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George Mason University (Employee)
FBI Laboratory (Grant Support)
Amanda S. Gareis, BS - B97
University New Haven (Other Financial/Material Support)
Heather Garvin, MS - H86
Discloses no financial relationships with commercial entities.
Jose A. Garza-Leal, MD - G29
Discloses no financial relationships with commercial entities.
Lorie Gearhart, MD - I22
Discloses no financial relationships with commercial entities.
Vernon J. Geberth, MPS, MS
M. Evans and Company, Inc. (Discussion of Commercial Products or Services) - D11
CRC Press (Discussion of Commercial Products or Services and Discussion of Unlabeled/Investigational Use of Product/Device) - W7
Irina Geiman, BS - J11
National Institute of Justice (Grant Support)
Zeno J. Geradts, PhD
Ministry of Justice Netherlands (Employee) - D76, D79
Defraser (Discussion of Unlabeled/Investigational Use of Product /Device) - D79
Discloses no financial relationships with commercial entities - W10
Thomas G. Gersbeck, MFS - D22
Leica Geosystems (Discussion of Commercial Products or Services)
Laser Scanning (Discussion of Unlabeled/Investigational Use of Product/Device)
Paul C. Giannelli, JD, MSFS, LLM - B130
Discloses no financial relationships with commercial entities.
Robert C. Giles, PhD - B32
Orchid Cellmark (Employee)
James R. Gill, MD - G55
Discloses no financial relationships with commercial entities.
M.G.F. Gilliland, MD - G32
Discloses no financial relationships with commercial entities.
Kanya M Godde, MA - H85
Discloses no financial relationships with commercial entities.
M. Lee Goff, PhD - W2
Discloses no financial relationships with commercial entities.
Bruce A Goldberger, PhD - S2
Discloses no financial relationships with commercial entities.
Gregory S. Golden, DDS - BS8
Fujifilm North America (Discussion of Commercial Products or Services)
Fujifilm North America (Speakers Bureau)
UVIR Digital Cameras (Discussion of Unlabeled/Investigational Use of Product/Device)
Ariel Goldschmidt, MD - G49
Discloses no financial relationships with commercial entities.
Magadalena Gomez - G29
Discloses no financial relationships with commercial entities.
Richard A. Gonzalez, PhD - H79
Jeffrey Campbell Graduate Teaching Fellowshing, St. Lawrence University (Grant Support)
William T. Gormley, MD, PhD - G92
Discloses no financial relationships with commercial entities.
Charles Gould, BS - B74
Discloses no financial relationships with commercial entities.
Eleanor A.M. Graham, PhD - B68
Applied Biosystems, Qiagen (Discussion of Commercial Products or Services)
Risa B. Grand, MD - I25
Discloses no financial relationships with commercial entities.
Kirk M. Grates, BA - B46, D17
National Institute of Justice (Grant Support)
Teresa R. Gray, MS - K51
Toronto Research Chemicals, International Diagnostic Systems Corporation, Phenomenex, United Chemical Technologies), Shimadzu, Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Intramural Research Program of the National Institute on Drug Abuse, National Institutes of Health. (Employee)
Valerie S. Green, MD - G25
Discloses no financial relationships with commercial entities.
Tony Grissim - D19
Leica Geosystems (Discussion of Commercial Products or Services)
Leica Geosystems (Employee)
3D Laser Scanning (Discussion of Unlabeled/Investigational Use of Product/Device)
Christopher R. Grivas, MS - H93
Discloses no financial relationships with commercial entities.
Ann Marie Gross, MS - W16
Discloses no financial relationships with commercial entities.
Shannon Gross, BS - B38
Applied Biosystems (Discussion of Commercial Products or Services)
Ana C. Guatame-Garcia, BSc - H33
Computer based model for drift trajectories of objects in rivers (Discussion of Unlabeled/Investigational Use of Product/Device)
Bethany K. Guckert - K28
Discloses no financial relationships with commercial entities.
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National Institute of Justice Grant 2006-DN-BX-K027 (Grant Support)
Wendy M. Gunther, MD - ES2, LW8, WS1
Discloses no financial relationships with commercial entities.
Alberto Gutierrez, PhD - K48
Discloses no financial relationships with commercial entities.
Gerald Guzy, DDS - F4
Discloses no financial relationships with commercial entities.

