrometry

K20 Changed Contrast Agent Like Imagopaque the Concentration CNS Active Drugs by Cadavers?

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After attending this presentation, attendees will understand the basics of the downspout by a computed tomography angiography (CTA) and the effects from the contrast agent imagopaque on the concentration of the analyzed CNS active drugs.

After reading this poster presentation, the observer will understand the basics of the downspout by a computed tomography angiography (CTA) and the effects from the contrast agent imagopaque on the concentration of CNS active drugs to be analyzed. At the Centre of Forensic Imaging and Virtopsy in Bern, 22 selected decedents underwent a whole body computed tomography angiography (CTA). The cases were from 9 casualties, 10 natural deaths, 1 homicide, and 1 error in medical treatment. The gender of the cases were 7 women and 15 men. The mean age at time of death was 48.2 years, ranging from 3 to 85 years. The mean interval between estimated times of death and imaging was 29.5 hours, ranging from 5.5 to 70 hours.

A conventional autopsy, which started in the 5 hours later (mean) was performed in every case for a direct comparison with the radiologic findings. In all cases a mixture of a water-soluble, hydrophilic medium with polyethylene glycol (PEG) as a large molecular carrier substance and iohexol as the contrast agent in a mix ratio of 15:1 was used. During the angiography, we needed between 12.5 and 78.9 ml/kg KG from the contrast agent. Prior to the CT angiography, 10 ml peripheral venous blood was sampled from the femoral vein from each cadaver. On the occasion of the autopsy, the second venous blood sample was taken. In this study a comprehensive screening for central nervous system (CNS) active drugs was performed by LC/MS/MS. All analysis were carried out using an 1100 LC system (binary pump and autosampler) coupled to an API 4000 mass spectrometer equipped with a Turbo-Ion Spray source. The instrument software Analyst (ver. 1.4.2) was used for data processing. The multi target screening strategy is in principal described at Thieme & Sachs (2003).[1]

In five of the cases opioids, antidepressants, and benzodiazepines were detected in therapeutic ranges. The results of this study shows, that there are no new volumes of distribution and that the applied analytical method is practical. The most important result of the study is that a qualitative and quantitative analysis for drugs could be performed after a CTA with injected contrast volume.

Reference:

[1] Thieme D, Sachs H, Improved Screening capabilities in forensic toxicology by application of liquid chromatography-tandem mass spectrometry. Anal Chim Acta 483,171-186, 2003

CTA, Drug Concentration, Toxicological Analysis

K21 Death Caused by Fentanyl Smoking

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After attending this presentation, attendees will have greater awareness that smoking should be considered as a potential route of administration in cases of fatal fentanyl intoxication.

This presentation will impact the forensic science community by informing attendees of an uncommon route of administration for a drug that has become increasingly important in drug overdose deaths.

Fentanyl is a highly efficacious synthetic opioid analgesic marketed under a variety of proprietary names. Fentanyl is commonly implicated in deaths attributed to recreational drug abuse in West Virginia; a state which currently endures the highest per capita rate of opioid fatality in the U.S. Fentanyl is clinically employed in combination with other analgesics for post-surgical pain control as well as in the treatment of chronic pain. When employed for outpatient chronic pain control, fentanyl is characteristically prescribed as a transdermal patch preparation. It is in this form that fentanyl is often diverted and fatally abused, with patch mastication and/or ingestion as well-described patterns of drug misuse. A case will be reported of fatal recreational fentanyl abuse by a method of drug intake rarely described in forensic literature: smoking of fentanyl patch material.

Authorities were notified when two unresponsive individuals were discovered in a parked car. The man in the driver's seat was pronounced dead on the scene. The investigating officer noted a piece of singed aluminum foil in the decedent's lap. The foil was retained as evidence and the decedent was transported to the medical examiner's office.

The body was that of a 33-year-old white male with a height of 74.5 inches and weight of 223 lbs. A complete autopsy revealed marked pulmonary edema but no apparent anatomical cause of death. Review of the decedent's medical records failed to demonstrate current or prior prescription access to fentanyl or other opioid pharmaceuticals. Specimens submitted for toxicological analysis included subclavian blood, gastric contents, urine, liver, and vitreous humor.

The following tests were performed by the toxicology laboratory: blood alcohol by GC-FID, blood precipitate immunoassay for drugs of abuse (EMIT), and acid/neutral and alkaline drug screens of blood by GC-MS. No alcohol or drugs were detected by these methods. A directed assay was then performed for fentanyl using liquid-liquid extraction of subclavian blood. Analysis was performed on an HP 1100 series LC-MSD using a Zorbax SB-CN column, APCI+ ionization, and data collection in SIM mode.

Fentanyl was identified and quantitated in the blood at 9.3 ng/mL, a concentration at which fatal toxicity has been reported. Norfentanyl, an

active metabolite, was not detected suggesting rapid accumulation of lethal fentanyl blood levels and respiratory arrest. No commercial fentanyl preparations were present in the vehicle where the decedent was discovered; however, the piece of aluminum foil was analyzed and found to be positive for fentanyl with no other drugs detected. Cause of death, as determined by peer review, was the result of non-prescribed fentanyl abuse and the manner was accidental.

The majority of fatal overdoses involving fentanyl use in West Virginia occur in the setting of multiple drug toxicity. This case of fatal fentanyl intoxication in a 33-year-old man was unusual in that no other drugs or alcohol were detected and that smoking was concluded to be the route of administration.

Fentanyl, Smoking, Postmortem

K22 Methcathinone Formation During Analysis of Ephedrine or Pseudoephedrine

Wendy R. Adams, PhD, Joseph Homan, MS, and Joseph Corvo, BS, NMS Labs, Inc., 3701 Welsh Road, Willow Grove, PA 19090*

After attending this presentation, attendees will gain awareness of how analytical artifacts can lead to false positive results, as illustrated by the formation of a schedule I substance from over-the-counter cold medicines present in blood and urine specimens. Suggested methods for detecting and avoiding this artifact will also be provided.

This presentation will impact the forensic science community by raising awareness of the potential for controlled substances to form as artifacts in specimens containing high concentrations of ephedrine or pseudoephedrine. The *in vitro* formation of methamphetamine has previously resulted in false positive reports on proficiency tests. Now it appears that methcathinone may also be formed *in vitro* with similar specimens and analytical techniques. Determining the source of the methcathinone in biological samples is essential for correct interpretation in postmortem and DWI investigations.

Methcathinone is a schedule I controlled substance easily synthesized by oxidation of ephedrine or pseudoephedrine. Use of methcathinone peaked briefly in the 1990s, but has since declined; in large part due to stricter control of pseudoephedrine. Methcathinone produces euphoric and stimulant effects similar to, but less intense than, methamphetamine. Methcathinone is not nearly as popular as methamphetamine, but is easier to synthesize, and may serve as a starting point for clandestine chemists. A recent raid in Valdez, AK uncovered a methcathinone lab in the home of an 18-year-old and a 16-year-old was arrested in Irvine, CA for experimenting with a methcathinone recipe she found online. Due to its rarity, methcathinone findings in biological specimens usually arouse suspicions.

Low levels have occasionally been found of methcathinone in blood or urine during forensic drug screening by gas chromatography mass spectrometry (GCMS). There is usually an overload of ephedrine or pseudoephedrine present in these cases, and many do not confirm when methcathinone is tested directly. These observations suggest that methcathinone can form as an artifact during GCMS analysis if high concentrations of ephedrine or pseudoephedrine are present.

The Navy Drug Screening Laboratory reported a similar issue in 1993. Proficiency urines spiked with pseudoephedrine were reported as positive for methamphetamine. Further investigation revealed that GCMS injection above 220°C promoted the loss of a hydroxyl from derivatized pseudoephedrine to form methamphetamine. The addition of a preparatory acetylation or oxidation step was suggested to remove ephedrine and pseudoephedrine in order to avoid false positive results for methamphetamine. While the oxidation of pseudoephedrine does eliminate the possibility of methamphetamine formation, it can also create methcathinone by converting the hydroxyl to a carbonyl group.

Pharmacokinetic studies of methcathinone have established that it is primarily reduced to form ephedrine. This is one explanation for why ephedrine (or its stereoisomer pseudoephedrine) is almost always detected when methcathinone is present in biological specimens. Unfortunately, this creates a chicken-and-egg situation, making it difficult to determine if methcathinone was intentionally ingested or if it might have formed in vitro due to oxidation of ingested ephedrine/pseudoephedrine. A previous report established that ingestion of 60 mg pseudoephedrine did not produce detectable levels of methcathinone in urine. Higher concentrations were not tested.

A series of experiments were conducted to determine the role of analytical conditions in methcathinone formation. Spiked blood samples were analyzed by GCMS and liquid chromatography tandem mass spectrometry (LCMSMS). Neat standards of pseudoephedrine and ephedrine were also tested to exclude the possibility that methcathinone was present as a contaminant in the ephedrine and pseudoephedrine standard materials.

Methcathinone was detected by GCMS from 20 mcg/mL ephedrine and 40 mcg/mL pseudoephedrine in spiked blood samples. Trace amounts were present at ten-fold lower concentrations. Surprisingly, methcathinone was also detected by LCMSMS in blood samples spiked with 40 mcg/mL pseudoephedrine. The methcathinone did not come from the standard material because neat injections of 50 and 100 mcg/mL ephedrine and pseudoephedrine were negative for methcathinone (LOD 1 ng/mL). Instead, methcathinone appears to form as an artifact due to interactions with the biological matrix.

It is important to consider the possibility of in vitro oxidation when methcathinone is detected in the presence of pseudoephedrine/ephedrine. This combination looks very similar to actual methcathinone ingestion since ephedrine is the major metabolite of methcathinone. However, it is possible for methcathinone to form during analysis of specimens that contain high concentrations of pseudoephedrine/ephedrine. Methcathinone formation can be minimized by using analytical procedures that avoid excessive heat (LCMSMS).

Methcathinone, Artifact, Stability

K23 Thiosulfate Antemortem and Postmortem Blood Concentrations Following Suspected Hydrogen Sulfide Exposures - An Evaluation of Ten Positive Cases

Lee M. Blum, PhD, Laura M. Labay, PhD, and Marianne T. Flanagan, NMS Labs, Inc., 3701 Welsh Road, Willow Grove, PA 19090*

After attending this presentation, attendees will learn about hydrogen sulfide as a toxic agent, the recommended specimen types that should be collected for toxicological analysis following a possible exposure and the application of thiosulfate as a biomarker of exposure.

This presentation will impact the forensic community by providing additional information that may be of benefit when evaluating cases of hydrogen sulfide gas exposure.

Situations involving hydrogen sulfide gas exposures are frequently encountered in the practice of forensic toxicology and the interpretation of analytical findings is directly dependent upon selecting the appropriate marker of exposure. Hydrogen sulfide is a colorless, flammable gas that is highly toxic. It is a natural gas that can be produced by decaying organic matter or as a by-product of various industrial processes including petroleum refining and mining. Hydrogen sulfide is insidious in that even though the gas has a distinctive rotten-egg odor that may be detectable at concentrations as low as 0.5 ppb, olfactory fatigue, depending upon concentration and length of exposure, may also occur. At room temperature hydrogen sulfide is a gas and, since it is heavier than oxygen, it tends to accumulate in poorly

ventilated low-lying areas. Inhalation is the major route of exposure, and its mechanism of action is such that it causes disruption of the mitochondrial electron transport system. In the body hydrogen sulfide is rapidly metabolized to its major oxidation product thiosulfate and it is mostly for this reason that this metabolite has often been used as a biomarker in the evaluation of non-fatal and fatal hydrogen sulfide exposure cases. Also, even though sulfide may also be used as an indicator of exposure, the detection of sulfide is difficult especially in non-fatal cases since it undergoes rapid metabolism in the body. Another potential complexity involving the interpretation of a postmortem sulfide level is that sulfide may be formed during the decomposition process.

Over the course of a 5-year period several blood specimens collected for investigative purposes where hydrogen sulfide exposure was suspected, were submitted to NMS Labs for thiosulfate analysis. The analytical technique utilized for this work is ion chromatography (IC) and the test, as it specifically relates to the analysis of a blood specimen, is briefly described as follows: specimens first undergo a two-fold dilution using deionized water followed by vortexing and centrifugation. Specimens are passed through an ultrafiltration device and the filtrates transferred to autosampler vials that are crimped with Teflon-lined caps. Identification is based upon retention time (RT) and peak shape (e.g., area to height ratio) as compared to that of calibrators and quality control samples. All analytical work is performed using the technique of standard addition and the final analytical result is reported based upon this calculation. The lower limit of quantification (LLOQ) is 2 mcg/mL.

A review of our testing results revealed ten positive cases where thiosulfate was detected in antemortem and/or postmortem blood specimens. Out of these ten cases, postmortem blood was tested in eight cases while antemortem blood was tested in three cases. It should be noted that one case had both antemortem and postmortem blood submitted for testing. The thiosulfate postmortem blood concentrations in the eight death cases ranged from 2.3 to 100 mcg/mL (average 25 ± 37 mcg/mL, median 7.0 mcg/mL). The three antemortem specimens were positive at a concentration slightly less than the reporting limit of the assay (approximately 1.6 mcg/mL), 5.8 mcg/mL and 17 mcg/mL. The specimen reported at 5.8 mcg/mL was collected from an individual believed to have been chronically exposed to hydrogen sulfide gas in the workplace. The 17 mcg/mL specimen involved the death of an individual where the sample was collected antemortem. As a point of reference, whole blood thiosulfate concentrations in healthy persons are normally less than 0.3 mcg/mL.

Although the majority of the above cases involved suspected occupational exposures to hydrogen sulfide, there was one distinctive case where two commonly used household cleaning products were purposefully mixed together so that hydrogen sulfide gas was generated in an apparent suicide. It was this case where the highest concentration (100 mcg/mL) of thiosulfate was detected.

Even though thiosulfate is not a unique marker of hydrogen sulfide exposure its detection and measurement may aid in the verification of a hydrogen sulfide exposure especially when case history supports the analytical finding.

Thiosulfate, Hydrogen Sulfide, Gas Exposures

K24 The Application of CE- and CEC-TOF/MS to the Analysis of Non-Traditional Drugs Used to Facilitate Sexual Assaults

Jennifer Greaux, BS, and Bruce R. McCord, PhD, Florida International University, Department of Chemistry, 11200 Southwest 8th Street, Miami, FL 33199*

After attending this presentation, attendees will become aware of a wide range of "non-traditional" drugs which have the potential to be used to facilitate sexual assaults as well as newer techniques for analyzing these drugs.

This presentation will impact the forensic science community by detailing the analysis of various drug mixtures to show that CE and CEC are both efficient and reliable techniques for the detection of drugs in sexual assault samples. It is hopeful that the techniques can then be used to aid authorities in prosecuting criminals accused of sexual assault in a quick but efficient manner.

The overall purpose of this project is to develop and optimize methods for the analysis of drugs which may be found in blood and urine specimens from sexual assault cases. Capillary electrophoresis coupled to electrospray ionization time-of-flight mass spectrometry (ESI-TOF-MS) permits the rapid separation and identification of these drugs. In addition, CE provides high efficiency due to its plug-like flow, which is valuable when separating mixtures. The use of capillary electrochromatography (CEC) coupled to time of flight mass spectrometry was also investigated. Because CEC is a hybrid technique of CE and HPLC, it offers both high efficiency and stationary phase selectivity. This is important when separating drugs with similar physical and chemical properties.

The first part of this project involved an optimization of injection parameters for the CE system. The drugs studied belonged to the following classes: anticholinergic (scopolamine), anticonvulsant (valproic acid), antidepressants (citalopram, doxepin, fluoextine, imipramine, paroxetine, sertraline, desipramine, nortriptyline), antihistamines (diphenhydramine, doxylamine, brompheniramine), antihypertensive (clonidine), cough suppressants (dextromethorphan), and muscle relaxants (carisoprodol, cyclobenzaprine). Mixtures of different DFSA candidate drugs and their metabolites in their salt form were prepared via a simple three step process: addition of 1% HCl in methanol, evaporation to dryness, and reconstitution of sample in water (Hudson). This provided higher sensitivities when compared to previous methods where mixtures were prepared in buffer and deionized water. In addition, a water plug was added prior to sample injection to help preconcentrate the sample via an in-line stacking process. Buffer systems examined for these analyses included phosphate and more volatile buffers, such ammonium phosphate, ammonium bicarbonate and ammonium acetate. Controlled studies were performed to determine their effect on MS signal intensity. The pH and concentrations of the buffers as well as the run voltage were adjusted to optimize CE separations. The mixtures were then separated by CE-MS on a fused silica capillary (50 µm internal diameter, 84.5 cm total length). Run times provided by the system were under 15 minutes, with UV detection possible in the first 5 minutes of the analysis. There appeared to be some overlap between peaks; however, the drugs were still able to be identified by the mass spectrometer based on their mass-to-charge ratio.

In the second part of this project, monolithic capillary electrochromatographic (CEC) stationary phases were developed to improve the selectivity and efficiency of the analysis of this group of compounds. These stationary phases were prepared in-situ via polymerization of various monomers in the presence of porogenic materials, creating stationary phases with high surface areas and good porosity. These properties also permit drug preconcentration prior to analysis. Stationary phases were tailored to provide specificity by changing the type of retentive monomers and porogenic solvent used during the polymerization process.

The analysis of various drug mixtures will be detailed to show that CE and CEC are both efficient and reliable techniques for the detection of drugs in sexual assault samples. It is hopeful that the techniques can then be used to aid authorities in prosecuting criminals accused of sexual assault in a quick but efficient manner.