H

Michael G. Haag, BS - D19
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Kathryn H. Haden-Pinneri, MD - G45
Discloses no financial relationships with commercial entities.
Kristin A. Hagan, BS - B62
Discloses no financial relationships with commercial entities.
Ashley Hall, PhD - B136
Midwest Research Institute (Employee)
Aimee M. Halphen, MS - K7
Sarstedt, Inc., OraSure Technologies, Inc. (Discussion of Commercial Products or Services)
Kroll Laboratory Specialists, Inc. (Other Financial/Material Support)
OraSure Technologies (Discussion of Unlabeled/Investigational Use of Product/Device)
Derek L. Hammond, BA - J2
Collaborative Testing Services, Forensic Expertise Profiling Laboratory, ST2AR (Discussion of Commercial Products or Services) - J2
Rosculux, Lee, Foster & Freeman (Discussion of Commercial Products or Services) - J19
Kristen Hancock, BS - B163
Bode Technology (Employee)
Rebecca Hanes, BS - B111
National Institute of Justice (Grant Support)
H. Theodore Harcke, MD - G77
Discloses no financial relationships with commercial entities.
Brett E. Harding, MBA - D9
Discloses no financial relationships with commercial entities.
Albert B. Harper, PhD - B97
Applied Biosystems, Inc., Invitek (Discussion of Commercial Products or Services)
Henry C Lee Institute (Other Financial/Material Support)
Heather L. Harris, MFS, JD - W22
Discloses no financial relationships with commercial entities.
Greg Harvey, MJA - W4
Taser International (Discussion of Commercial Products or Services)
Neal H. Haskell, PhD - D23
BioQuip (Discussion of Commercial Products or Services)
Gwendolyn M. Haugen, MA - H7
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Joseph T. Hefner, PhD - H29, W15
Discloses no financial relationships with commercial entities.
Mellissa Helligso, MT - B96
Discloses no financial relationships with commercial entities.
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U. S. Department of Justice, 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.
Christen E. Herrick, BS - H21
Discloses no financial relationships with commercial entities.
Edward E. Herschaft, DDS - F28
Aribex (Discussion of Commercial Products or Services)
Dean P. Hildebrand, PhD - B64
Applied Biosystems, Promega Corporation (Discussion of Commercial Products or Services)
BCIT's Centre for Forensic and Security Technology Studies (Employee)
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Applied Biosystems, Inc., National Institute of Standards and Technology,
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
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MVA Scientific Consultants (Employee)
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Discloses no financial relationships with commercial entities.
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International Committee of the Red Cross (Employee)
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Nanette Hollands, BSc - H73
Discloses no financial relationships with commercial entities.
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Kristin E. Horner, MA - H117
eBay® (Discussion of Commercial Products or Services)
Katie M. Horsman, PhD - B65
Applied Biosystems, Inc., Promega Corp. (Discussion of Commercial Products or Services)
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Department of Defense-DACA (Employee)
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David G. Howitt, PhD - D47
Discloses no financial relationships with commercial entities.
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Netherlands National Police (Grant Support)
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Intramural Research Program of the National Institute on Drug Abuse, National Institutes of Health (Employee)
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Agilent Technologies, Inc. (Discussion of Commercial Products or Services)
James B. Hyzer, PhD - C18
Discloses no financial relationships with commercial entities.

I

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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Yasumi Ito, PhD - C3
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J

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European Commission Marie Curie Actions, Framework Programme 6 (Grant Support)
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Discloses no financial relationships with commercial entities.
Amanda J. Jenkins, PhD - K64
Immunalysis Corp (Grant Support)
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Department of Justice, Midwest Forensic Resource Center, Ames Laboratory, Iowa State University, Ames Iowa (Grant Support), Adobe Photoshop, CS2, SAS Analytic (Discussion of Unlabeled/Investigational Use of Product/Device)
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Cheryl A. Johnston, PhD - H48
Discloses no financial relationships with commercial entities.
Alan W. Jones, PhD, DSc - K44
Swedish government (Employee)
Roger W. Jones, PhD. - J13
JEOL USA, Inc. (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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National Institute of Standards and Technology (Grant Support)
Chelsey A. Juarez, MA - H58
U.C. Mexus Foundation (Grant Support)
Sara L. Jubelirer, BS - B173
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.

K

Sherri L. Kacinko, BS - K50
Reckitt Benckiser (Discussion of Commercial Products or Services)
Intramural Research Program of the National Institute of Drug Abuse, National Institutes of Health. (Employee)
Buprenorphine (Discussion of Unlabeled/Investigational Use of Product/Device)
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Discloses no financial relationships with commercial entities.
Timothy S. Kalafut, PhD - W16
Discloses no financial relationships with commercial entities.
Paul Kamen, ME - C44
Discloses no financial relationships with commercial entities.
Roman Karas, BS - K30
JEOL / Ionsense (Discussion of Commercial Products or Services)
DART™/Ion source (Discussion of Unlabeled/Investigational Use of Product/Device)
Erin L. Karschner, BA - K46
Joint Analytical Systems, Inc., Phenomenex, Agilent Technologies, Inc., United Chemical Technologies (Discussion of Commercial Products or Services)
Intramural Research Program of the NIH, National Institute on Drug Abuse (Employee)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Raymond C. Kelly, PhD - K43
Discloses no financial relationships with commercial entities.
Ronald L. Kelly, BS - W22
Discloses no financial relationships with commercial entities.
Bobbie J. Kemp, MS - H50
Sigma Aldrich (Discussion of Unlabeled/Investigational Use of Product/Device)
Philip M. Kemp, PhD - W23
Discloses no financial relationships with commercial entities.
Philip M. Kemp, PhD - K65
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Robert D. Keppel, MEd, PhD - W7
Academic Press (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Yi-Suk Kim, MD, MS - H96
The Korea Research Foundation Grant funded by the Korean Government (Grant Support)
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Discloses no financial relationships with commercial entities.
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Agilent, J & W Capillary, Restek Corporation (Discussion of Commercial Products or Services)
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National Institute of Justice, National Institute of Standards and Technology Office of Law Enforcement (Grant Support) – B158
Discloses no financial relationships with commercial entities – W6
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Promega (Discussion of Commercial Products or Services), Promega (Employee)
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FBI Laboratory (Employee)
Sarathchandra Kodikara, MBBS, MD, DLM - G67
Discloses no financial relationships with commercial entities.
Laura Kolb, MPH - C33
Discloses no financial relationships with commercial entities.
Erin A. Kolbrich, BS - K52
Intramural Research Program of the National Institute on Drug Abuse, National Institutes of Health (Employee)
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Duco cement (Devcon Duco Cement) (Discussion of Commercial Products or Services)
Debra Komar, PhD - H122
Wenner Gren Foundation (Grant Support)
Robert J. Koolkin, DDS - LW3
Discloses no financial relationships with commercial entities.
Robert D. Koons, PhD - B131
Discloses no financial relationships with commercial entities.
Roger G. Koppl, PhD - D66
Discloses no financial relationships with commercial entities.
Kevin L. Kramer, BS - B37
Oklahoma State Bureau of Investigation (Employee)
Adrian S. Krawczeniuk, MS - B79
Discloses no financial relationships with commercial entities.

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Discloses no financial relationships with commercial entities.
Carl R. Kriigel, BS - D24, W10
Discloses no financial relationships with commercial entities.
Clarissa Krinsky, MD - G85
Discloses no financial relationships with commercial entities.
Diane M. Kruger, LLB, JD - J15
Unotchit (Discussion of Commercial Products or Services)
Thomas Kubic, JD, PhD - S1
Discloses no financial relationships with commercial entities.
Elzbieta J. Kubicz, PhD - B120
Securetec (Discussion of Commercial Products or Services)
Maiko Kusano, BA - B4
Discloses no financial relationships with commercial entities.
Michael A. Kusluski, MFS - B144
Discloses no financial relationships with commercial entities.
Alicja K. Kutyla, BS – H52, H104
Discloses no financial relationships with commercial entities.