Capillary Electrophoresis, Mass Spectrometry, DFSA

K25 Inline Derivatization and Detection of Primary and Secondary Amine Containing Drugs Via CE-LIF

Britt E. Turnquest, BSc, and Bruce R. McCord, PhD, Florida International University, Department of Chemistry & Biochemistry, Florida International University, 11200 Southwest 8th Street, Miami, FL 33199*

After attending this presentation, attendees will be able to understand the mechanism by which drugs containing primary and secondary amine groups can be derivatized on-capillary using 4-fluoro-7-nitro-2,1,3-benzoxadiazole (NBD-F) for the purpose of detection using capillary electrophoresis with laser-induced fluorescence.

This presentation will impact the forensic science community by providing a method that can be an excellent screening procedure for trace levels of amphetamines and other drugs in body fluids.

In forensics capillary electrophoresis has become an increasingly common analytical method due to its ability to be coupled to a variety of detection systems. One such method of detection is through laser-induced fluorescence which can provide high sensitivity and specificity in spite of the short path length used. This is particularly useful for the detection of compounds that undergo extensive first-pass metabolism and thus are present at trace levels in biological matrices. Unfortunately, compounds which fluoresce naturally are few and in order for them to be detected by fluorescence derivatization is necessary. This presentation will permit attendees to understand the mechanism by which drugs containing primary and secondary amine groups can be derivatized on-capillary using 4-fluoro-7-nitro-2,1,3-benzoxadiazole (NBD-F) for the purpose of detection using CE-LIF. NBD-F is a non-fluorescent compound which reacts to primary and secondary amines through a nucleophilic reaction whereby the fluorine attached at the benzene ring is lost and the amine group of the analyte loses a hydrogen atom and subsequently binds at that site. The resulting derivative is strongly fluorescent and has an emission wavelength around 530 nm.

Many drugs commonly feature amine groups within their structures which can be primary, secondary or tertiary in nature. The authors have focused on four specific compounds (3, 4-methylenedioxyamphetamine, 3, 4-methylenedioxymethamphetamine, norephedrine and ephedrine) that represent primary and secondary amines as well as two distinct chemical structures. It is to be noted that these compounds are either pre-cursors to or commonly encountered illicit "designer" drugs. To determine the capability of the selected fluorescent tag derivatize the analytes of interest in this study and optimize the reaction kinetics, an offline procedure was used based on work previously done by Lurie. These kinetic studies looked at derivatization temperature and time, drug concentration, molar ratio of tag to analyte, tag concentration and buffer pH.

Drug standards for each drug were obtained from Cerilliant and diluted to concentrations of 1 µg/mL. 75 µL aliquots of the drug, 20 mM NBD-F freshly prepared in ethanol and 50 mM sodium tetraborate buffer at pH 6.5 were combined in a 1:1:1 ratio and placed in a thermocycler for 10 minutes at 60°C. Samples were then hydrodynamically injected at 0.3 psi for 5 seconds into a fused silica capillary of 50 µm inner diameter, 40 cm length, 30 cm effective length. Separation took place using 50 mM $Na_2B_4O_7$ with 10 mM sodium dodecyl sulfate buffer at pH 8.5 at an applied potential of -15kV for 5 minutes. All steps in the CE method used reverse flow and polarity in order to shorten the effective length of the capillary to 10 cm. Fluorescence is then induced using an argon laser at 488 nm and separation is done using the Beckman Coulter P/ACE MDQ system. This procedure produced detection limits in the pg/µL range for each of the mentioned analytes.

Given the lack of fluorescence of NBD-F prior to derivatization, the detected fluorescence intensity can be used to quantify the amount of the analyte present. Differences in mobility between compounds and subsequently elution time can be used to determine the identity of the analyte(s) in question. The method proposed by the authors would incorporate an electrokinetic mixing step to facilitate a fast reaction between the analyte(s) and the tag after a hydrodynamic sandwich injection. As this method is geared towards urine samples where analytes of interest are in trace quantities the drug samples would be isolated via a liquid-liquid extraction procedure and reconstituted in run buffer prior to injection into the instrument.

On-Capillary derivatization, Amines, Drugs

K26 Sample Collection Tips for Automated and Comprehensive Drug Analysis in Biological Specimens Using LC/MS/MS

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After attending this presentation, attendees will learn how to automate sample preparation for biological specimens using minimal manual labor. Most importantly, the method is comprehensive for basic, acidic, and neutral drugs.

This presentation will impact the forensic science community by demonstrating how this automated method permits the possibility of forensic labs to improve chain-of-custody of samples, and increase confidence of results due to automation and tandem mass spectrometry.

The SC-Tips for biological fluids are pipette tips that contain a screen, an absorbent material, and a cap. The screen is used to contain the absorbent material and to filter subsequent solutions during automated extractions. The absorbent material serves two major purposes, to absorb and to remove sample matrix components including salts and proteins. The cap comprises a thin membrane to contain the biological samples, has grooves for robotic transportation, and an entry for a syringe needle. A multi-purpose sampler (MPS) is used to process extractions directly from the SC-Tips into LC vials and perform automated injections into the LC/MS/MS instrumentation.

The automated liquid extraction process takes approximately 1 minute to perform. By using an automated dry down station, the total extraction time is less than 6 minutes, which is less than the chromatographic analysis time. Therefore, the extraction of one sample is being performed during the chromatographic analysis of the previous sample, so high throughput is achieved one sample at a time.

For analysis of urine specimens, the samples are first pre-treated with enzymatic hydrolysis. Afterwards, 0.5 mL of acetonitrile (with spiked internal standards) and 0.26 mL of the hydrolyzed urine solution (0.2 mL equivalent of urine) are transferred to the top of the SC-Tip, and then the cap is added to close the tip. The tip is then placed on the sample tray of the MPS for robotic liquid handling. There is no other manual labor for this sample preparation. Oral fluid is prepared similarly to urine except hydrolysis pre-treatment is not required.

For blood specimens, 0.2 mL is transferred onto the absorbent material of the SC-Tip, then 0.5 mL of acetonitrile with spiked internal standard is dispensed into the SC-Tip either manually (before adding the cap) or robotically (after adding the cap). The use of the absorbent material and acetonitrile combine to precipitate proteins, remove salts, and provide a clean extract with reduced ion suppression.

High recoveries are shown for the analysis of opiates and opioids, benzodiazepines, barbiturates, stimulants (amphetamines and cocaine), analgesics (propoxyphene, tramadol), hallucinogens (PCP, THC), and muscle relaxants (carisoprodol, meprobamate). The comprehensive nature of this extraction is exemplified by simultaneous extraction of over 40 pain management drugs in a single specimen.

Duplicate or triplicate analyses of specimens can be readily performed by using 2 to 3 SC-Tips per sample without significantly increasing labor, providing better quality and confidence of results. This

may be relevant to forensic toxicological specimens, where the analytical quantitative results include the error associated with the analysis. Furthermore, the use of bar code labels on the SC-Tips ensures sample integrity and minimizes possible mishandling errors and chain-of-custody issues.

Recoveries and %RSDs for over 60 drugs are shown, with most recoveries and %RSDs being greater than 70% and less than 10%, respectively.

Sample Preparation, LC/MS/MS, Automation

K27 Ricin-Binding Proteins in Buccal Cells and Salivary Fluid

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After attending this presentation, attendees will learn how specific binding proteins for the toxin ricin can be identified in human buccal cells and cell free saliva.

This presentation will impact the forensic science community by demonstrating how the characterization of ricin binding proteins in salivary fluid and buccal cells proteins may facilitate discovery of methods for diagnosis of ricin poisoning and clarify additional details of mechanisms involved in ricin toxicity.

The plant protein ricin is one of the most poisonous known substances, is subject to biological and chemical weapons bans and is of concern as a tool of terrorists. There is no cure for ricin poisoning and diagnostic difficulty in distinguishing its effects from other harmful agents. Routes of exposure include ingestion, inhalation and injection. There are gaps in the knowledge of specific molecular identities of cell surface ricin-binding proteins. This research describes binding of ricin and the related lectin RCA-I to proteins in buccal cells and salivary fluid which are biological material that could be exposed to ricin during poisoning.

This study investigated if binding of ricin could be detected to buccal cell surfaces, salivary and buccal proteins and identification of molecular masses of ricin ligands. Whole saliva was collected by expectoration and salivary fluid and buccal cell fractions isolated by centrifugation. Ricin and RCA-I-binding proteins were detected by lectin blotting after SDS gel electrophoresis of saliva and buccal cell proteins and also measured by Enzyme-linked microtiter plate binding assays. Fluorescence microscopy with biotinylated ricin and RCA-I was used to visualize localization of ricin and RCA-I binding to buccal cell surfaces.

After electrophoresis, lectin blots identified a 170kDa buccal cell protein band in reduced samples that bound to ricin, binding was absent or decreased in non-reduced samples. Major ricin-binding proteins in salivary fluid included 170-150kDa, 75kDa, 50kDa, 40kDa and 25kDA molecules. Neuraminidase from Clostridium perfringens increased the binding of ricin to blots of salivary fluid proteins but had less effect on the binding of RCA-I. Treatment with neuraminidase from *Vibrio cholerae* did not affect the binding of ricin and RCA-I to buccal cell proteins in lectin blots. In fluorescence microscopy and microtiter plate binding assays, ricin bound only weakly to buccal cells in contrast to strong staining and binding seen with RCA-I.

Specific ricin and RCA-I –binding salivary and buccal cell proteins can be detected by lectin blotting after electrophoresis including a common 170kDa protein. There are differences in the reactivity patterns of the related molecules RCA-I and ricin with buccal cells and saliva, even though in the literature both are reported to bind to galactose-terminated oligosaccharide structures on proteins and glycolipids. Binding to buccal cells and salivary proteins could be relevant to the bioavailability of ricin or dose reaching other tissues in the event of poisoning by the oral route.

Ricin, Toxin, Saliva

K28 Workplace Toxicity In the Archives of Ottoman Empire

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After attending this presentation, attendees will understand the residual effects of multiple applications of chemical products, including heavy metals, pesticides, and rodenticides, over a five century period and its affects on archive employees.

This presentation will impact the forensic science community by demonstrating workplace toxicity due to multiple applications of pesticides and rodenticides.

The employees of the Ottoman Archives are exposed to different molds and chemical products such as heavy metals, pesticides, and rodenticides. The goal of this study is to investigate the inorganic elemental composition of archived papers to predict whether if there is any toxicity or not in the 100 to 500 years old Ottoman Archives as a work place.

Material and Method: Five ml of 70 % HNO3 and 1 ml of concentrated HCl were added to the 0.1 g aliquots of the collected paper samples from randomly chosen fifteen departments of the archive and nails from the randomly selected ten employees and digested in microwave oven under 170º C/400 watt/15 minutes. Thirty-five elements of the collected pieces of papers of each of fifteen archive rooms and a blank plain paper have been analyzed and compared by using ICP MS technique.

The ICP-MS conditions were as follows: Rf power:1200 w; Nebuliser gas flow: 0.87 ml/min; Auxiliary gas flow: 0.75 ml/min; cooling gas flow: 13.8 ml/min. sample uptake: 60 s; Dwell time: 10 ms.

Results: Average values in ppm of fifteen archive rooms for related elements have been found as follows Li : 0,1 Be: 0,174 B: 29,1 Na: 1659,0 Mg: 3104,7 Al: 9538,2 P: 652,5 S: 0,0 K: 3047,7 Ca: 10573,4 V: 3,8 Cr: 97,7 Mn:68,0 Fe: 13857,1 Co: 7,8 Ni: 24,3 Cu:82,6

Zn:312,9 As: 24,6 Se: 0,3 Sr: 51,3 Zr: 1,5 Mo: 1,4 Cd: 0,3 Sn: 14,2 Sb: 1,4 Ba: 384,6 W: 0,1 Pt: 0,0 Hg: 4,9 Tl: 0,1 Pb: 282,8 Bi: 5,1 Th: 0,676 U: 0,344 respectively.

Conclusion: This study showed that, toxic metals such as As, Cu, and Pb varied between 100 and 1,000 folds of the nowadays produced plain (blank) paper. Employees that working for long times in restoration or examination of the archived papers inside the archive rooms subjected to chronic workplace heavy metal toxicity. Furthermore from the analysis of their nail samples, employees are under the risk of heavy metal toxicity. On the other hand, 160 employees of the archives have been sent to the department of thoracic medicine where breathing functions were administered. When compared, the values in the patients files of the hospital; Forced Expiratory Volume in One Second (FEV1) breathing function although statistically not significant, decline in ten years was greater in the achieve employees, in spite of smoking was more common in the control group while other functions such as FVC, FEV1/FVC, MEF 25-75%, DLCO/VA still in normal values.

Workplace, Toxicity, Archives

K29 Preliminary Drug Screening on Postmortem Urine: An Impractical Practice

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After attending this presentation attendees will: (1) become aware of the practice of "urine-first" screening of decedents for toxicological study; (2) learn the drugs commonly detected by urine and blood drug screening; (3) be familiar with the overall sensitivity and specificity of urine drug screening on postmortem specimens; and, (4) observe a cost analysis of different protocols for postmortem drug screening; and 5. be able to form an opinion about "urine-first" drug screening based on cost and effectiveness.

This presentation will impact the forensic science community by showing how initial drug screening of urine specimens followed by reflex screening of positive urine specimens as a protocol for assessing toxicological factors in the autopsy is financially beneficial, but is too inaccurate to be of adequate quality for forensic use.

Background: In serving rural communities with limited budgets, the request often comes from the county medical examiners that screening for drugs on decedents be performed initially on urine, and if positive, reflex testing be performed on blood for confirmation. The rationale for the request is the rapid turnaround of the urine drug screen and the significant difference in cost. These requests are generally honored, since in rural counties where these data were obtained, medical examiners are very conscious of cost containment for county services. Therefore, most drug screens were performed on urine, and negative results were not further evaluated. Trying to find literature to support this "urine-first" screening practice was not successful. Therefore, we elected to perform a study of known urine and blood drug screens with discrepant results. By so doing, we hope to bring reliable data to the discussion of whether the "urine first" policy is scientifically or financially prudent.

Materials and Methods: Results of 501 autopsies were reviewed from the years 1997-2009. All cases with discrepant urine and drug blood screens were collected and analyzed. The urine drug screens were a seven-item panel that screens for cannabinoids and their metabolites, benzodiazepines, amphetamines, opiates, cocaine and its metabolite, tricyclics, and barbiturates. Blood specimens from decedents with positive urine drug screens were sent to a reference laboratory for confirmation.

Results: In all, 11 decedents had both urine and blood drug screens performed, approximately 2% of the group studied. The decedents' demographics showed 7 men and 4 women, mean age for both 39 years. Men had more positive drugs detected on urine screen than did women (20 versus 6), although this difference was not significant. There were 9 true positive tests, 17 false positives, 45 true negatives, and 5 false negatives. Thus, the sensitivity was 64% and the specificity was 73%.

Discussion: Screening urine for drugs on postmortem specimens does not appear to be an accurate way to determine which drugs were present at the time of death. It is inexpensive, however, given an example of 100 autopsies in a given period, the costs incurred for the "urine-first" protocol would be: ($36 initial urine work-up cost + $180 follow-up blood work-up cost)(36 false positives) = $7,776 spent on further working-up specimens that were positive in the absence of drugs; ($180 blood work-up cost)(27 false negatives) = $4,860 "saved" on false negatives, i.e. specimens not worked-up because they were negative in the presence of drugs; and (27 false negatives + 51 all other specimens)($36 urine work-up cost) = $2,808; total cost, $7,776 – 4,860 + 2,808 = $5,724. Compared to the price of initial screening by blood work- up for all cases ($180 blood work-up cost)(100 specimens) = $18,000, the savings are substantial, $12,276. However, the reliability of the results must be considered as well. In a screening protocol for which nearly half of the results are not accurate because of poor sensitivity and low specificity, one must make a judgment as to whether the money saved is worth the information lost, or scrambled by misleading results. Considering how many critical decisions about manner and cause of death are based on the presence or absence of drugs in a decedent, it would seem inappropriate to choose such a protocol as a routine practice.

Urine, Postmortem, Drug Screen

K30 Fatal Caffeine Intoxication: A Review of Seven Cases From 1999-2009

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After attending this presentation, attendees will understand the symptoms and postmortem toxicological assessment of caffeine intoxication. The purpose of this study was to retrospectively study all caffeine intoxication deaths over a ten year period.

This presentation will impact the forensic community by analyzing the largest series of caffeine intoxication deaths to date and highlighting the importance of testing for caffeine in postmortem samples.

Caffeine, 1,3,7-trimethylxanthine, is the most widely consumed legal stimulant given its natural occurrence in foods including coffee, tea, chocolate, yerba matte and guarana. The average content per serving is 30-60 mg per 12 ounces of a soft drink, 50 mg in 8 ounces of iced or hot black tea, 50-70 mg in 8 ounces of iced coffee and 80-120 mg in 8 ounces of hot coffee. It is estimated that average daily adult caffeine consumption is 300 mg and that moderate consumption for most adults is thought to be safe. Caffeine has been widely used in pharmaceuticals including treatment of neonatal sleep apnea, acute respiratory depression, anorectant, and most commonly for headaches and migraines. The most potent forms are available as over the counter oral caffeine tablets, each containing 100-200 mg per tablet, taken for fatigue and alertness. Rarely, serious toxicities are seen with caffeine excess, at plasma levels of 15 mg/L or higher. Toxic symptoms include weakness, vomiting, fever, seizures, cerebral edema, cardiac arrhythmias (supraventricular tachycardia or ventricular fibrillation), hypokalemia, hypocalcemia, hyperglycemia, coma, and even death. Caffeine concentrations of 80 mg/ L are considered lethal. We report seven fatal cases of caffeine intoxication listed over the past 10 years.