L

Douglas S. Lacey, BS - D83
Discloses no financial relationships with commercial entities.
Denis Lafleche - W3
Discloses no financial relationships with commercial entities.
Sylvain Laforte, DMD - F44
Discloses no financial relationships with commercial entities.
Abigail Clare Lagden, BSc - H45
Discloses no financial relationships with commercial entities.
Lisa LaGoo, BS, BA - B6
Discloses no financial relationships with commercial entities.
Hanh T. Lai, BS - B76
Discloses no financial relationships with commercial entities.
Valerie Lane, MSc - C59
Discloses no financial relationships with commercial entities.
Guihua L. Lang, PhD - B150
ATF Forensic Science Laboratory (Employee)
Christopher Lange, MD - I17
Discloses no financial relationships with commercial entities.
Loralie J. Langman, PhD - K61
Discloses no financial relationships with commercial entities.
Kenneth V. Lanning, MS - I11
Discloses no financial relationships with commercial entities.
Patrick E. Lantz, MD - G82
Discloses no financial relationships with commercial entities.
Gerald M. LaPorte, MSFS
(Foster & Freeman, USA Inc. (Discussion of Commercial Products or Services) – W5Discloses no financial relationships with commercial entities – J28, S1
Elizabeth A. Laposata, MD - BS2
Discloses no financial relationships with commercial entities.
Tony Larkin, MSc - D46
Metropolitan Police Service (Employee)
Krista E. Latham, MS, MA - G74
University of Tennessee (Discussion of Commercial Products or Services)
Beth Lavach - BS4
Discloses no financial relationships with commercial entities.
Marc A. LeBeau, PhD - W20
Discloses no financial relationships with commercial entities.
Carol Kaluen Lee, MD - G16
Media Cybernetics (Discussion of Commercial Products or Services)
University of British Columbia, University of New Mexico (Employee)
Henry C. Lee, PhD - ES1, S2
Discloses no financial relationships with commercial entities.
Lin Kiak Lee, BSc - B53
Abacus Diagnostics, BLUESTAR (Discussion of Commercial Products or Services)
Steven B. Lee, PhD - B94
Biomatrica, Inc. (Discussion of Commercial Products or Services)
Biomatrica, Inc. (Paid Consultant)
SampleMatrix by Biomatrica, Inc. (Discussion of Unlabeled/Investigational Use of Product/Device)
U-Young Lee, MD - H90
Discloses no financial relationships with commercial entities.
John J. Lentini, BA - B80, W22
Discloses no financial relationships with commercial entities.
Erin J. Lenz, BS - B2
Discloses no financial relationships with commercial entities.
Joseph A. Levisky, MS - K37
Defense Threat Reduction Agency (DTRA) (Grant Support)
James M. Lewis, DMD - F21
Discloses no financial relationships with commercial entities.
Kristen E. Lewis, MS - B59
University of Washington Genetics Training Grant (Grant Support)
John A. Lewis, Jr., DDS - F43
Discloses no financial relationships with commercial entities.
George C. Li, MS - B125
Discloses no financial relationships with commercial entities.
William T. Lichon, DDS - LW1
Discloses no financial relationships with commercial entities.
Peter T. Lin, MD - G14
Discloses no financial relationships with commercial entities.
Wen-Ling Lin - G42
Discloses no financial relationships with commercial entities.
Brian S. Lindblom, BA - J21
Pikaso Software (Discussion of Commercial Products or Services)
Christina D. Lindquist, MS - B108
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
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Brian S. Linert, BS - G59
Discloses no financial relationships with commercial entities.
Laura L. Liptai, PhD - C44
Discloses no financial relationships with commercial entities.
Ray H. Liu, PhD, LLB - K13
Microgenic Corporation, International Diagnostic Systems, Neogen Corporation, Immunalysis Corporation, Diagnostix (Discussion of Commercial Products or Services)
National Science Council (Grant Support)
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Southwestern University (Grant Support)
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Discloses no financial relationships with commercial entities.
Benjamin Long, BA - D39
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Ana E. Lopez, MD - G84
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Arizona Criminal Justice Commission/National Institute of Justice Funds (Grant Support)
David A. Lounsbury, PhD - I8
Discloses no financial relationships with commercial entities.
Jennifer C. Love, PhD - G33
Discloses no financial relationships with commercial entities.