A retrospective database search of cases with "caffeine" in the cause of death was performed 1999 to present. All available medical records and scene investigation data were reviewed. At autopsy, heart blood and peripheral blood were collected for routine toxicological screen of 12 classes of alkaline drugs. Caffeine was detected during routine comprehensive drug testing by gas chromatography-nitrogen phosphorus detection following an alkaline extraction of the biological specimens. The presence of caffeine was confirmed by full scan electron ionization gas chromatography-mass spectrometry. Caffeine was quantified using gas chromatography-mass selective detector using spiked caffeine calibrators.

A total of seven cases were identified over the ten-year period. The subject demographics were 4 women and 3 men. There were five Caucasians, one Hispanic and one African American subjects. The average age was 49 years (range 37-57). The manner of death for two cases was classified as suicide while the remaining five cases were undetermined. The average postmortem caffeine level was 117 mg/L (range 33-320 mg/L). Isolated caffeine intoxication occurred in five cases, combined caffeine and butalbital intoxication was seen in one case

and one case had combined caffeine and alcohol intoxication. Sources of caffeine included over the counter caffeine tablets and prescription medication.

This study is the largest case series reported to date of lethal caffeine intoxication. Although caffeine is generally regarded as safe for routine use, this study clearly demonstrates that lethal intoxications can occur. Both clinical and postmortem awareness must be maintained and comprehensive toxicological testing should screen for methylxanthines to detect caffeine.

Caffeine Intoxication, Methylxanthine, Toxicology

K31 Determination of Organochlorine Pesticides Residues in Human Subcutaneous Adipose Tissue

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The goal of this presentation is to demonstrate OCP residues in human adipose tissue as a result of chronic exposure in non-agricultural people.

This presentation will impact the forensic science community by describing how chronic exposures to OCP'S may cause serious damages to an individual, in means of cancer mechanisms, as also may explain the mechanism, cause of deaths. Environmental policies will soon be a forensic discussion and insurance problem.

Cukurova region is one of the most important agricultural areas of Turkey and approximately 32% of agrochemicals is consumed in this region. Negligence of performing required safety measures and lack of appropriate equipment for the preparation, and use of pesticides frequently cause accidental, acute, or ignored chronic exposure of pesticides in Turkey. Thus, in our region, biological monitoring of the pesticides, environmentally more persistent ones in particular, has a great importance. This study was aimed to monitor the chronic exposure of organochlorine pesticide (OCs) which are highly persistent in environment, and are tend to accumulate in human tissues due to their lipophilicity and resistance to metabolism.

Gas chromatography with electron capture detector (GC-ECD) was used to identify and quantify residue levels on a lipid basis of OCs. The minimum detection limits on fat basis for the studied organochlorine pesticides were as follows: 0.48 ng/g for α-BHC, β-BHC, and δ-BHC, 0.24 ng/g for HCB, *p,p'*-DDE and 0.97 ng/g for *o,p'*-DDE, *o,p'*-DDT, and *p,p'* –DDT. Recovery studies were performed on fortified blank animal fat samples at 50 and 100 ng/g concentrations. Ten samples were examined for each concentration. Depending on the pesticide, repeated analyses showed mean values from 74 to 107% of recovery. The concentrated sulfuric acid used in the clean- up step of adipose tissue extracts in order to degrade the phthalate esters that interfere in the gas chromatographic identification of organochlorine pesticides.

The average results (±S.D) for females and males were as follows; For females: HCB 5.47 ± 6.21, α-BHC 11.27±9.89, β-BHC 3.99±5.36, Σ-BHC 12.13±10.19, *p,p'*-DDE 106.68 ±90.31, *o,p'*-DDT 1.09±0.0, *p,p'*-DDT 8.49±10.54, Σ-DDT 113.43 ±94.99 ppb. For males: HCB 5.32 ±5.57, α-BHC 6.96±5.86, β-BHC 1.22 ±0.94, Σ-BHC 4.65 ±5.67, *o,p'*-DDT 1.41 ±0.59, *p,p'*-DDE 41.07 ±38.45, *o,p'*-DDT 2.34 ±0.15, *p,p'*-DDT 3.31 ±3.33, Σ-DDT 44.02 ±40.33 ppb.

We determined dichlorodiphenytrichloroethane, and its metabolites (DDTs), hexachlorobenzene (HCB), Benzenehexachloride (BHC) residues in human subcutaneous adipose tissues of 82 autopsy cases from the Morgue Department of Adana Branch of the Council of Forensic Medicine. Of all cases, 14 were female, and 68 were male and the average age was 40.51. The relationships between the age, gender, and body mass indexes of cases, and the accumulation of OCs residues were also investigated. Detectable concentrations of *p,p'*-DDE were found in 100% of adipose tissue samples. Among the remaining *p,p'*-DDT (84.1%), HCB (62.2%) were followed by α-BHC, β-BHC, *o,p'*-DDT, *o,p'*-DDE.

Concentrations of OCs in female adipose tissues were significantly higher than male adipose tissues ($p<0.05$). Positive correlations were found between concentrations of OCs in human adipose tissues and age of cases. The obtained results were compared to the results of studies conducted in countries where pesticide use is prohibited or allowed and with similar studies performed in our country.

The present study revealed that although the use OCs is forbidden biologic monitoring still shows residues in human tissues, in Turkey. This work is highly significant, being the first study pointing out the chronic exposure to organochlorine pesticides in our region.

Organochlorine Pesticide, Subcutaneous Adipose Tissue, Gas Chromatography

K32 Concentration Distributions of the Drugs Most Frequently Identified in Postmortem Femoral Blood Representing All Causes of Death

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The goal of this presentation is to provide quantitative information about the types of drugs most commonly identified in postmortem femoral blood samples representing all causes of death. Each drug was characterized by its mean, mean and upper 90, 95, and 97.5 percentile concentrations.

This presentation will impact the forensic science community by comparing the types of drugs used and abused in Sweden with other countries.

The compilation of drugs will prove useful to compare with future cases from the same population of death cases. This allows forensic practitioners "to flag" for an unusually high concentration of a certain drug, which might be important to consider as a contributing factor in the death.

Interpreting the concentration of drugs determined in postmortem blood in terms of toxicity and whether overdosing and drug poisoning was a likely cause of death is not always easy. The circumstances surrounding the death, the police reports, eye-witness statements, the findings at autopsy and not least the toxicology report all need to be considered. People differ widely in their response to the same dose of a drug depending on pattern of absorption, dosage form, route of administration, ethnicity, enzyme polymorphism and not least previous experience with the drug and the development of tolerance. Poly-pharmacy is widespread in today's society, which increases the risk of an adverse drug-drug or drug-alcohol interaction. The concentration of a single drug might be within an accepted therapeutic range, although toxicity is exaggerated owing to concomitant use of other psychoactive substances, or because of an idiosyncratic or allergic reaction. Some drugs share the same metabolic pathways and compete for binding sites on hepatic enzymes, whereas others have similar mechanisms of action in the brain occupying receptor sites or opening or blocking an ion-channel.

Many factors determine the types of drugs identified in post-mortem specimens, including life-style, social norms and customs, availability of pharmaceutical products, media reports and advertising as well as the prescribing practices of family physicians. The popularity of recreational drugs in society, the number of forensic autopsies performed and the comprehensiveness of the analytical toxicology performed are important considerations. Drugs available on prescription in one country might not even be registered in another, as exemplified by the hypnotic flunitrazepam, which is not approved in United States but is available on

prescription in many European nations. Scheduled substances are generally more dangerous and carry a greater risk of toxicity compared with non-scheduled or over-the-counter (OTC) medication. The combined use of alcohol and central nervous system depressants, both licit and illicit, often require emergency hospital treatment.

An in-house database (TOXBASE) was used to compile a list of the drugs most frequently identified in over 25,000 forensic autopsies representing all causes of death. The age and gender of the deceased were noted as well as the types of drugs determined in femoral venous blood samples. Ethanol (> 0.1 g/L) topped the list of psychoactive substances (N = 8,108 thus 32% of cases) at mean, median and highest concentrations of 1.43 g/L, 1.20 g/L and 8.0 g/L, respectively. Acetaminophen was in second position in 11% of cases. Amphetamine and cannabis (identified as tetrahydrocannabinol in blood) were the major illicit drugs at 13th and 15th positions, respectively. Newer antidepressants, citalopram (nr 3), sertraline (nr 14), venlafaxine (nr 16) were prominent prescription drugs as were sedative-hypnotics exemplified by diazepam (nr 4), zopiclone (nr 5) and zolpidem (nr 18). Many findings of morphine and codeine in blood were heroin-related deaths as evidenced by the presence of heroin's unique metabolite 6-acetyl morphine. Finding a high morphine/codeine concentration ratio (> 2.0) in blood gives compelling evidence for a heroin-related death.

Results of post-mortem toxicology are complicated by poly-drug use, adverse drug-drug interactions, as well as a host of pre-analytical factors. This compilation of drugs and the concentration distributions should prove useful in helping toxicologists and medical examiners in deciding if a certain drug might be implicated as likely cause of death. There is only a 1 in 40 chance of the drug concentration being above the upper 97.5 percentile of the distribution. This information along with the autopsy findings and police reports will prove useful when the cause and manner of death are determined.

Autopsy, Drugs, Toxicology

K33 Determination of Lidocaine in Postmortem Cases: Direct Implication in the Cause of Death vs. Incidental Detection

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The goals of this presentation are to provide a review of the toxicity associated with lidocaine by multiple means of administration, highlight three postmortem examinations cases since 2007 in which lidocaine played a role in the cause of death, and briefly present an LC/MS/MS analytical method for both lidocaine and its primary metabolite, MEGX.

This presentation will impact the forensic community by providing information from actual case studies to better understand and interpret the role of lidocaine in the cause of death. Additionally, comparative data between intentional ingestion versus administration of lidocaine by emergency medical services personnel will be presented to determine if there are any distinguishing factors in the measurements of lidocaine and MEGX.

Lidocaine was discovered in 1948 and today has gained widespread use as a local anesthetic and antidysrhythmic. Lidocaine poisoning results in central nervous system toxicity primarily manifested by seizures and potentially respiratory arrest. Cardiac toxicity may follow to include atrioventricular block, arrhythmias, and cardiac arrest. Toxic events have been reported via multiple routes of administration including subcutaneous, intravenous, and topical. Oral ingestion is considered to be particularly toxic due to extensive first-pass metabolism to MEGX, which is as or more toxic than lidocaine itself and may accumulate due to slower elimination.

Cases are screened for lidocaine by a standard alkaline liquid-liquid and back extraction procedure and analysis by gas-chromatography-mass spectrometry. Quantitative analysis employed a single-step liquid-liquid extraction with data collection performed by LC/MS/MS on an Applied Biosystems API2000. Separations were conducted using an isocratic mobile phase on a Phenomex Synergi Polar RP column (75 mm, 2 mm, 4 micron). The LC effluent at 0.250 ml/min was introduced to the mass spectrometer via electrospray ionization.

Of the three cases investigated by our office, the first is a suspected case of lidocaine substitution for cocaine. The decedent was a 19-year-old Hispanic male, moderately decomposed, found at his place of residence nude and in front of a laptop computer. Large amounts of white powder and marijuana were observed in the kitchen. Two samples of the powder were tested and both contained lidocaine, benzocaine, and procaine. A trace of cocaine was found in one of the powders. It is unknown if the decedent knew that the primary component was lidocaine. The cause of death was ruled as lidocaine intoxication, manner accident.

The second case involved a 30-year-old Caucasian male with a history of ulcerative colitis who had been hospitalized for six days due to oral ulcers and pain and difficulty swallowing. Treatment included lidocaine and he was discharged with medications including 2% oral viscous lidocaine and Lortab elixir. Early the next morning he was witnessed to consume shots of Gatorade mixed with GHB. He was found unresponsive later that morning. The cause of death was ruled bronchopneumonia due to multiple drug intoxication manner accident.

The final case in the series involved a 27-year-old Caucasian female who was found unresponsive lying in the driver's seat of her car parked on a residential street. A box of diphenhydramine HCl and Bactine antiseptic liquid were recovered from the scene. Cause and manner of death are pending at the time this abstract was drafted; however, there is indication of lidocaine as the primary intoxicant leading to death.

Femoral blood lidocaine and MEGX concentrations the above cases ranged from 3.6 – 39 mg/L and 1.1 – 7.3 mg/L, respectively. Additional data from vitreous samples in all cases and tissue samples from case one will be presented. Lidocaine and MEGX concentrations from cases where administration by emergency medical services personnel is documented will be presented as a basis of comparison.

Lidocaine, Postmortem Toxicology, MEGX

K34 Illicit Drugs Surveillance System and Ketamine-Related Fatalities in Taiwan, 2001-2008

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After attending this presentation, attendees will learn about the illicit drug surveillance system in Taiwan and target new trend of the emerging illicit drug ketamine.

This presentation will impact the forensic science community by building on the achievements of the government's tough on drugs initiative and measuring the emerging illicit ketamine by the illicit drug surveillance system.

Ketamine, a dissociative anesthetic agent that has acquired a unique, unpleasant emergence reaction with a cardiovascular stimulant properties since synthesized in 1961 by Calvin Stevens. Recent development of pharmacology and clinical anesthesia evolves concepts of its mechanism of action and advantage of alternative routes of administration, may arise the attention of illicit drug abusers. Epidemiological studies accompanied with illicit drugs surveillance system by using illicit-drug monitor system of illicit drug-related fatalities reveal heroin (35.2%), methamphetamine (19.2%), zolipidem

(16.9%), flunitrazepam (15.7%) and ketamine (13.8%) are top five in Taiwan in 2008, and ketamine-related fatalities are only three cases in 2001 with sequential increased from 2002 (11 cases), 2003 (10 cases), 2004 (9 cases), 2005 (11 cases), 2006 (18 cases), 2007 (16 cases) and to 36 cases in 2008. Total 114 ketamine-related fatalities with 75 male (65.8%) and 39 female (34.2%) of 14391 autopsy cases during 2001-2008 are discovered. The manners of deaths of ketamine-related fatalities of accidental, homicidal, suicidal and natural cause of deaths are 57 cases (50.0%), 27 cases (23.7%), 14 cases (12.3%) and 5 cases (4.4%), respectively. Average age of ketamine-related fatalities is 27.3 years old with peak around 15-24 years old range. Increasing the multi-drugs abuse with flunitrazepam, MDMA and methamphetamine can either reduce the unpleasant or increase the risk of ketamine-related toxicity is hypothesized. The total 114 cases with incidence of ketamine taken concomitantly, was 4.4% (5 cases) for flunitrazepam, 7.0% (8 cases) for methamphetamine, and 27.2% (31 cases) for MDMA. The ketamine concentrations (mean±Std. deviation) in blood, urine and gastric content were 2.40±4.84, 3.56±5.25 and 29.34±70.43 μg/mL. The surveillance system of forensic fatalities with illicit drug monitor system can identify the emerging trend of illicit drug. Ketamine is one of the new surveillance drugs of emerging trends since 2001 that the government will continue to monitor as part of their "anti-drug" efforts.

Ketamine, Illicit Drug, Drug Abuse

K35 You Don't Look/You Don't See: Delayed Death Due to Suboxone Ingestion Involving Analysis of Alternate Non-Biological Specimens (Clothing) – The Cleveland Experience

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After attending this presentation, attendees will have a better understanding of the utilization of alternate non-biological specimens (clothing and fabric) in addition to traditional matrices (blood, urine, bile, vitreous humor, gastric) as part of the death investigation process. Utilization of clothing or relevant material is important when biological specimens from the time of death are not available.

This presentation will impact the forensic science community by reminding attendees to think outside of the normal paradigms of toxicological analysis of only utilizing biological specimens from the body or from hospital admission. In this case, the decedent survived more than a month in a coma and antemortem specimens from the drug incident were not available for analysis. Alternate non-biological specimens (clothing) impregnated with drugs from urine and vomitus were utilized as the nexus needed in clarifying the cause of death.

In 2008, a 24-year-old white female was found unresponsive at her home by her family. That evening she entered her home and asked her sister to make her a cup of tea. The sister then retired for the evening. The decedent was last seen to be seated in a chair in front of a computer. When she came into the house that evening she told her sister that she had smoked marijuana, took SuboxoneÒ and drank 3/4 of a can of beer.

The next morning she was found unresponsive on the floor next to the chair. The previous day she was in the accompaniment of a friend outside of the home. She was conveyed to the hospital with an initial diagnosis of anoxic encephalopathy secondary to possible drug overdose. The decedent had a history of drug and ethanol abuse and depression. Heroin, Suboxoneâ, and alprazolam were suspected in the overdose. She remained in an unconscious state and died approximately one month later.

An autopsy was performed at the Cuyahoga County Coroner's Office, Cleveland, Ohio. Postmortem blood: heart and femoral, urine, vitreous humor, bile and gastric were submitted for a comprehensive toxicology analysis. The initial post-mortem toxicological analysis produced a paucity of information. The blood was positive for Oxycodone 1.85 mg/L, Acetaminophen 41.9 mg/L, Diazepam 0.16 mg/L and Nordiazepam 0.08 mg/L. Fluconazole and Oxymorphone were reported as positive. All of these drugs were administered during her hospital stay. No antemortem admission blood samples were available for reanalysis. Hospital admission urine toxicology only revealed the presence of benzodiazepines, testing for Suboxoneâ was not conducted.