Ross H. Lowe, PhD - K17
Phenomenex, Inc., United Chemical Technologies, Inc., Joint Analytical Systems, Inc., Agilent Technologies (Discussion of Commercial Products or Services)
National Institute on Drug Abuse - IRP (Paid Consultant)
Helge Lubenow, PhD - B91
QIAGEN GmbH (Discussion of Commercial Products or Services) – B91
QIAGEN GmbH (Employee) – B91, B123
A novel platform for the automation of spin column based pre-analytical laboratory processes (Discussion of Unlabeled/Investigational Use of Product/Device) – B91
QIAGEN GmbH, Applied Biosystems Inc. (Discussion of Commercial Products or Services) – B123
Fully Automated Robotic System (Discussion of Unlabeled/Investigational Use of Product/Device) – B123
Coral Luce, BS - B45
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Todd M. Luckasevic, DO - G58
Discloses no financial relationships with commercial entities.
James R. Lyle, PhD - D40
Discloses no financial relationships with commercial entities.
Bruce M. Lyons, JD - W12
Discloses no financial relationships with commercial entities.
Zachary R. Lysek, BA - L2
Discloses no financial relationships with commercial entities.
Albert H. Lyter, PhD - J3
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M

Michael S. Macias, BS - B20
National Institute of Justice (Grant Support)
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Microsoft Corporation (Discussion of Commercial Products or Services)
Merrill Main, PhD - I6
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.
Christina A. Malone, BHS, BA - H99
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.
Kerriann Marden, MA - H51
Discloses no financial relationships with commercial entities.
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Applied Biosystems, Invitrogen (Discussion of Commercial Products or Services)
Sorenson Genomics (Employer and Other Financial/Material Support)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Laureen Marinetti, PhD - W14
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities – S1
University of Tennessee (Employee) – H68
Peter M. Marone, MS – BS4, W21
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Discloses no financial relationships with commercial entities.
Lucas J. Marshall, BS - B89
Discloses no financial relationships with commercial entities.
Daniel A. Martell, PhD - I10
Discloses no financial relationships with commercial entities.
Audrey N. Martin, MS - B77
Discloses no financial relationships with commercial entities.
Thomas L. Martin, BA - E7
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Promega Corporation (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.
Lara E. McCormick, MA - H97
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.
Edward T. McDonough, MD - W2
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Sigma, MilliPose, Applied Biosystems, Inc., BioRad (Discussion of Commercial Products or Services)
John Jay Research Assistance Fund (Grant Support)
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Department 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.
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Discloses no financial relationships with commercial entities.
Amy Michael, BA - H128
Discloses no financial relationships with commercial entities.
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Cedar Crest College (Other Financial/Material Support)
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Rotogene 3000 (Corbett Robotics) (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
Eric R. Miller, BSE
Ford Motor Company (Discussion of Commercial Products or Services) – C13
Full90 Sports Discussion of Commercial Products or Services) – C46
Discloses no financial relationships with commercial entities – C7
Raymond G. Miller, DDS - F7
Adobe Systems, Inc.) (Discussion of Commercial Products or Services)
James Millette, PhD - C54
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Discloses no financial relationships with commercial entities.
Christie L. Mitchell, MFS - J20
Discloses no financial relationships with commercial entities.
Linton Mohammed, MFS - J1
Neuroscript Software, Inc., Wacom, Inc. (Discussion of Commercial Products or Services)
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UN-DU, 3-M Corporation (Discussion of Commercial Products or Services)
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Discloses no financial relationships with commercial entities.
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Qiagen Corporation, Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Christine Moore, PhD - W14
Immunalysis Corporation (Discussion of Commercial Products or Services)
Immunalysis Corporation (Employee)
Megan K. Moore, MS - H63
Discloses no financial relationships with commercial entities.
Reuben E.L. Moreton - H75
Discloses no financial relationships with commercial entities.
Philip R. Morey, PhD - C31
Discloses no financial relationships with commercial entities.
Zoe Hensley Morris, HBSc, MA - H12
Discloses no financial relationships with commercial entities.
Diana K. Moyers, MA - H14
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JEOL (Discussion of Commercial Products or Services) – K10
Discloses no financial relationships with commercial entities – K9
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Turhon A. Murad, PhD - G72
Discloses no financial relationships with commercial entities.
Claire Murden, BS - B116
Gene Codes Forensics (Discussion of Commercial Products or Services)
Ann Murphy, BS - W12
Discloses no financial relationships with commercial entities.