The family had retained the clothing that the decedent was wearing on the morning she was found. They provided to law enforcement a pair of underwear, a hooded sweatshirt and a cushion cover on which she was last seen to be seated. Previous studies have demonstrated the ability to isolate various drugs from the fibers of textile fabrics. The decedent had vomited on her sweatshirt and had urinated when she was found unconscious.

From these materials, swatches of the stained areas were cut and subjected to a comprehensive Toxicology analysis. The initial Toxicology screens of the clothing and seat cushion cover were positive for fluoxetine and caffeine, respectively.

Further testing by liquid chromatography with tandem mass spectrometry (LC-MS/MS) on the stained fabric extracts for non-routinely covered drugs was performed at NMS Labs, Willow Grove, Pennsylvania. The underwear and sweatshirt were positive for alprazolam, naloxone, buprenorphine, and norbuprenorphine. The seat cushion swatches were "negative."

In 2002 the FDA approved Suboxoneâ to treat opiate addiction. It contains Buprenorphine and Naloxone and has both analgesic and opioid antagonist properties. Suboxoneâ may dangerously increase the effects of drug-drug interactions; this includes some antidepressants, antihistamines, benzodiazepines, sedatives, analgesics, antianxiety, and muscle relaxants. Coma and death has been associated with the concomitant intravenous misuse of buprenorphine and benzodiazepines. Selective serotonin reuptake inhibitors also inhibit buprenorphine metabolism. Cytochrome CYP 3A4 interactions with azole antifungal drugs, macrolide antibiotics, and HIV protease inhibitors and may also increase concentrations of plasma buprenorphine.

The cause of death was ruled anoxic encephalopathy due to acute intoxication by combined use of Suboxoneâ, Alprazolam, and Fluoxetine. The manner of death was ruled as accidental self-administered overdose by drugs. The case is still under investigation; police are now considering criminal charges on the friend for unauthorized distribution of Suboxoneâ.

Suboxone Fatality, Death Investigation, Alternate non-biological Specimens

K36 NMR Analysis of 3,4-methylenedioxy-N-methylamphetamine (MDMA or Ecstasy) and its Metabolites in Urine

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After attending the presentation, attendees will learn about the use of NMR spectroscopy for the detection of drugs of abuse in urine. Real case studies are also presented.

This presentation will impact the forensic science community by introducing a new technique to detect and quantify the presence of MDMA (ecstasy) in human urine.

Drug testing in urine is a common technique used today. Current methods of testing urine for drugs and their metabolites include HPLC, GC-MS, or immunoassay analysis. These methods all have their drawbacks.[1] Recently, nuclear magnetic resonance, (NMR), has emerged as a means of analyzing drugs and drug metabolites in urine. There is literature precedence describing the use of NMR spectroscopy to identify compounds in urine from intoxication.[2] There are many benefits to using NMR spectroscopy: NMR is non-destructive and samples can be analyzed as many times as desired. There is also little sample preparation required.

3,4-methylenedioxy-*N*-methylamphetamine, more commonly called MDMA or "ecstasy", is a synthetic drug similar in structure to methamphetamine.

In this project, we investigated the practicality of using NMR spectroscopy to detect and quantify the presence of 3,4-methylenedioxy-*N*-methylamphetamine (MDMA or ecstasy) in human urine.

First, a calibration curve was established with spiked samples of real urine. To determine the standard deviation, seven independent urine samples spiked with the different compounds at a concentration of 0.05mg/mL were run. Variance (S^2) and standard deviation (S) of the measurements were calculated.

As for the LOD, the very nature of NMR makes it impossible to determine as it depends on the amount of scans used for the experiment. In this study the experimental time was limited to overnight experiments, allowing a quantification in the 0.01 mg/mL concentrations range.

Following this, real urine samples from MDMA users were analyzed. The real samples were collected following an IRB approved protocol. Five different samples were collected. This presentation discusses the spectra of the urine obtained from these 5 volunteers. Figure 1 shows the spectrum of the first sample. Surimposed in gray is the spectrum of MDMA spiked urine (0.50 mg/mL). All peaks for the protons of MDMA are clearly visible.

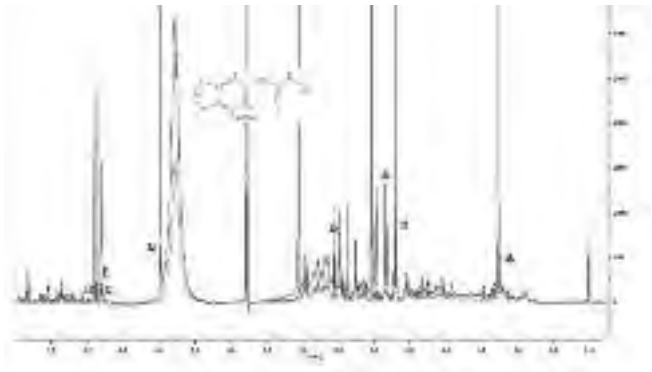
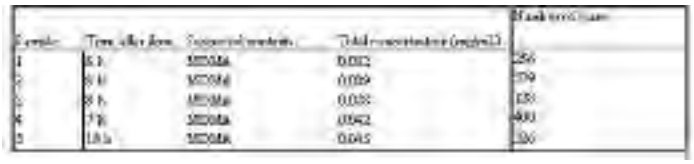


Figure 1: Sample 1, 256 scans. Superimposed in gray is the spectrum of MDMA spiked urine (0.50 mg/mL).

The results are summarized in the following table:



These results suggest the 1H NMR spectroscopy could provide a convenient tool for the rapid detection of MDMA in human urine. This method presents the advantage of a rapid diagnosis with little of urine needed and no sample preparation. Furthermore, samples were analyzed within 20-30 minutes. The NMR method should be useful in rapidly confirming the diagnosis of poisoning.

The limitation of using NMR for the identification of MDMA is that at lower concentrations, the presence of small amounts of metabolites or other therapeutic agents can interfere. In that case, the quantification procedure can be difficult.

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NMR, Ecstasy, Urine

K37 Applications of Fire Debris Analysis to Problems in Toxicology

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After attending this presentation, attendees will understand how methods and procedures used in one of the disciplines of trace evidence, fire debris analysis, applies to problem solving in toxicology. Attendees will learn of methods and solvents to use with a case example showing the usefulness of the application.

This presentation will impact the forensic community by describing how methods and procedures in fire debris analysis could be useful to the toxicologist in certain cases. Cooperation between laboratory sections brings results unattainable by staying with existent expertise in a section. The static adsorption-elution approach should be considered by toxicologists when faced with volatile or ignitable liquid substances.

Toxicologists often use liquid-liquid or solid phase extraction to solve the majority of their case work. When faced with a poisoning case where the agent is gasoline, charcoal starter fluid, or other ignitable liquids, these typical methods fail. Ignitable liquids consist of various mixtures of alkanes, isoparaffins, aromatics, and cycloparaffins. These hydrocarbons would extract with tissue matrix consisting of fats, proteins, and cellular decomposition products soluble in organic solvents. These co-extracting matrix compounds could mask or interfere with interpreting the ignitable liquid chromatograms.

Fire debris analysts have similar problems separating the ignitable liquids from condensed pyrolysates and post-burn residues which extract similarly. By using the static adsorption-elution (SAE) method borrowed from industrial hygienists and used in fire debris analysis, a majority of the matrix materials can be separated from the compound(s) of interest. To capture the volatiles, the method uses activated charcoal strips and warming the sample to approximately 65 ^{0}C.

To elute the captured liquid, an appropriate solvent such as carbon disulfide (CS2) or n-decane can be used depending on the anticipated analyte(s). Most ignitable liquids will elute after CS2 allowing the analyst to categorize the captured liquid without the solvent interfering. Using a GC-FID or GC/MS with a DB-1 column (or equivalent) with a length of 15 meters, 0.25mm diameter and 0.25um film thickness, the GC method ranges from 40^O C to 300^O C for typical samples, with a 2 minute hold at the lower and upper limits. A rapid 25^O per minute ramp rate allows for a short 14.4 minute analysis. Inject 1 uL of the eluted liquid. The MS is turned on at injection, turned off just before the CS2 solvent elutes, and then turned on immediately after CS2 elutes until the

end of the run. Comparison of the resulting total ion chromatogram and extracted ion chromatograms against n-alkane series and previously categorized laboratory standards of consumer ignitable liquids analyzed on the same instrument will permit classification of the ignitable liquid according to ASTM E-1618.

If the potential liquid consists primarily of low boiling compounds, a later eluting solvent such as n-decane would be suggested. Use an isothermal temperature program at low temperatures (e.g., 35^{O} C) with the MS active from the time of injection until just before the n-decane (or other chosen solvent) elutes. Using different analytical strategies can improve detection of the volatile analytes of interest. The method can be used to determine the presence of toluene and similar compounds in huffing cases.

In one case of petroleum consumption suicide, the SAE method with CS2 was used. The male decedent a one-gallon and a one-quart paint thinner cans in his vehicle nearby. No trauma or significant levels of drugs were found. The SAE method was used to extract the lung, liver, brain, stomach contents, blood, and vitreous fluid then analyzed by GC-FID and GC/MS. The blood and vitreous did not have recognizable chromatograms. The chromatograms of the lung, liver, stomach contents, and brain eluted from the octane (C8) to the dodecane (C12) n-alkanes with at least two significant n-alkane peaks, and unresolved compounds creating a Gaussian like peak over the C8 to C12 range which was categorized in the medium petroleum distillate category. Many paint thinners are included in this category. The lung, liver, and brain each showed slight variations in their chromatograms from each other and the stomach contents. Close inspection of the stomach contents chromatograms with the liquid from each paint thinner can from the car revealed the decedent likely drank from the one-gallon container. A comparison against corresponding tissues from non-petroleum consumption deaths showed no similar compounds naturally occurring. The death was ruled a suicide by consumption of the paint thinner.

Using the SAE method can help extract volatile liquids cleanly from most toxicological matrix materials. Accomplishing identification or categorization of the captured liquid can be performed easier with a chromatogram containing fewer matrix peaks.

Ignitable Liquid, Toxicology, Analysis

K38 Development of a Method for Detecting Papain in Adulterated Urine Samples

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After attending this presentation, attendees will become familiar with a newly developed enzymatic assay for detecting papain in adulterated urine samples.

This presentation will impact the forensic community by providing a method to detect papain, a novel adulterant, in urine samples. Papain testing by this method can contribute to determining the validity of urine samples and will diminish the likelihood of individuals obtaining false negatives during drug screening due to the presence of papain in urine.

Papain is a novel urine adulterant being used to interfere with the common drug screening methods used in urine drug testing. In a study by Burrows et al., papain was found to interfere with the analysis of some drugs and was not detected in urine using current guidelines of specimen validity testing.[1] Thus, a method is needed to detect papain in urine and contribute to rendering the urine sample invalid. The current research developed an enzymatic assay for detecting papain in urine samples.

Papain is a cysteine protease that has a broad specificity, cleaving peptide bonds involving basic amino acids, leucine, and glycine. It hydrolyzes both esters and amides. A synthetic substrate, Nα-Benzoyl-DL-arginine-4-nitroanilide (BANI), was used in assay development. Papain acts on BANI to release p-nitroaniline which absorbs at 410 nm. The rate of formation of this product is easily monitored by following the change in absorbance at 410 nm. Assay conditions were established. Experiments examining the rate of product formation with varying papain concentrations and found that a linear relationship existed between the rate of product formation and concentration of papain. Papain activity as low as 0.003 units could be detected by this method. Unknown blind samples of papain were analyzed and were accurately determined as being either positive or negative for papain using this method. ***Papain itself is available from a variety of vendors and there are currently no restrictions on possession or use of papain, which makes it an easily accessible urine adulterant. However, there are also common consumer products that contain papain such as*** Adolph's® Meat Tenderizer and Beverly International® Multiple Enzyme Complex which is marketed as a digestive supplement. The assay could also detect papain in urine when these consumer products were the source of papain. The effect of storage conditions on papain activity in urine was also examined. Storage for one hour at room temperature had no significant effect on papain activity. Storage at room temperature for 2 h to 24 h led to a decrease in activity ranging from a 22% decrease at 2 h to a 48% decrease at 24 h. Storage at 4º C for 2h to 24 h led to a decrease in activity ranging from 22% at 2 h to 52% at 24 h. The results of testing for potential interference by common drugs of abuse in this papain assay will also be presented.

Reference:

[1] Burrows, DL, Nicolaides, A, Rice, PJ, Dufforc, M, Johnson, DA. Papain: A Novel Urine Adulterant. Journal of Analytical Toxicology 2005;29:275-295.

Papain, Adulterant, Urine Drug Testing

K39 Propofol Analytical Challenges and Interpretation

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After attending this presentation, attendees will have an overview of propofol concentrations reported in 71 cases between July 2008 and July 2009 along with relevant case history where available.

Propofol is a sedative-hypnotic widely used as an intravenous anesthetic agent. There is also increasing incidences of propofol abuse, especially among healthcare workers. Recently, propofol has garnered media attention and the DEA has indicated it is considering classifying propofol as a "scheduled drug", tightening restrictions on its distribution and use. Some lots of propofol were recently recalled due to contamination with suspected endotoxins. Propofol concentrations in previously reported overdose deaths were 0.22 – 5.3 µg/mL and the concentration in a homicide case was 4.3 µg/mL.

Cases submitted to NMS Labs that included a positive propofol finding were included in the analysis. Quantitative propofol analysis was performed if indicated by a gas chromatography-mass spectrometry screen performed at NMS Labs or if ordered directly by the submitting agency. Propofol quantification was conducted using capillary gas chromatography with flame ionization detection. The method has a limit of quantification of 0.05 µg/mL. Once identified, cases were reviewed and sorted according to the information initially available at the time of abstract preparation.

During a one-year period, there were 71 cases with quantifiable propofol. In two cases, propofol quantification was approximated due to sample matrix problems; these were excluded from further analysis. In the remaining 69 cases, propofol concentrations were 0.05 – 110 µg/mL (mean= 2.55 ± 13.35 µg/mL; median= 0.35 µg/mL). Forty specimens

were identified to have been collected during autopsy; the average propofol concentration in these cases was 3.29 ± 17.31 µg/mL. The elevated mean and standard deviations can be attributed to two cases with propofol concentrations of 20 and 110 µg/mL. The mean propofol concentration from central blood (0.84 ± 1.03 µg/mL) was higher than peripheral blood (0.44 ± 0.31 µg/mL) in the post-mortem cases where blood source was identified.

Of the 40 specimens collected during autopsy, case histories indicated that 12 patients were hospitalized at the time of death, five of which died while under or recovering from anesthesia. Lack of sufficient case history prohibits identification of anesthesia use in the other seven hospital deaths. The average propofol concentrations were similar for the hospitalized patients overall and those for which anesthesia use was indicated, 0.79 ± 1.03 and 0.98 ± 1.52 µg/mL, respectively. One patient who died during anesthesia induction had a propofol concentration of 3.7 µg/mL and history indicated the patient had hepatitis C. If this individual is excluded, the average propofol concentration for the remaining 4 patients was 0.30 ± 0.16 µg/mL.

Two cases were described as "suspected propofol overdose" and in a third case syringes containing propofol and fentanyl were included, though it is unclear if the patient in this case was dead. Propofol concentrations were 1.2 and 1.0 µg/mL in the suspected overdose cases and 0.20 □g/mL in the case where syringes were present. In one case, propofol testing was performed based on "reasonable suspicion/cause" and a serum propofol concentration of 1.4 µg/mL was reported.

The data provided is based on information provided with case submission and thus available at the time this abstract was prepared.

Propofol, Blood Concentrations, Death

K40 Detection of Fentanyl and Lidocaine in Dried Blood Spots Using High Performance Liquid Chromatography Tandem Mass Spectrometry

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After attending this presentation, attendees will understand a unique toxicological analysis on an alternate sample matrix using HPLC/MS/MS.

The goal of this presentation is to communicate the validation and analysis of dried blood spots which were deposited onto household tissue paper. The circumstances of the donor's death were suspicious; a unique analytical opportunity was presented to the laboratory to either confirm or refute a suspect's version of the events.

This presentation will impact the forensic toxicology community in several ways. Firstly, it demonstrates that even in the absence of traditional toxicological samples such as liquid blood or urine, valuable information can be extracted from materials that more closely resemble trace evidence. Secondly, it demonstrates the sensitivity capable when state of the art instrumentation is used, suggesting that high performance liquid chromatography tandem mass spectrometry can allow for drastically reduced sample amounts. Lastly, the simplicity of the sample preparation points to streamlined extraction procedures for general drug screens.

Dried blood spots (DBS) on paper have been routinely used in DNA analysis for some time. Stain cards are routinely used by forensic laboratories for both analysis and archival of blood samples. Recently, the use of DBS samples has been also applied to clinical toxicological studies. A primary advantage of DBS analysis is that much smaller blood volumes are necessary; 15 microliters of blood can be sufficient. Another advantage of DBS analysis is the collection, transport, and storage of the stained paper material. A final benefit of the DBS analysis is the opportunity for significantly simplified sample treatment procedures due to the reduced matrix effects. The extraction employed a simple methanolic solvent extraction followed by centrifugation of a punch taken from the DBS. The success of clinical DBS analysis suggests that utility may also be found in the forensic toxicology arena.