N

Mohan Nair, MD - I7, W23
Discloses no financial relationships with commercial entities.
Gary H. Naisbitt, PhD - B115
Discloses no financial relationships with commercial entities.
Lillian A. Nawrocki, MA, DDS - F30, F46
Discloses no financial relationships with commercial entities.
Margherita Neri, MD - G38
Discloses no financial relationships with commercial entities.
P. Francis Ngande, BDS - F22
Agilent Technologies, Phenomenex, Applied Biosystems, Inc., SPEX (Discussion of Commercial Products or Services)
Freezer Mill HPLC Column Mass Spectrometer (Discussion of Unlabeled/Investigational Use of Product/Device)
Janice A. Nicklas, PhD - W6
Discloses no financial relationships with commercial entities.
John R. Nixon, MBA - E3, E9, E12
Discloses no financial relationships with commercial entities.
Anna C. Noller, PhD - G40
Discloses no financial relationships with commercial entities.
Jessica Voorhees Norris, MSc - B31, B107
Discloses no financial relationships with commercial entities.
Emilio Nuzzolese, DDS, PhD - K15
Cozart, Ltd., SPADA Dentsply Italia, Dental Molteni Srl Italia, Ogna Italia Spa, Dentsply Italia (Discussion of Commercial Products or Services)

O

Kathryn E. O'Brien, BS - D53
Oak Ridge Institute of Science Education (Other Financial/Material Support)
Jennifer O'Day, MD - I22
Discloses no financial relationships with commercial entities.
Kingsley O. Odigie, BS - B23
Applied Biosystems, Inc. (Discussion of Commercial Products or Services
NSF-REU (Grant Support)
Lucy S. Oldfield, MChem, MSc - K20
National Institute of Justice (Grant Support)
Antonio Oliva, MD, PhD
Catholic University, School of Medicine, Rome, Italy (Employee) – G17
Discloses no financial relationships with commercial entities – G1, G18, G51
William R. Oliver, MD - W10
Adobe Systems, Inc., The GIMP Team, The National Institutes of Health), Meesoft, Autodesk, Inc., The Blender Foundation (Discussion of Commercial Products or Services)
Daniel B. Olson, MSFS - BS1, J12
Discloses no financial relationships with commercial entities.
Zachariah Oommen, PhD - B70
Albany State University, National Institutes of Health (Grant Support)
Kerry L. Opel, MA - B66
Corbett Robotics (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
David K. Ord, DDS - F29
Mideo System (Discussion of Commercial Products or Services)
Scott R. Oulton, BS - B142
Discloses no financial relationships with commercial entities.
S. Sebnem Ozcan, MSc - E1
Discloses no financial relationships with commercial entities.

P

Melissa M. Pablic - B85
National Institute of Justice (Grant Support)
William Pace, DDS – F15, F16
Discloses no financial relationships with commercial entities.