An application of the DBS paper analysis technique was used to answer a unique analytical question posed by law enforcement during the investigation of a suspicious death. Blood stained tissue paper was recovered from the victim during the process of emergency medical treatment and law enforcement investigation. DNA analysis confirmed that the dried blood was from the expired donor. Statements from the victim's spouse seemed to be in conflict with the observed events. Establishing the veracity of the spouse's statements was dependent upon determining the precise timing of the blood deposition on the tissue paper. Emergency room medical treatment included the application of 8 drugs, including fentanyl and lidocaine. The presence or absence of these drugs in the dried blood deposited on the tissue would either confirm or refute the suspect's statements.

The analytical approach, validation, and outcome will be presented highlighting the advantages of the technique and suggesting directions for simplified drug screening methods.

Dried Blood Spots, Alternate Matrix, Tandem Mass Spectrometry

K41 Postmortem Pediatric Toxicology

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After attending this presentation, attendees will gain an appreciation for the challenges unique to toxicological findings in postmortem pediatric cases. Attendees will learn interpretive guidelines for pediatric cases involving forensic toxicology in both a general and case-specific sense.

This presentation will impact the forensic science community by further delineating the interpretive aspects of toxicological findings in the pediatric population.

In this 11th Annual Special Session within the Toxicology Section, pediatric cases involving toxicological findings are discussed. As a relative dearth exists of interpretive information involving toxicological findings in the pediatric population, this session is a forum to help elucidate and clarify such issues. The format is a short case presentation including pharmaco-toxicokinetic data and other relevant ancillary information followed by audience participation to provide interpretive clarity around the case-specific impact of the toxicological findings.

Pediatric, Toxicology, Postmortem

K42 *Melendez-Diaz* and Other 6th Amendment, Confrontational Clause Cases - Their Impacts and Perspectives

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After attending this presentation, the attendee can expect to learn about the impacts that the *Melendez-Diaz* decision from the Supreme Court has had on laboratory practice and also the perspectives of the Judiciary, prosecution and defense.

The presentations will impact the forensic science community by providing knowledge about the *Melendez-Diaz* decision and other related cases and provide important perspectives on the impacts to the laboratory, defense, and prosecution.

Throughout the years there have been many decisions that affect how scientific evidence can be entered into court proceedings with the most recognized being the *Frye* and *Daubert* decisions. The right of a criminal defendant to confront and question evidence that establishes an element of the crime of which he is accused exists in tension with the impact on laboratories that provide scientific testimony about standardized methods and results whose analysts must now personally testify about their work. The *Melendez-Diaz v. Massachusetts* decision was issued by the United States Supreme Court on June 25, 2009. While it is the latest in a line of Sixth Amendment or Confrontation Clause type cases it is the most recent decision to affect how scientific evidence can be entered into court proceedings. Specifically this case addressed the admission of evidence identifying controlled substances by affidavit. The ruling that the Massachusetts statues allowing for the admission of this evidence by affidavit was an unconstitutional violation of a defendant's right to confront and cross examine witnesses impacts every federal and state court in the United States. In doing so, the court further elucidated its position about "testimonial evidence" begun in the *Crawford* case. The implications for laboratories producing results from analytical tests and evidence generated through other disciplines will have significant impacts in some jurisdictions.

Before the end of the 2008-09 term, the US Supreme Court granted argument on another case concerning whether an witness can testify to another's work from the original analyst's report. This case, *Briscoe v. Virginia* again looks at a very similar case. Where the central question in *Melendez Diaz* is whether the Confrontation Clause requires treating crime lab reports as testimonial evidence, the central question of Briscoe is if a state allows a prosecutor to introduce a certificate of a forensic laboratory analysis, without presenting the testimony of the analyst who prepared the certificate, does the state avoid violating the Confrontation Clause of the Sixth Amendment by providing that the accused has a right to call the analyst as his own witness.

A goal of the session is to provide a forum for the discussion of the needs of forensic science evidence for each of the justice system components.

Confrontation Clause, *Melendez-Diaz*, Briscoe

K43 Brain Serotonin Transporter Reduction in Human Polydrug MDMA (Ecstasy) Users

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After attending the presentation, attendees will be alerted to the question whether use of MDMA (ecstasy) might cause damage to the brain.

This presentation will impact the forensic and general community by advising on the possible risks of MDMA use and by illustrating the need to conduct drug hair analyses to confirm use or lack of use of MDMA and other recreational drugs when investigating possible effects of MDMA on the human brain.

Background: MDMA (3,4-methylenedioxymethamphetamine, ecstasy) is an analog of methamphetamine that is widely used recreationally and is also being tested in clinical trials for the treatment of post-traumatic stress disorder. Recreational interest in MDMA is related in part to the ability of the drug to cause increased energy and sociability. Animal data indicate that chronic ecstasy exposure can cause a long term reduction in brain serotonin neurone markers, raising the public health issue of actual damage to brain serotonin neurones and associated behavioral problems in the human. However, brain neuroimaging studies in MDMA users measuring levels of a serotonin neurone marker, the serotonin transporter (SERT), have been contradictory, with most investigations not confirming by drug testing use of MDMA or other drugs.

Objective and Hypothesis: The objective was to test the hypothesis, based on animal data, that brain levels of SERT are decreased in living human MDMA users.

Methods and Subjects: SERT levels were estimated by measuring binding of 11C-DASB in a Positron Emission Tomography (PET) procedure in 50 normal subjects and 49 MDMA users. MDMA users were withdrawn from the drug for approximately 7 weeks and reported using approximately two tablets/session, two sessions/month, and 200 lifetime tablets over four years duration.

Results: All MDMA users tested positive for MDMA in hair. As expected, of the 49 MDMA users, most (40) tested positive in hair for methylenedioxyamphetamine (MDA), a metabolite of MDMA. The levels of MDA in 39 of these subjects were lower than that of MDMA, suggesting that MDA had derived from metabolism of MDMA. However, one subject demonstrated higher levels of MDA than MDMA in hair, suggesting that this subject might have ingested both MDA and MDMA.

Many MDMA users also used other stimulant drugs and there was a discrepancy between self-reported use of other stimulants vs. drug hair findings (e.g., 32/49 subjects testing positive for methamphetamine in hair vs. only 9 reporting use by self-report; 23 vs. 14 for cocaine). This discrepancy is likely explained in part by inclusion of other stimulants in tablets marketed as "ecstasy" and possibly by the expectation of the ecstasy user that he/she would more likely be included for study if other drugs were not reported as used.

Most MDMA users reported increased sociability and body temperature while on the drug (typically in a club setting) and partial tolerance developing to the behavioral effects of MDMA. Consistent with the literature, most MDMA users reported a dysphoric drug discontinuation/withdrawal syndrome (sometimes severe) occurring one or more days following last use of the drug. There was no consistent response when MDMA users were asked to report whether they were

more empathetic (caring) to others while on the drug.

Brain SERT binding was significantly decreased in the MDMA users as compared with control values, but the regional pattern was highly selective with the cerebral cortical brain regions (frontal, -27%; temporal, -27%, insular, -26%, anterior cingulate, -20%; occipital, -46%) bearing the brunt of the loss. High SERT density subcortical regions (caudate, putamen) were strikingly normal. There was marked overlap between the ranges of the control and MDMA user values. SERT binding was similar in those who tested and did not test positive for methamphetamine in hair.

Conclusions: The PET findings showing a cerebral cortical loss of SERT in MDMA users are similar to those recently obtained by a Johns Hopkins group and may help bring some consistency to this confusing literature.

Taken together, our data suggest that cerebral cortical SERT levels will be decreased, for at least two months after last use of the drug, in chronic MDMA users who use, on average, two tablets/session and two sessions/month. However, use of other drugs (methamphetamine, cocaine, cannabis) is a potentially important confound that could modify this conclusion. The observed discrepancy between recent use of drugs (other than MDMA) by self-report vs. drug hair testing also raises the possibility that other studies that do not conduct drug hair testing for stimulant drugs such as methamphetamine and cocaine may well have underestimated use of these drugs.

The special sensitivity of cerebral cortex vs. subcortical brain areas to SERT loss might be explained by differences in serotonin nerve ending characteristics or proximity to cell bodies. Finally, we emphasize that our findings cannot distinguish between actual loss of serotonin neurones and loss of SERT within intact neurones.

MDMA, Ecstasy, Serotonin Transporter

K44 Toxicological Findings in Cases of Sexual Assault in the Netherlands

Ingrid J. Bosman, PhD, Netherlands Forensic Institute, Laan van Ypenburg 6, The Hague, 2497GB, NETHERLANDS*

After attending this presentation, attendees will be provided an overview of the extent and types of drugs found in forensic cases of alleged drug facilitated sexual assault in the Netherlands.

This presentation will impact the forensic community by providing data on the most common drugs found in victims of alleged sexual assault in the Netherlands.

Reports on cases of alleged drug facilitated sexual assault have increased since the 1990s. The prevalence and types of drugs encountered during investigations of alleged sexual assault are likely to differ between countries depending on social norms and the use of drugs in society. Alcohol alone, or together with other drugs has been a common finding in many previous studies in America, Australia, the United Kingdom, and Sweden.

In this paper, the toxicological results from cases of drug-facilitated sexual assault were examined that were presented at the Netherlands Forensic Institute (NFI) between January 2004 and December 2006. The aim of this study was to identify the extent and types of drugs found in cases of alleged sexual assault. Included were those cases with an indication for sexual assault in the archives and the presence of a blood sample, a urine sample or both for analysis. Depending on the case description, information from the police, the type of biological material and the amount of sample available, analysis of alcohol, GHB and/or screening methods for drugs of abuse and prescription drugs were performed. For confirmation analysis, specific methods for the different classes of drugs were used, mostly involving GC-MS after SPE and derivatisation.

In total, 135 cases of alleged drug facilitated sexual assault were identified; 35 cases were included in 2004 and in the years 2005 and 2006 fifty cases per year were included. In 28 of the submitted cases only blood samples were available, in 50 cases only urine samples, and in 57 cases both blood and urine samples were present. Along the year, there was no clear seasonal variation in the number of reported cases of alleged sexual assault. Although the total number of reported cases is small, this is in contrast with other literature reports showing peaks during summer months or in December during the festive season. Most of the victims were female (94%) and the mean age of the victims was 25 years (range 4 – 69 years, median age 24 years).

In 27% (36 out of 135) of the cases no alcohol and/or drugs were found. The relationship between these negative toxicology results and time delay between alleged sexual assault and sampling was examined. This showed that with a time delay of less than 12 hours 11% of the cases were negative, with a time delay between 12 and 24 hours 25% and with a time delay of more than 24 hours 47% showed negative results. Therefore, some cases may represent false negative results due to the time delay.

In 108 cases, blood or urine samples were tested for both alcohol and drugs. In 47% of these cases alcohol was detected: in 22% of the cases alcohol was the only drug identified and in 25% of the cases alcohol and at least one drug were tested positive.

In 134 cases, blood or urine samples were screened for drugs. In 54% of these cases at least one drug was identified. The most common group of drugs identified was the analgesic group with paracetamol and ibuprofen being the most frequently found in respectively 27 and 16 cases. Cocaine, MDMA and THC or metabolites were the most commonly illicit drugs found. The so-called date-rape drug GHB was detected in only two cases (out of the 109 tested). Benzodiazepines were detected in 14 cases.

In conclusion, the results show that alcohol is the most commonly found drug in alleged sexual assault cases followed by analgesics, illicit drugs and benzodiazepines. Although it was not possible to distinguish between voluntary and involuntary ingestion, the presence of drugs may contribute to the victim's vulnerability. In some cases the absence of alcohol and drugs may represent false negative results due to the time delay between alleged sexual assault and sampling.

Sexual Assault, Alcohol, Drugs

K45 Validation of a High Performance Liquid Chromatography Tandem Mass Spectrometry Method for the Detection of Opioids in Hair

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After attending this presentation, attendees may evaluate the validation of an HPLC/MS/MS method for the detection of opioids in hair, and whether application of this method in their own laboratories may enhance their investigative capabilities.

This presentation will impact the forensic science community by providing another technique for the screening and confirmation of an important drug class in hair, particularly useful for the investigation of drug facilitated sexual assaults.

The detection of drugs in hair specimens poses a unique set of analytical challenges for the forensic toxicologist: limited sample amount, often vague target lists, and instrumental characteristics all impose limitations on the types of exams that may be performed upon the hair matrix. A well-validated method for the detection of opioids in hair can then serve as yet another technique for determining an individual's possible exposure to a drug, perhaps most meaningfully in drug-facilitated sexual assault (DFSA) cases.

While benzodiazepines are commonly associated with DFSA case, opioids are also used to render victims unconscious or less able to resist.

In developing a full panel of DFSA examinations, opioids should not be overlooked when the type of drug used is less clear.

The validation of an HPLC/MS/MS method for the detection of opioids in hair is presented. The method is adapted from an existing standard operating procedure previously validated by the FBI Laboratory for matrices such as blood, urine, and tissue. The adaptations necessary for the preparation of the hair matrix are discussed. The types of hair matrices included in the validation as well as various sample trial sample pretreatments are also discussed. Optimization of the HPC/MS/MS parameters is described.

The procedure allows for the screening and confirmation of morphine, codeine, hydromorphone, hydrocodone, oxymorphone, oxycodone, 6-acetylmorphine, normorphine, norcodeine, noroxycodone, dihydromorphine, and dihydrocodeine. Hair specimens are qualitatively screened and quantitated if necessary. The hair is pulverized using a freezer mill cooled by liquid nitrogen, rendering the hair to a fine powder like consistency. The specimens are mixed with buffer and internal standards, and extracted using mixed mode hydrophobic/cation exchange solid phase extraction cartridges. Target drugs are eluted using a mixed solvent system of methylene chloride, isopropanol, and ammonium hydroxide. The eluent is taken to dryness and reconstituted prior to analysis by HPLC/MS/MS.

Case studies will be presented in which the laboratory's drug screening standard operating procedures were useful in an investigation.

LC/MS/MS, Opioids, Hair

LW1 The Great White Dope: Was Jim Jeffries Drugged Before his Heavyweight Title Fight With Jack Johnson?

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The goal of this presentation is to inform the forensic community of a little known, but interesting case involving an alleged poisoning.

This presentation will impact the forensic science community by discussing the signs and symptoms of alleged poisoning in a historical context.

In 2007, George Foreman announced that he lost his 1974 heavyweight title fight with Muhammad Ali – the "Rumble in the Jungle" – because he had been drugged. Foreman's revelation was not the first time that a former heavyweight champion claimed that he lost his crown because he had been "doped."

On July 4, 1910, heavyweight champion Jack Johnson fought the "Great White Hope," former heavyweight champion Jim Jeffries, in Reno, Nevada. Although the "tale of the tape" (a boxer's weight, height, arm length, and other measurements) favored Jeffries, age and diminishing skills did not.

Jeffries had been born in 1875. He won the heavyweight title on June 9, 1899 by knocking out Bob Fitzsimmons in the eleventh round at Coney Island, New York. Jeffries stood six feet two inches and weighed 206 pounds when he won the title. He had a reach of seventy-six and one-half inches. Jeffries retired in 1904 with a record of seventeen wins, two draws, and no losses. Fourteen of his victories came by knockout. After his retirement, Jeffries did not fight again until he began training for his comeback against Johnson. In the intervening years, his weight ballooned to almost three hundred pounds. Jeffries died in 1953 of natural causes.

Jack Johnson was the younger man by three years. He took the title from Tommy Burns on December 26, 1908 in Sydney, Australia. Johnson won a unanimous decision when police stopped the bout after fourteen rounds. Johnson was six feet one and-a-half inches and weighted 192 pounds when he beat Burns. His reach was seventy-four inches. When Johnson finally retired in 1938 at the age of 60, his record stood at eighty-two wins, fourteen losses, and ten draws. He scored fifty-one knockouts. Johnson died in 1946 in an automobile accident. Significantly, in the six years between Jeffries's retirement and Johnson's match with the former champion, Johnson's boxing skills and reflexes had been sharpened by thirty-seven fights, of which only two were lost.

On the day of the fight, Jeffries described himself as having become "weaker and more sluggish" every day for a week, although he experienced no pain. In his own words, he was "dull," "listless," "numb," and suffered from "dysentery." On the morning of the fight, Jeffries overslept. His handlers had difficulty waking him and when they finally did, noted that his body was as "cold as ice." When Jeffries tried to warm up, first by walking and then by running, he stumbled so much that some thought he was intoxicated. By his own admission, Jeffries had had nothing to drink that day – not even water – except a glass of champagne. As the fight was about to begin, Jeffries became chilled again, even though the temperature in the ring approached 100 degrees Fahrenheit. Not surprisingly, Johnson easily dominated Jeffries and retained his title with a fifteenth round technical knockout.

A few days later Jeffries's brother and others claimed that the former champion had been "doped" before the fight. Jeffries initially denied the rumors, but reversed himself with the publication of his authorized biography in 1929. He claimed that his physician, a leading Los Angeles internist, confirmed that he been drugged and that he had continued to suffer from the drug's ill effects until 1927. Although Jeffries described his symptoms, he never identified his doctor or the drug, and only vaguely hinted at who may have given the mysterious substance to him.

Was Jeffries's claim simply a proud, old champion's attempt to rationalize his only defeat or was he really "doped"? If so, what might the drug have been, who gave it to him, and how might it have been administered?

Boxing, Poisoning, Doping

LW2 A Mummy's Tale: Surprising, New Evidence Refutes Oral Tradition

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After attending this presentation, attendees will have greater insight into how forensic anthropologists and other forensic scientists can assist in answering questions posed by historians regarding ancient human remains.