Christopher S. Palenik, PhD - B139
Discloses no financial relationships with commercial entities.
Frederick H. Panhorst, MSM - BS7
US Army Criminal Investigation Laboratory (Employee)
Josephine M. Paolello, MS - H115
Discloses no financial relationships with commercial entities.
Suzanne D. Parisian, MD - G76
Discloses no financial relationships with commercial entities.
Dae-Kyoon Park, MD, PhD - H91
Discloses no financial relationships with commercial entities.
Sung-Woo Park, PhD - B13
Discloses no financial relationships with commercial entities.
Joseph L. Parker, MSA - J25
Adobe Systems, Inc., Microsoft, Appligent, Inc., Verypdf.com (Discussion of Commercial Products or Services)
Nicolette M. Luney Parr, BA, MS - H95
Discloses no financial relationships with commercial entities.
Nicholas V. Passalacqua, MS - H94
Discloses no financial relationships with commercial entities.
Susan Paterson, PhD - W14
Discloses no financial relationships with commercial entities.
Victoria R. Pavlova, BS - B42
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
Graham F. Peaslee, PhD
National Science Foundation (Grant Support) – B110
Federal Bureau of Investigation (Grant Support) – B147
Tanya R. Peckmann, PhD - G78
Discloses no financial relationships with commercial entities.
John Pellerin, PhD - W9
Chemstation Software (Agilent Technologies) (Discussion of Commercial Products or Services), Agilent Technologies (Employee)
Michel Perrier, MS, DDS - F48
Discloses no financial relationships with commercial entities.
DeMia E. Peters, MS - D15
Discloses no financial relationships with commercial entities.
Diane C. Peterson, MD - K1
Forest Laboratories, Ortho-McNeil Neurologics, Inc. (Discussion of Commercial Products or Services)
Donn N. Peterson, MSME, PE - C12
Discloses no financial relationships with commercial entities.
Stojan Petkovic, MD - G36
Discloses no financial relationships with commercial entities.
Nicholas D.K. Petraco, PhD - B135
Discloses no financial relationships with commercial entities.
Amy Phenix, PhD - I7
Discloses no financial relationships with commercial entities.
Brittany N. Philbin, BS - G26
Discloses no financial relationships with commercial entities.
Benjamin G. Phillips, BS - F9
Discloses no financial relationships with commercial entities.
Daniel G.K. Phillips, MD - G21
Discloses no financial relationships with commercial entities.
Katie M. Phillips - B87
The National Institute of Justice (Grant Support)
David Pienkowski, PhD - C8, C17
Insurance Company (Paid Consultant)
Richard Pinchin, BA - D69
FSS (Discussion of Commercial Products or Services)
Gina M. Pineda, MS - B30
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
ReliaGene Technologies, Inc. (Employee)
João Pinheiro - H108
Discloses no financial relationships with commercial entities.
Deborrah C. Pinto, MA - H97
Discloses no financial relationships with commercial entities.
Seth Pitkin, MS - C60
Stone Environmental, Inc. (Discussion of Commercial Products or Services, Employee, and on of Unlabeled/Investigational Use of Product/Device)
Haskell M. Pitluck, JD - W4
Taser International (Discussion of Commercial Products or Services)
Pisha Pittayapat - F24
Discloses no financial relationships with commercial entities.
Alphonse Poklis, PhD – K48, S1, W11
Discloses no financial relationships with commercial entities.
Justin Poklis, BS - K29
Discloses no financial relationships with commercial entities.
Diana Poli - K60
Discloses no financial relationships with commercial entities.
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Department of Defense-DACA (Employee)
Elayne J. Pope, MA - H23
Discloses no financial relationships with commercial entities.
Ryan J. Postlethwait, BS - B126
National Institute of Justice (Grant Support)
Mark Powell, MS - B160
Beckmann Coulter,Promega,Invitrogen,Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Tamar Powell, BS - B114
Applied Biosystems, Inc., BioRad, Promega Corporation (Discussion of Commercial Products or Services)
University of California (Grant)
Houston Police Department Crime Lab, Santa Clara County Crime Lab (Employee and Grant Support)
Robert H. Powers, PhD - S2
Discloses no financial relationships with commercial entities.
Mark C. Pozzi, MS – C15, C35, C48, C49, C50
Discloses no financial relationships with commercial entities.
Paola A. Prada, BS - B8
Technical Scientific Support Group (Grant Support)
Joseph A. Prahlow, MD - K48
Discloses no financial relationships with commercial entities.
Alan Price, MA - D4
Discloses no financial relationships with commercial entities.
Jennifer J. Prutsman-Pfeiffer, MA - H61
Discloses no financial relationships with commercial entities.