This presentation will impact the forensic science community by demonstrating how the use of non-invasive investigative technology, such as x-rays and CT scans, can overturn previously held beliefs and reveal a wealth of secrets about a two-thousand-year-old Egyptian mummy.

Some time during the 1920s, a mummy from ancient Thebes made its way to the United States with little known of its history. Well preserved, its linen wrappings with accompanying cartouche indicated that it was from the Ptolemaic period, dating from 323 B.C. to 30 B.C. In 1964, the mummy was transported to the Louisiana Arts and Science Center in Baton Rouge. Visitors saw a well-preserved mummy with a shock of curly hair, wrapped in linen, and encased in glass. According to sparse records, the mummy had always been known as "A Princess of Thebes." Forty-three years later in an effort to display the mummy with accurate detail, museum curators asked experts from multiple disciplines to assist in learning more about the mummy's origin, her age-at-death, and anything about her health that could be determined.

Researchers at Louisiana State University's Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory and the Akhmim Mummy Studies Consortium in Pennsylvania participated in the project. The curator at The Louisiana Art and Science Museum, as the center is now known, allowed the LSU FACES Laboratory researchers to transport the mummy to the lab's facility and to x-ray the entire body. No invasive procedure was permitted. X-rays and skeletal analysis by FACES Lab anthropologists and subsequent CT scans interpreted by Egyptologist Elias revealed aspects of the Egyptian mummy that have made it unusual among its peers.

First, and foremost, the "she" is a "he." Radiographic details clearly revealed a pelvis only a male could possess. The CT scan confirmed it. He was a young adult, somewhere between 25 and 30

years of age and was approximately five-feet, seven inches tall. Skeletal trauma, possibly peri-mortem in origin, was evident.

Additionally, an intriguing set of mysteries surrounding the young man's death can only be understood partially. The mummy was not prepared for burial in the typical Egyptian fashion; his internal organs, including his brain, were still intact. This atypical physical condition and the presence of an ancient stretcher incorporated into the mummy's wrappings suggest he may have died some distance from the site where his final burial preparation occurred.

In an effort to provide him with a face, an imaging specialist at the LSU FACES Laboratory, used an anterior/posterior skull x-ray to assist in creating a two-dimensional approximation of what he may have looked like in life.

Finally, in recent years, each new discovery of mummies in Egypt claims national headlines and evokes images of gods and goddesses, pharaohs, and movie monsters. Yet, other, unexamined mummies reclining in the chambers and warehouses of local museums may provide evidence for untold, fascinating stories of that ancient civilization's culture.

Egyptian Mummy, Forensic Anthropology, Facial Approximation

LW3 Philadelphia's Forgotten Abolitionist: Resurrecting the Legacy of Reverend Stephen H. Gloucester

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The goal of this presentation is to describe the excavation and identification of the remains of Reverend Stephen H. Gloucester (1802-1850), a formerly prominent and now virtually forgotten African-American abolitionist, educator, and community leader from Philadelphia.

This presentation will impact the forensic science community describing the compelling yet controversial life of Reverend Stephen H. Gloucester and his re-emergence from the shadows of history through the methods of forensic anthropology.

Forensic anthropology often provides a pathway back to public recognition for forgotten historical figures. This was the case in November 2008 in Philadelphia where, not eight blocks from Independence Hall, lay the remains of the remarkable Stephen H. Gloucester in his vault beneath the narrow front yard of the defunct church he had founded in 1844. Long obscured after the congregation had moved to the other side of the city in 1939, the vault was discovered during the conversion of his former church building into a 10,000-sq.-ft. luxury home. Excavation of the vault revealed the commingled remains of three adults: Gloucester, his wife Ann (Crusoe) Gloucester, and a third adult whose identity was a mystery.

Stephen H. Gloucester's father, Reverend John Gloucester (1776-1822), was the first African-American Presbyterian minister ordained in the United States. He arrived in Philadelphia in 1807 at the urging of Reverend Archibald Alexander of the Third ("Old Pine") Presbyterian Church to establish the First African Presbyterian Church, the earliest African-American Presbyterian congregation in the county. Borrowing money from various donors, John amassed sufficient funds to purchase the freedom of his wife and six children. All four of his sons later became ministers.

Born enslaved in Tennessee, Stephen H. Gloucester was purchased by his father for $400 and arrived in Philadelphia in 1814. Following his father's ministry, Gloucester was a founder and secretary of the American Moral Reform Society and an officer of the Union Missionary Society. Between 1820 and 1840, he ran a school for African-American children and established a reading room for adults. He also became one of the primary operators of the Underground Railroad in Philadelphia.

In April 1842, Gloucester became the minister of the Second African Presbyterian Church. His success there, however, was short-lived: on August 1, 1842, a mob attacked and destroyed the church during race riots that followed an African-American parade organized to commemorate the abolition of slavery in the British West Indies. Although deeply traumatized by the destruction of his church, in 1844 Gloucester established the Lombard Street Central Presbyterian Church at 832-836 Lombard Street. The church building was completed there in 1848.

Among antebellum African Americans, ministry, abolitionism, and education were often deeply entwined. African-American churches served as centers for education and activism, and it is perhaps in this context as an activist clergyman that the greatest part of Stephen H. Gloucester's historical significance is found.

The abolitionist movement was not monolithic – opinions ranged widely on topics including African-American colonization of Africa, feminism, temperance, the pace of emancipation, and whether the abolitionists should form their own national political party. In the 1830's, Gloucester represented Philadelphia at the annual meetings of the American Anti-Slavery Society and was initially an ally of William Lloyd Garrison and Frederick Douglass. In 1840, however, deep divisions over numerous issues led Gloucester and seven other African-American pastors to join a less politically radical splinter group called the American and Foreign Anti-Slavery Society, in part because of Garrison's strong disavowal of the Constitution as a "covenant with death" that perpetuated slavery. In 1838, Gloucester had become a co-publisher of the *Colored American*, an influential African-American publication that often presented counterpoints to Garrison's positions, especially on the topic of the Constitution. This newspaper provided Gloucester with a national voice and his own influence grew.

Everything changed for Stephen H. Gloucester, however, when his church was destroyed in 1842. Believing that his own aggressive stance on abolition had contributed to the attack on his church, Gloucester began to approach the topic more cautiously. To the dismay of his more strident colleagues in the abolitionist community, Gloucester avoided making antagonistic statements during what they termed his "tepid" anti-slavery speeches for fear that his comments might spark new violence aimed at his congregation and his family.

Gloucester's more low-key public approach was opposed by the fiery Frederick Douglass and his supporters, including Garrison. The real issue, however, was that Douglass had vehemently criticized the Free Church of Scotland in Britain for accepting financial support from southern U.S. Presbyterian congregations, many members of which were slaveholders. Douglass subsequently became an international superstar in abolitionist circles when he went to Scotland and denounced the Free Church for accepting this "blood money" from the southern congregations. In 1847, only a few months after Douglass' return from Scotland, Gloucester made a series of speeches at several Free Church of Scotland services seeking financial support for his new Lombard Street Church. Douglass equated Gloucester's appeals with seeking money from slaveholders, igniting his wrath in print and during his public speeches. It was at this point that many of Gloucester's former colleagues in the abolitionist movement ostracized him, with Douglass publicly calling Gloucester "one of the vilest traitors to his race that ever lived."

Stung by this criticism and remaining cautious in his public remarks, for the next three years Gloucester focused his energies on building the Lombard Street Church, dying of pneumonia on a church trip to Reading, Pennsylvania on May 21, 1850 at age 48. He was interred in the large, subterranean brick vault in the front yard of his Lombard Street Church and was joined by his wife Ann when she died

in 1880 at 67 years old. The Central Lombard Presbyterian Church stayed at its location until 1939 when the congregation moved out of center-city to West Philadelphia, where it still holds services today.

Excavation of the Gloucesters' vault in November 2008 revealed the commingled skeletal remains of two individuals in the northern half of the crypt and, unexpectedly, a third adult resting in its southern half. Since their grave marker had been missing for decades, coordinated osteological analyses and archival research were required to first distinguish and identify the Gloucesters and then determine the name of the mysterious third person buried with them.

Results of the skeletal analysis indicated that the third set of remains represented a male of African descent who was in his early 40s when he died. Additional research ultimately identified Reverend Benjamin Franklin Templeton, the church's third pastor and an accomplished African-American activist in his own right, as the person buried in the vault with the Gloucesters. Benjamin Templeton had died on February 6, 1858 at age 40. It remains unknown why he was buried with Stephen Gloucester but the vault was probably designated for the church's pastors, although none were subsequently buried there.

One month after their excavation, the Gloucesters and Reverend Templeton were reburied in the graveyard of the Third Presbyterian ("Old Pine") Church in Philadelphia's Old City, where John Adams and numerous other Revolutionary-era icons worshipped. In a true historical irony it was at the Old Pine Church where, in 1807, Reverend Archibald Alexander began the saga of the Gloucester family's ministry when he arranged to bring John Gloucester from Tennessee to Philadelphia. Today, Reverend Stephen H. Gloucester shares a graveyard with three representatives to the Continental Congress as well as Jared Ingersoll, a signer of the U.S. Constitution in which Gloucester so strongly believed.

Reverend Stephen H. Gloucester, Abolitionism, Forensic Anthropology

LW4 The Scientific Genius of Archimedes: How Do We Know That Much of It Was Real?

Abraham T. Philip, MD, Onondaga County, Medical Examiner's Office, 100 Elizabeth Blackwell Street, Syracuse, NY 13210*

The goal of this presentation is to familiarize attendees with the life and work of Archimedes, a native of Syracuse. Though he is acknowledged to be the father of many branches of science, there is little by way of direct proof of his legacy. This presentation will inform the audience how a new discovery has shed light on the authenticity of his achievements.

This presentation will impact the forensic science community by filling in several gaps regarding the research that this great man of science undertook. Despite numerous commentaries on his work, there has not been any direct evidence of his writings – that is until a discovery made about a 100 years ago.

Archimedes reportedly was born in a Greek colony on the island of Sicily, in the year 287 B.C. and died in 212 B.C. While the year of his death was documented by historical events, the evidence of his year of birth, parental lineage, and early childhood are unknown and subject to conjecture. Archimedes is best known for resolving the issue of adulteration of gold, used in a crown, with baser metal, using then available non-destructive technology. How he accomplished this difficult quandary is certainly the stuff that legends are made of. The role of this scientific genius in the planning of the defenses around Syracuse, and his participation during the Second Punic War is less known. There are only speculations about the manner of his death during the rout and rape of Syracuse and the carnage that followed.

The reason for these large gaps in the knowledge and appreciation for the works of Archimedes stems from the lack of documentation about his publications. Almost nothing of his original writings or publications has survived the vagaries of nature, time, and war. Archimedes wrote about his research and sent it out to associates, none of which has survived. Some of his material was translated and preserved in other languages and these have provided limited insights into the mind and work of this great man of science. There is some additional information in commentaries by scholars who wrote about him many years after he died and somewhere along the line facts blurred and truth was supplanted with fiction and evolved into legends.

The first comprehensive compilation of the mathematical writings of Archimedes was made in 530 A.D. and commentaries of his works made in the sixth century opened his work to scientists during the Renaissance period. The discovery in 1906 of previously unknown works - *The Archimedes Palimpsest* - was the first modern day look into how this great man of science obtained the amazing results of mathematical calculation far ahead of his time. This manuscript on parchment was first written, then scraped over, and rewritten (as was the literary fashion of the time). Professor Johan Ludvig Heiberg realized the 174-page parchment, with thirteenth century prayers overlay a tenth century writing about the previously unknown works of Archimedes. After spending hundreds of years in a monastery library, the first modern translation of the writings, with numerous limitations, was made approximately a hundred years ago.

The limitation of Professor Heiberg's work was that it interpreted only the words of the text without the diagrams. The document disappeared again, and surfaced in 1998, and was sold to an anonymous buyer. As described in the book, *The Archimedes Codex*, the Palimpsest has now been reinterpreted using the more modern scientific techniques of image analysis, paleographical (script deciphering), and philological (text – analyzing) skills of modern day scholars. The *Codex* itself is now stored at a museum in Baltimore, Maryland and is an amazing example of bringing to life ancient texts.

In summary, this presentation will review the available information, confirmatory tests to prove its veracity, and attempts to separate the truth from legends. There is no good forensic tale complete without a death and a mystery - the circumstances of the death of Archimedes and the speculations about the manner of his dying will be briefly outlined. The educational impact of this presentation will be to demonstrate a link between use of science and history to build an archeological detective story.

Archimedes, Scientist, Mathematician

LW5 Money, Malice, or Meat? The Whys and Wherefores of Horse Murder

Jennie C. Meade, JD, The George Washington University Law Library, 716 20th Street, Northwest, Washington, DC 20052*

After attending this presentation, attendees will understand the predominant motives underlying the intentional killing of horses through examination of several cases of horse murder. Attendees will also learn how some instances of horse death resemble murder, yet actually result from human mistake or natural events.

This presentation will impact the forensic science community by illuminating the motives behind horse murder and by exploring cases that appear to be horse murder, but were actually caused by human error or natural events.

Historically in horse-owning cultures, the horse has been both charmed and cursed. Cherished by humans for its noble character, heart, and generosity in its working relationship with man, the horse was also highly prized and well-treated due to the economic benefit it could produce when in the prime of its strength and power. Conversely, the waning of a horse's ability to produce income could ensure its lot as a passenger in the knacker's wagon, or worse, a victim of its owner's plot to realize economic benefit when the horse was worth more dead than

alive. Ironically, the noble equine species because of its unique dependence on humans and consequent vulnerability, is a magnet for a coterie of human parasites bent on exploitation. Money can drive horse murder, as in the long string of equine murders on the American national horse show circuit from the 1980s and into the early 1990s.

Malice in all its forms is a potent horse murder stimulus. Ownership of top performance horses, and realizing success with them, can make one's horses a target, as in the case of the world champion Saddlebred horses poisoned in Kentucky in 2003.

Recently, meat appears to have become a major motivator in killing horses. Since January 2009, Florida police have been investigating a series of horse butcherings and dismemberments, mostly on or near the properties of the owners of the horses, which they speculate are tied to an illegal horsemeat market in Florida. With the closure of the three U.S. horse slaughter plants in 2007, USDA horsemeat inspections were halted, effectively closing the door on the legal availability of horsemeat in the United States, in the states where the sale of horsemeat is still legal.

Despite having been domesticated since perhaps 3500 B.C., the horse has not adapted fully to its artificial living conditions, and it is known as a relatively fragile, reactive animal, predisposed to a surprising array of maladies. It can respond quickly to a variety of stimuli, sometimes with fatal results, the earmarks of which can mimic murder. In April 2009, the nearly simultaneous deaths of 21 world-class polo ponies in Wellington, Florida, on the eve of a championship match led many to suspect foul play. However, veterinarians determined that an incorrectly-compounded vitamin supplement killed the animals, a reminder that often horses dying en masse do so as a result of human error, or a feed or environmental contaminant, rather than as a result of intentional malfeasance.

Horses, Murder, Polo Ponies

LW6 The Tom Horn Affair: A Ballistic Review

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The goals of this presentation are to present the 1901 case against Tom Horn that led to his hanging for the murder of 14-year-old Willie Nickell near Cheyenne, Wyoming, and to show how modern methods could resolve the various questions and issues related to this historic incident.

This presentation will impact the forensic science community by exposing attendees to contemporary forensic methods associated with shooting incident reconstruction.

The 1980 Steve McQueen film, *Tom Horn* brought to life the story of one of the West's most interesting and complex characters. Tom Horn left his Missouri home in 1875 at age the age of 14 and went to Arizona where he ultimately ended up working for the U.S. Army as a scout, mule packer, and interpreter during the Apache Wars. He spoke both Spanish and Apache and participated in the final capture and surrender of Geronimo. He was also a champion rodeo rider and roper in the Globe, Arizona area before he moved north to Colorado and Wyoming where he would work for a year as a Pinkerton detective and then moved on to take a job as a cattle detective in the Cheyenne-Laramie area. He was hired for this latter position by wealthy Wyoming cattlemen who were having little success stopping rustlers. It is not in dispute that Tom Horn used his superior marksmanship skills to either kill or frighten off most of the cattle thieves. Two of his most famous quotes on the subject of dissuading or dispatching rustlers were *"Whenever everything else fails, I have a system that never does,"* and *"Killing men is my specialty; I look at it as a business proposition, and I think I have a corner on the market."*

On the early morning of July 18, 1901 Willie Nickell, the 14-year-old son of a sheep rancher was shot twice by an unknown gunman as he was opening a gate about ¾-mile from the Nickell ranch. He was wearing his father's yellow slicker and hat at the insistence of his mother due to the weather. He was also riding his father's horse raising the likelihood that this was a case of mistaken identity on the part of the shooter.

There were a number of likely suspects but no eye witnesses or physical evidence beyond the two perforating gunshot wounds and the bullet holes in the boy's clothing. A single .30-30 cartridge case was found by Willie's brother near the scene 10 days after the murder but comparison microscopy was about 30 years in the future. Law enforcement officials were frustrated for many months until the infamous "confession" elicited from Horn by Deputy U.S. Marshal Joe LeFors and recorded by a stenographer listening and writing on the opposite side of a door. Tom Horn was arrested the next day on January 13, 1902 and convicted on October 25, 1902 after a lengthy trial and over 1,000 pages of testimony. A year later after exhausting all of his appeals, he was hanged on specially constructed gallows on November 20, 1903, a day before his 43rd birthday. While waiting execution, he wrote his autobiography, *Life of Tom Horn: Government Scout and Interpreter,* first published in 1904 by his close friend and employer, rancher John Coble. Several books have been written since Horn's autobiography, with the most recent by Wyoming rancher and author, Chip Carlson.

This presentation will provide a view of the murder scene and a modern-day assessment and application of the exterior ballistic capabilities of the firearms and ammunition of that time to the physical evidence that existed and the gunshot wounds suffered by Willie Nickell. The State's theory of the case as well as certain "facts" asserted in Tom Horn's famous confession will also be presented and evaluated.

Tom Horn, Willie Nickell, Trial

LW7 Who Let the Dogs Out? How Lombroso Launched the Morbid Marketplace

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After attending this presentation, attendees will have heard it argued that when professional criminological exhibits went public during the nineteenth century, the intent to improve society by teaching laypeople about the causes and instruments of crime opened a door to ghoulish fascination and a market for "crime kitsch."

This presentation will impact the forensic science community by discussing the fact that while professionals today opine against the "CSI Effect" and the thriving business in crime-related items, they will learn that commercial crime kitsch has roots in a nineteenth-century professional movement. International crime exhibits and criminological museums offered titillating fare that reached beyond education's intent. Visiting laypeople sought more details about the macabre side of crime, and once entrepreneurs spotted this market there was no stopping the burgeoning business in depravity.

Serial killer John Wayne Gacy earned over $100,000 from his post-conviction paintings, thanks to dealers who found paying customers. Charles Manson sold sock puppets, Albert de Salvo made chokers, and others found buyers for their hair and toenail clippings. Even during the nineteenth century, crime souvenirs were in demand. When Theodore Durrant, the "Monster of the Belfry," was tried in 1895 for the murder of two young women, six area newspapers competed for sensational details and the wealthy held "Durrant parties." Around the same time in Chicago, after the public learned about the "murder castle" that H.H. Holmes had built to trap and kill young women, an enterprising police officer tried to transform it into a house of horrors.

Relatives of victims are sickened that some people think it's fun to own a Jeffrey Dahmer doll with dismembered human parts in its belly, play a serial killer board game with dead babies as tokens, or don an Ed

Gein apron for a barbeque, but there's no end in sight for such grisly commercial ventures. Websites for "murderabilia" are easy to find and CSI-type television shows proliferate at an unprecedented rate on prime time. Crime kitsch is here to stay.

The media could be the blame for fanning the flames, but in fact an urge among professionals to educate the masses had a hand in this business. Positivist theories during the late nineteenth century inspired the first criminological museums as teaching institutions. Objects and pictures were exhibited that best showcased current theories about crime and its perpetrators. When Austrian criminologist Hans Gross attested to how quickly knowledge about criminology was growing obsolete, museum developers decided that a display of actual objects would establish a visual history and provide a fuller education. Into these museums went microscopes, weapons, poisons, blood samples, uniforms, crime tools, crime reconstructions, photographs, handwriting samples, criminal disguises, and even human remains.

Such museums popped up in different cities under the supervision of prominent figures in criminology such as Hans Gross and Cesare Lombroso. Initially meant for professionals, they soon opened to the public. In Rome, for example, the Prison Administration acknowledged that "the public is enormously interested in the vicissitudes and the phenomena of criminal life" when it set up the Criminology Museum. These officials realized that statistical gazettes for professionals were "dead letters," so they decided to put crime and criminals on open display. The exhibits of torture implements, executions, and criminal escapades were intended to show in general "what science brings to the treatment of crime" to give people a "font of culture and guidance." As a result, they might grow wiser about their own safety. While the collections did fulfill this function, they also introduced viewers to titillating tales about dangerous people that inspired curiosity. The public wanted more, so vendors devised morbid products to sell. Once the market was established, its content was difficult to control.

Crime, Museum, Murderabilia

LW8 Where There's a Will There's a Way: The Howland Will Case

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After attending this presentation, attendees will understand how testimony, based on probabilities, was first introduced into American courts, how questioned document examinations were conducted in mid-nineteenth Century America, and the basis for testing probability models.

This presentation will impact the forensic science community by making forensic science practitioners aware of the hazards of the use of unvalidated probability models as the basis for expert testimony.

This presentation will discuss the so-called Howland Will Case (*Robinson v. Mandell et al.*, 20 F. Cas. 1027; 1868 U.S. App.), a case sometimes appealed to by handwriting examiners to support the notion that no one writes his/her signature exactly the same way twice. The Howland Will Case is also the first case in the United States in which testimony based on probabilities was given.

The basic facts of the case are convoluted. Sylvia Ann Howland died in 1865, leaving an estate of slightly more than $2 million. According to her will signed in 1863 and a codicil signed in 1864 half the estate was to go to a number of individuals and institutions; the remainder was to be held in trust for Ms. Howland's niece, Henrietta (Hetty) Howland Robinson. Hetty Robinson would receive the income of the trust but would not have access to the principal. The terms of the will also provided that upon Hetty's death, the remainder of the trust was to be distributed to lineal descendants of Gideon Howland (Hetty's grandfather and Sylvia Ann Howland's father). Hetty Robinson filed suit in Federal court against the executor of her aunt's estate seeking to set aside the will and its later codicil in favor of an 1862 will that left the entirety of Ms. Howland's estate to her without restriction. Hetty alleged that she and her aunt had entered into a contract according to the terms of which each would make out a will disinheriting Hetty's father. The wills were to be exchanged and both parties agreed not to execute a new will without informing the other party. These stipulations were set out on a second page of the aunt's earlier will which was supposedly signed by the aunt in two places. According to Hetty, the pages of the 1862 will were arranged so that the witnesses to the will could not read the second page. Thomas Mandell, the executor of Sylvia Ann Howland's estate, insisted that the second page had never been part of the 1862 will and that it was a forgery in its entirety. The suit was filed in Federal court because Sylvia Ann Howland was a resident of New Bedford, Massachusetts and Hetty Robinson of New York City.

Much of the testimony in this case was devoted to the issue of the existence of a contract between Hetty Robinson and her aunt. Testimony relating to the authenticity of the two signatures on the second page of the 1862 will was also offered by twenty-nine expert witnesses: twelve for plaintiff Hetty Robinson and seventeen for the defendant executors. The witnesses included photographers, heads of commercial colleges, bank managers, bank cashiers, accountants, engravers, scientists, and mathematicians. Several of these witnesses were frequent expert witnesses on the examination of handwritings. The testimony of these witnesses gives us a window into forensic questioned document examinations in the middle to the nineteenth century. One of the estate's experts presented photographic enlargements of the questioned signatures and showed that they could be exactly superimposed on the authentic signature on the 1862 will. His conclusion was that the questioned signatures were traced forgeries of the authentic signature on the 1862 will. Another of the estate's witnesses offered a scenario of how the traced forgeries were created: one questioned signature was traced with lead pencil from the authentic signature, and then filled in with ink, while the other questioned signature was traced in ink directly from the authentic signature. While two microscopists testifying for the estate supported the tracing theory, Hetty Robinson was able to deploy heavier artillery than the executors of the estate: Louis Agassiz, professor of zoology and geology at Harvard College, and Oliver Wendell Holmes, Sr., Parkman Professor of Anatomy and Physiology at Harvard Medical School, both testified that their microscopic examinations of the questioned signatures did not reveal any traces of pencil marks.

The most compelling evidence that the questioned signatures were tracings was the almost exact correspondence of these signatures with the authentic signature. Several witnesses for the estate maintained that writers cannot produce two signatures that correspond as closely as the questioned and authentic signatures. The issue of the probability of a random or coincidental match between the authentic signature and one of the questioned signatures was addressed in the testimony of Benjamin Peirce, formerly Perkins Professor of Astronomy and Mathematics at Harvard College and at the time of the trial Superintendent of the United States Coast Survey. Professor Peirce had had his son, Charles Sanders Peirce, then an employee of the Coast Survey, do pair-wise comparisons of overlays of forty-two authentic signatures of Sylvia Ann Howland and tally the coincidence of the thirty downward strokes in the two signatures. Professor Peirce concluded that the probability of two corresponding downward strokes overlapping was 1/5. Charles Sanders Peirce repeated the overlaying and tallying procedure with the authentic signature on the 1862 will and one of the questioned signatures. All thirty downward strokes in the two signatures matched up, allowing Professor Peirce to opine that the probability of such a match of authentic signatures was $(1/5)^{30}$ or one in 2,666,000,000,000, 000,000,000. Professor Peirce went on to say: "…I declare that the coincidence which has here occurred must have had its origin in an intention to produce it." Modern statisticians have pointed out that Professor Peirce's probability model fits the data derived from the forty-two authentic signatures so poorly that it would be rejected by a standard chi squared goodness-of-fit test. The assumption that it was valid to compare the coincidence of

downward strokes in authentic signatures written over a span of time with the coincidence of strokes in signatures supposedly written the same day is also open to challenge. Hetty Robinson's attorneys took the testimony of the Peirces head on with the testimony of another of their expert witnesses. This witness had obtained one hundred and ten cancelled checks of President John Quincy Adams and overlaid photographic enlargements of the signatures. He found several matches among the Adams signatures that were, in his judgment, better than those obtained with the questioned and authentic Howland signatures. This witness had the authentic Howland signatures re-photographed and produced overlays of admittedly authentic signatures which he claimed demonstrated the uniformity of Ms. Howland in signing her name.

Faced with a mass of contradictory testimony what was the Court to do? In his decision, Judge Nathan Clifford excluded Hetty Robinson's testimony regarding the existence of a pact or contract between herself and her aunt to write mutual wills. Other than Hetty's testimony there was no evidence that the second page of the 1862 will had ever been part of that will: Hetty had not been able to produce other witnesses to support her claim. As a beneficiary of the aunt's 1862 will she was excluded by Massachusetts law from testifying regarding the circumstances surrounding its preparation. Judge Clifford dismissed Hetty's suit and assessed her court costs. In the end, Hetty Robinson (who by the time the Court's decision was handed down was Mrs. Edward H. Green) did not fare too badly. She reached an out-of-court settlement with the executors of her aunt's estate which covered her trial expenses, court costs and attorneys' fees. This settlement may have entailed her dropping her appeal to the United States Supreme Court. Hetty's share of the estate provided her with an annual income of $65,000. Using her shrewd business sense and parsimony, Hetty Green went on to become "The Witch of Wall Street." When she died in 1916 she left behind a fortune worth $100 million, which makes her the wealthiest woman in American history.

Probability, Handwriting, Questioned Documents

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Discloses no financial relationships with commercial entities.
Jason H. Byrd, PhD - G70
Discloses no financial relationships with commercial entities.
John E. Byrd, PhD - W20
Discloses no financial relationships with commercial entities.
Jennifer F. Byrnes, MA - H82
State University of New York (Grant Support)
Joan A. Bytheway, PhD
Sam Houston State (Grant Support) - H13
Discloses no financial relationships with commercial entities - H4, H78

C

Mary E. Cablk, PhD - D9
Desert Research Institute (Grant Support)
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Discloses no financial relationships with commercial entities.
Erica M. Cahoon, BS - A205
Discloses no financial relationships with commercial entities.
Stephanie E. Calce, BSc - H102
University of Toronto (Grant Support)
Michael Caligiuri, PhD - W7
Neuroscriptsoftware.com, Wacom.com (Discussion of Commercial Products or Services)
Martha L. Camargo, BS - A165
International Criminal Investigative Training Assistance Program (Grant Support)
Isla Yolima Campos Varela - H116
Discloses no financial relationships with commercial entities.
Felice Carabellese, MD - I2
Discloses no financial relationships with commercial entities.
Anthony Cardoza, DDS - F56
Discloses no financial relationships with commercial entities.
Amy Y. Carney, MS, MFS - D57
Discloses no financial relationships with commercial entities.
Douglas J. Carpenter, MS - W17
Discloses no financial relationships with commercial entities.
Henry J. Carson, MD - K29
Discloses no financial relationships with commercial entities.
Mary E.S. Case, MD - W5
Discloses no financial relationships with commercial entities.
Eoghan Casey, MA - B6, B17
Discloses no financial relationships with commercial entities.
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Washington State Patrol (Employee)
Salih Cengiz, PhD - K28
Istanbul University (Grant Support)
Ranajit Chakraborty, PhD - W9
U.S. National Institute of Health Research (Grant Support)
Elise Champeil, PhD - K36
Discloses no financial relationships with commercial entities.

Chien-Wei Chang, PhD - A162
Life Technologies (Discussion of Commercial Products or Services & Employee)
Wen-Ruey Chang, PhD - C24
Liberty Mutual Group (Employee)
Carlos F. Chavez-Arias, MD - G104
Discloses no financial relationships with commercial entities.
Linda L. Chezem, JD - W18
Discloses no financial relationships with commercial entities.
Stephanie L. Child, MA - H58
Discloses no financial relationships with commercial entities.
Mi-Jung Choi - J10
Discloses no financial relationships with commercial entities.
Alexander F. Christensen, PhD - A132
U.S. Department of Defense (Employee)
Angi M. Christensen, PhD - H7, H38, H68
Discloses no financial relationships with commercial entities.
Sarah Chu, MS - E39
Discloses no financial relationships with commercial entities.
Renaud Clement, MD - G58, G75
Discloses no financial relationships with commercial entities.
Michael D. Coble, PhD - W9
Applied Biosystems, Millipore, Qiagen (Discussion of Commercial Products or Services)
American Registry of Pathology, Armed Forces DNA Identification Laboratory (Employee)
Kenneth F. Cohrn, DDS - F3
Discloses no financial relationships with commercial entities.
Peter J. Colleran, BS - H73
Discloses no financial relationships with commercial entities.
William J. Collins, MD - I18
Discloses no financial relationships with commercial entities.
Michael R. Condron, MD - G80
Discloses no financial relationships with commercial entities.
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Simon Fraser University, Social Sciences and Humanities Research Council of Canada (Other Financial/Material Support)
Gerald J. Conlogue, MHS - D25
Discloses no financial relationships with commercial entities.
Patrick J. Connor, MFS - D34
Discloses no financial relationships with commercial entities.
Jillian Conte, BS - A85
Discloses no financial relationships with commercial entities.
Michael R. Corbett, PhD - K1, K3
Discloses no financial relationships with commercial entities.
Inge Corbin, BS - A96
Discloses no financial relationships with commercial entities.
Cristina G. Cordeiro, MD - G27
Discloses no financial relationships with commercial entities.
Stephen Cordner, MB - W20
Discloses no financial relationships with commercial entities.
Gilbert E. Corrigan, PhD - G26
Discloses no financial relationships with commercial entities.
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McGill University, Social Sciences and Humanities Research Council (Grant Support)
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Longhorn Diagnostics (Discussion of Commercial Products or Services & Discussion of Unlabeled/Investigational Use of Product/Device) - A62
Discloses no financial relationships with commercial entities. - A139
Cristopher A. Cowan, PhD - A125
Applied Biosystems, Beckman, Promega Corp., Tecan (Discussion of Commercial Products or Services)
Heather M. Coyle, PhD - A89
Applied Biosystems, New England Biolabs, Qiagen, Whatmann (Discussion of Commercial Products or Services)
Office of National Drug Control Policy (Grant Support)
Patricia A. Crane, PhD - D45
Discloses no financial relationships with commercial entities.
Stephanie M. Crider, BA - H92
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University of Alabama (Other Financial/Material Support)
Peter A. Cross, MSc - H79
Discloses no financial relationships with commercial entities.
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Applied Biosystems, Beckman, Biomatrica, Qiagen (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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D

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Citrix, VMWare (Discussion of Commercial Products or Services)
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AFFIC Foundation (Employee)
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OdontoSearch, WinID (Discussion of Commercial Products or Services)
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Adobe Inc. (Discussion of Commercial Products or Services) – F36
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Ciro Di Nunzio - A12
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Discloses no financial relationships with commercial entities.
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Beverly International (Discussion of Commercial Products or Services)
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Mideo Systems (Discussion of Commercial Products or Services & Discussion of Unlabeled/Investigational Use of Product/Device)
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Lauren J. Duhaime, BSc - H97
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E

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Oak Ridge Institute for Science and Education (Employee)
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Applied Biosystems, Promega Corporation (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
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Microsoft Corporation (Discussion of Commercial Products or Services)
Digital Intelligence (Employee)
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Robert Epstein, JD - W18
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Duquesne University (Other Financial/Material Support)
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F

Paolo Fais, MD - G28
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Elizabeth N. Farnham, BS - A106
Discloses no financial relationships with commercial entities.
Helen M. Farrell, MD - I1
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Diana K. Faugno, MSN - D45
Discloses no financial relationships with commercial entities.
Genevieve L. Ferguson, BSc - A16
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Tricia A. Fernandes, BSc - H29
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Marcella F. Fierro, MD – G69
Discloses no financial relationships with commercial entities.
Benjamin J. Figura, MA - H57
National Institute of Justice (Grant Support)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Stephany Fiore, MD – G59
Pierce Chemicals/Royal Bond, Inc., The Dodge Company, Ultra 27, University of California (Discussion of Commercial Products or Services)
Barry A.J. Fisher, MS, MBA - A6
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Cara M. Fisher, BA - A44
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Duquesne University (Employee)
Maureen A. Fogarty, RN - D28, D47
University of Louisville Hospital (Employee)
Christina L. Fojas, BA - H56
Discloses no financial relationships with commercial entities.
Luis Fondebrider - H118, W20
Discloses no financial relationships with commercial entities.
Judith Fordham, BSc, LLB - E27
Discloses no financial relationships with commercial entities.
Peggy J. Forney, BS - C12
Discloses no financial relationships with commercial entities.
A. Robert W. Forrest, LLM - E21
Chauvin Bausch & Lomb (Discussion of Commercial Products or Services)
Manish Fozdar, MD - I10, I11
Discloses no financial relationships with commercial entities.
Harold E. Franck, MSEE, PE - C28
Discloses no financial relationships with commercial entities.
Branka Franicevic, MSc - H74
Discloses no financial relationships with commercial entities.
Kathryn L. Frazee, MS - H84
National Institute of Justice (Grant Support)
Jamie D. Fredericks, MSc - H28
EPSRC, Micropathology, Ltd. (Grant Support)
Michael Freeman, PhD - C36, C38, E26
Discloses no financial relationships with commercial entities.
Richard D. Friedman, DPhil, JD - K42
Discloses no financial relationships with commercial entities.
Rob Friedman, JD - BS1, I20
Discloses no financial relationships with commercial entities.
Marie Frigolette, BA - A38
Discloses no financial relationships with commercial entities.
Dan Frumkin, PhD - A81
Nucleix, Ltd. (Employee)
Amanda Fujikawa, MS - A175
Bayer (Discussion of Commercial Products or Services)
University of Nebraska-Lincoln (Grant Support)
Maribel E. Funes-Huacca, PhD - A146
Applied Biosystems, Promega Corporation (Discussion of Commercial Products or Services
Christine Funk, JD - E22
Discloses no financial relationships with commercial entities.
Christopher J. Furbish, BSc - C34
Discloses no financial relationships with commercial entities.
Kenneth G. Furton, PhD - A169
National Institute of Justice (Grant Support)

G

L. Sue Gabriel, EdD - D46
Discloses no financial relationships with commercial entities.
Robert C. Gaffney, MFS, MBA - D33, D35
Discloses no financial relationships with commercial entities.
Tamas Gal - J1, J16
Institute for Forensic Science (Employee)
Mario Galioto, BS - A64, A145
Discloses no financial relationships with commercial entities.
Donald T. Gantz, PhD - J5
Gannon Technologies Group (Discussion of Commercial Products or Services & Grant Support)
Jan C. Garavaglia, MD - BS8
Discloses no financial relationships with commercial entities.
Alex M. Garvin, PhD - A67
Discloses no financial relationships with commercial entities.
Heather M. Garvin, MS - H99
Discloses no financial relationships with commercial entities.
Vernon J. Geberth, MS, MPS
CRC Press, LLC (Discussion of Commercial Products or Services) - W4
Discloses no financial relationships with commercial entities. - SS2

Myron A. Gebhardt, MS - K21
West Virginia Office of the Chief Medical Examiner (Employee)
Zeno J. Geradts, PhD
Defraser (Discussion of Commercial Products or Services) – B11
Yahoo (Discussion of Commercial Products or Services) – B14
Ministry of Justice Netherlands (Employee) – B11, B14, B17, W8
Dean M. Gialamas, MS - A1, ES1
Discloses no financial relationships with commercial entities.
Paul C. Giannelli, JD - E9
Discloses no financial relationships with commercial entities.
Daniele Gibelli, MD - H16, H44
Discloses no financial relationships with commercial entities.
Stephen K. Gicale, BS - A41
Applied Biosystems (Discussion of Commercial Products or Services)
Jason R. Gilder, PhD - E30, E33
Applied Biosystems (Discussion of Commercial Products or Services)
Forensic Bioinformatics (Employee)
James R. Gill, MD - G119
Discloses no financial relationships with commercial entities.
M.G.F. Gilliland, MD - G4
Discloses no financial relationships with commercial entities.
Kerstin M. Gleim, BA, BS - W2
Discloses no financial relationships with commercial entities.
Kanya Godde, PhD - H90
William M. Bass Endowment (Grant Support)
Jeffery J. Gofton, MD - W11
Discloses no financial relationships with commercial entities.
Bruce A. Goldberger, PhD - W22
Journal of Analytical Toxicology (Discussion of Commercial Products or Services & Employee)
Ariel Goldschmidt, MD - G12
Discloses no financial relationships with commercial entities.
Diana Gonzalez, MS - A50
Clorox (Discussion of Commercial Products or Services)
Harris County Medical Examiner's Office (Employee)
John V. Goodpaster, PhD - W15
Agilent Technologies, Microsoft Corporation, Origin Labs, PRS, Inc., Starpoint, Inc. (Discussion of Commercial Products or Services)
Mark E. Goodson, PE - G84
Discloses no financial relationships with commercial entities.
William Goodwin, PhD - W20
Discloses no financial relationships with commercial entities.
Silke Grabherr - G87
Forim X-AG, Fumedica AG (Discussion of Commercial Products or Services)
Bundesamt für Berufsbildung und Technologie, Förderagentur für Innovation
KTI, Fumedica AG (Grant Support)
Fumedica AG (Discussion of Unlabeled/Investigational Use of Product/Device)
Robert Granacher, MD - I10, I11
Discloses no financial relationships with commercial entities.
Andrew H. Grange, PhD - C15
Dart, NoDoz (Discussion of Commercial Products or Services)
U.S. Environmental Protection Agency (Employee)
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Discloses no financial relationships with commercial entities.
Nathan Greeneltch, BS - C14
Delta Nu (Discussion of Commercial Products or Services)
Northwestern University (Grant Support)
Kristen E. Greenwald, MA - H72
Discloses no financial relationships with commercial entities.
Margaret Greenwald, MD - K41
Discloses no financial relationships with commercial entities.
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Applied Biosystems (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Ariel M. Gruenthal, BA - H30
Discloses no financial relationships with commercial entities.
Fessessework Guale, DVM - K2
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities - I14
Cukurova University (Grant Support) - K31
Standard Toxicology Analyses (Discussion of Unlabeled/Investigational Use of Product/Device) - K31
Wendy M. Gunther, MD - G113, G114, W11
Discloses no financial relationships with commercial entities.
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Social Sciences and Humanities Research Council of Canada, McGill University (Grant Support)
Gerald Guzy, DDS - F22
Emissive Energy Corp., Nichia Corp. (Discussion of Commercial Products or Services)
Erich Gygax – G89
Forim-X AG, Fumedica AG (Discussion of Commercial Products or Services)
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H

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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National Institute of Justice (Grant Support)
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Life Technologies (Discussion of Commercial Products or Services & Employee)
Amanda Hepler, PhD - J4
Intelligence Community Postdoctoral Fellowship (Grant Support)
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American Glass Products (Discussion of Commercial Products or Services)
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Aribex (Discussion of Commercial Products or Services)

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Cosmos Club Foundation (Grant Support)
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Edward E. Herschaft, DDS - F50
Aribex (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Carrie Herzog, BA - D14
Social Sciences and Humanities Research Council of Canada, McGill University (Grant Support)
Charles M. Heurich, MFS - E3
ORA Inc. (Discussion of Commercial Products or Services)
National Institute of Justice (Employee, Grant Support)
Dean P. Hildebrand, PhD - A49
British Columbia Institute of Technology (Employee)
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Applied Biosystems, Promega Corp. (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Stephanie M. Horner, BA - A198
Discloses no financial relationships with commercial entities.
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Promega Corp., Qiagen (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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GNU (Discussion of Commercial Products or Services)
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I

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J

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Applied Biosystems, Invitrogen, Promega Corp. (Discussion of Commercial Products or Services)
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K

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Sawait Kanluen, MD - BS6
Discloses no financial relationships with commercial entities.
Murray Kapell, MD - I25
Discloses no financial relationships with commercial entities.
Roman Karas, BS - K40, K45
Thermo Finnigan (Discussion of Unlabeled/Investigational Use of Product/Device)
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Discloses no financial relationships with commercial entities.
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Promega Corp. (Discussion of Commercial Products or Services) - H122
Discloses no financial relationships with commercial entities. - H127
Jeffrey D. Kelly, MS - D16, D56
Discloses no financial relationships with commercial entities.
Ronald L. Kelly, BS - A91
Agilent (Discussion of Commercial Products or Services)
Joseph N. Kenan, MD - I9
Discloses no financial relationships with commercial entities.
Ashley E. Kendell, BS - H95
Discloses no financial relationships with commercial entities.
Roderick T. Kennedy, JD - E22, E23, K42
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Rifat Kesetovic, MD - H121
Discloses no financial relationships with commercial entities.
Kazuhiko Kibayashi, MD - G52
Discloses no financial relationships with commercial entities.
Eric L. Kiesel, MD, PhD - K41
Discloses no financial relationships with commercial entities.
Chang-Seong Kim - J10
Discloses no financial relationships with commercial entities.
Deog-Im Kim, PhD - H87
Discloses no financial relationships with commercial entities.
Jung-Ho Kim - J25
Discloses no financial relationships with commercial entities.
Yi-Suk Kim, MD, PhD - H48
Ewha Womans University (Grant Support)
Erin H. Kimmerle, PhD - H105
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Stephen J. Kish, PhD - K43
U.S. National Institute on Drug Abuse, National Institutes of Health (Discussion of Unlabeled/Investigational Use of Product/Device)
Alexandra R. Klales, MS - H5, W10
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Maranda A. Kles, MA - H37
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Ruth E. Kohlmeier, MD - G13, K8
Discloses no financial relationships with commercial entities.
J. Steve Kohne - D7
Discloses no financial relationships with commercial entities.
Debra Komar, PhD - H117
Discloses no financial relationships with commercial entities.
Roger G. Koppl, PhD - E24
Discloses no financial relationships with commercial entities.
Renee Kosalka, MA - H120, H127
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Applied Biosystems (Discussion of Commercial Products or Services)
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L

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Seung Hwan Lee, PhD - A141, A142
Discloses no financial relationships with commercial entities.
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Biomatrica (Discussion of Commercial Products or Services) - A148, W9
Applied Biosystems (Discussion of Commercial Products or Services) - A148
San Jose State University (Employee) - W9
California State University, Howard Hughes Medical Institute, National Science Foundation (Grant Support) - W9
Bridge to Employment, National Science Foundation (Grant Support) - A148
U-Young Lee, MD - H49
Discloses no financial relationships with commercial entities.
John J. Lentini, BA
ASTM International (Discussion of Commercial Products or Services) - A4
ASTM International, National Fire Protection Association (Employee) - W17
ASTM International (Discussion of Unlabeled/Investigational Use of Product/Device) - A4
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Applied Biosystems (Discussion of Commercial Products or Services)
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The City University of New York (Grant Support)
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Discloses no financial relationships with commercial entities.
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Life Technologies (Discussion of Commercial Products or Services & Employee)
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Discloses no financial relationships with commercial entities.
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Microsoft Corporation (Discussion of Commercial Products or Services)
National Institute of Standards and Technology (Employee)
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Henry Troemner, LLC (Employee)
Barry K. Logan, PhD - W1
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Scott R. Lucas, PhD - C35
TASER International (Discussion of Commercial Products or Services)
Exponent, Inc. (Employee)
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Discloses no financial relationships with commercial entities.
James R. Lyle, PhD - B26
DBAN, Diskjocky, Logicabe, TABLEAU, VOOM, WiebeTech (Discussion of Commercial Products or Services)
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Kalan S. Lynn, BSc - H50
Discloses no financial relationships with commercial entities.
Albert H. Lyter, PhD - J19
Tascon USA Laboratories (Discussion of Commercial Products or Services)

M

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Applied Biosystems (Discussion of Commercial Products or Services)
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Wyeth (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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Horiba (Discussion of Commercial Products or Services)
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OrthoCad (Discussion of Commercial Products or Services) - F14
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Hunter Lab, Microsoft Corporation, Vident (Discussion of Commercial Products or Services)
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Applied Biosystems, Promega Corp. (Discussion of Commercial Products or Services)
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Ashley H. McKeown, PhD - H62
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Mitotyping Technologies (Discussion of Commercial Products or Services & Employee)
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Applied Biosystems, Promega Corp., Qiagen (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
John J. Miller, PhD - J5
Gannon Technologies Group (Discussion of Commercial Products or Services & Grant Support)
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Chromosomal Labs (Employee)
Raymond G. Miller, DDS - F54
Dentsply, Heraeus Kulzer, Ivoclar (Discussion of Commercial Products or Services)
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MVA Scientific Consultants (Employee)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Linton Mohammed, MFS - W7
Neuroscript Software, Wacom (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Kerri L. Moloughney, BS - D32
Oak Ridge Institute for Science and Education (Other Financial/ Material Support)
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Image Science International (Discussion of Commercial Products or Services)
Robert Monsour, BA - B27
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Discloses no financial relationships with commercial entities.
Wayne Moorehead, MSc - K37
Discloses no financial relationships with commercial entities.
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Henry Troemner, LLC (Employee)
Tamyra R. Moretti, PhD - A47
Applied Biosystems, Qiagen Inc. (Discussion of Commercial Products or Services)
Daniel Morgan, MS - D11
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Stephen L. Morgan, PhD - W15
Agilent Technologies, Microsoft Corporation, Origin Labs, PRS, Inc., Starpoint, Inc. (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Kathryn E. Moss, BS - H13
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Aribex, Kodak (Discussion of Commercial Products or Services)
Sigurd Murphy, BA - B19
Discloses no financial relationships with commercial entities.

N

Mohan Nair, MD - BS1, I7, I12, I20
Discloses no financial relationships with commercial entities.
Gary H. Naisbitt, PhD - A111, A183
Sirchie (Discussion of Commercial Products or Services)
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Transportation Security Laboratory (Discussion of Commercial Products or Services)
Transportation Security Laboratory (Other Financial/Material Support)
Gerald N. Nance, BA - G65
Discloses no financial relationships with commercial entities.
Lillian A. Nawrocki, DDS - F17
Discloses no financial relationships with commercial entities.
Samantha H. Neal, BS - A184
National Institute of Justice (Grant Support)
Sara E. Nedley, BA, MS - J2
ChemImage Corp. (Discussion of Commercial Products or Services)
ChemImage Corp. (Employee)
Barbara L. Needell, DMD - F2
Discloses no financial relationships with commercial entities.
Hannah C. Nelson, BS - A86
Discloses no financial relationships with commercial entities.
Margherita Neri, PhD - G47
Discloses no financial relationships with commercial entities.
Allison M. Nesbitt, BS - W10
Discloses no financial relationships with commercial entities.
Peter Neufeld, JD - E24, ES1, SS1
Discloses no financial relationships with commercial entities.
Cedric Neumann, PhD
FSS (Employee) - E38
Discloses no financial relationships with commercial entities. - J6, J21
Maryam Nickooshiam, BS - A66
Applied Biosystems, Qiagen, Roche Applied Science (Discussion of Unlabeled/Investigational Use of Product/Device)
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Discloses no financial relationships with commercial entities.
Jon J. Nordby, PhD - J27
Discloses no financial relationships with commercial entities.
Donald R. Norrell, BA - W11
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Teresa G. Nugent, BA - H21
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Epicentre Biotechnologies (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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O

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Armed Forces DNA Identification Laboratory (Employee)
Philip C. O'Donnell, PhD - I22
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Antonio Oliva, PhD - G16
Discloses no financial relationships with commercial entities.
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Fujifilm, General Electric, RayTech (Discussion of Commercial Products or Services) - G111
East Carolina University (Employee) - G77, G111
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Discloses no financial relationships with commercial entities.
Merissa Olmer, BA - H53
Discloses no financial relationships with commercial entities.
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Beckman Coulter (Discussion of Commercial Products or Services)
Oklahoma State University (Other Financial/Material Support)
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Mideo Systems (Discussion of Commercial Products or Services)
Mideo Systems (Discussion of Unlabeled/Investigational Use of Product/Device)
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National Institute of Justice (Grant Support) - H84
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National Institute of Justice (Grant Support)
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Accurate Arms, Accustandard, Inc., Alliant Powder Company, Eurenco VihtaVuori Oy, Hodgdon Powder Company, IMR, National Institute of Standards and Technology, Restek, Inc., Varian, Inc., Western Powder Company, Winchester (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)

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P

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NSK Nakanishi, Inc. (Discussion of Commercial Products or Services)
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Sung-Woo Park - J9, J10
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Discloses no financial relationships with commercial entities.
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Cybergenetics (Discussion of Commercial Products or Services & Shareholder)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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R

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Discloses no financial relationships with commercial entities.
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AccessData, Guidance Software (Discussion of Commercial Products or Services) - B23, E37
Apple, Blackbag Technologies, Microsoft Corporation, X-Ways (Discussion of Commercial Products or Services) - B23
Stroz Friedberg (Employee) - B23, E37
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National Science Foundation (Grant Support)
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Discloses no financial relationships with commercial entities.
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Bayer (Discussion of Commercial Products or Services & Discussion of Unlabeled/Investigational Use of Product/Device)
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Adnan Rizvic, MA - H126
Discloses no financial relationships with commercial entities.
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Roche Molecular Systems (Discussion of Commercial Products or Services) - A98
Roche Molecular Systems (Discussion of Unlabeled/Investigational Use of Product/Device) - A66, A98
Applied Biosystems Qiagen (Discussion of Unlabeled/Investigational Use of Product/Device) - A66
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Software (Discussion of Unlabeled/Investigational Use of Product/Device)
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Sandra E. Rodriguez-Cruz, PhD - A118
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Applied Biosystem, Qiagen (Discussion of Commercial Products or Services)
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Free Press (Discussion of Commercial Products or
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Sirchie (Discussion of Commercial Products or Services)

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Mideo Systems (Discussion of Commercial Products or Services & Discussion of Unlabeled/Investigational Use of Product/Device)

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