Q

Conrad Bezekiah Quintyn, PhD - H80
Discloses no financial relationships with commercial entities.

R

Donna M. Radice, BS - B17
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
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Praeger (Discussion of Commercial Products or Services) – L2
Berkley (Discussion of Commercial Products or Services) – LW7
Bernard A. Raum, JD, MFS - W22
Discloses no financial relationships with commercial entities.
David Raymond, MS
Discloses no financial relationships with commercial entities – C38
Joint Non-Lethal Weapons Directorate (Grant Support) – H49, H103
Linda A. Razzano, MS - B63
Discloses no financial relationships with commercial entities.
Carmen R. Reedy, BS - B113
National Institute of Health (Grant Support)

Kelly A. Rees, MSc - F5
American Society of Forensic Odontology (Grant Support)
Nicole M. Reeves, BA - H32
Discloses no financial relationships with commercial entities.
Kathleen J. Reichs, PhD - S2
Discloses no financial relationships with commercial entities.
Machelle A. Reid, MFS - B138
Michelin North America, Inc. (Discussion of Commercial Products or Services)
Jessica Reust, MFS - D33
EnCase, Genescan, Genotyper, X-Ways, Apple (Discussion of Commercial Products or Services)
Stroz Friedberg (Employee)
Michael D. Rexroad, JD - W22
Discloses no financial relationships with commercial entities.
Mary Mae Rezos, BA - H13
Discloses no financial relationships with commercial entities.
Simona Ricci - G52
Discloses no financial relationships with commercial entities.
Melanie Richard, MSc - W6
Discloses no financial relationships with commercial entities.
Ray Richmond, MPhil - F39
Discloses no financial relationships with commercial entities.
Irene Riezzo, MD - G83
Discloses no financial relationships with commercial entities.
Joan G. Ring, MS – B46, D17
National Institute of Justice (Grant Support)
Michael Risinger, JD – B130, W21
Discloses no financial relationships with commercial entities.
Kathleen A. Rix, BSN - W20
Discloses no financial relationships with commercial entities.
James M. Robertson, PhD - B121
National Instruments, Promega Corporation (Discussion of Commercial Products or Services)
Federal Bureau of Investigation (Employee)
Rhonda K. Roby, MPH, MS - B101
Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Applied Biosystems, Inc. (Employee)
William C. Rodriguez III, PhD – G68, W2
Discloses no financial relationships with commercial entities.
Sandra E. Rodriguez-Cruz, PhD - B75
Discloses no financial relationships with commercial entities.
Marc Rogers, PhD - D74
National Institute of Justice Grant (Grant Support)
Maurice G. Rogev, MBChB - G46
Discloses no financial relationships with commercial entities.
Douglas E. Rohde, MS - K62
Taser International (Discussion of Commercial Products or Services)
Mitchell M. Rohde, PhD - D82
Quantum Signal LLC (Discussion of Commercial Products or Services)
U.S. Army Criminal Investigation Laboratory, Technical Support Working Group (TSWG) (Grant Support)
Newly developed software tool (Discussion of Unlabeled/Investigational Use of Product/Device)
Timothy P. Rohrig, PhD - W14
Sedgwick County Regional Forensic Science Center (Employee)
Jeri D. Ropero-Miller, PhD - K2
Jeol, IonSense (Discussion of Commercial Products or Services)
National Institute of Justice Grant (Grant Support)
Kelly Rose, MD – G15, G35
Discloses no financial relationships with commercial entities.
Karen Rosenbaum, MD - I7, I22
Discloses no financial relationships with commercial entities.
William Rosenbluth, MSEE - C39
Advanced Vehicle Technologies, Snap-On, Bosch (Discussion of Commercial Products or Services)
Richard Rosner, MD - I3
Discloses no financial relationships with commercial entities.
Ann H. Ross, PhD
National Institute of Justice (Grant Support) – H83
Discloses no financial relationships with commercial entities – W15
Karen F. Ross, MD - W8
NeoGene, Familion, Boston University Center for Human Genetics (Discussion of Commercial Products or Services)
Clotilde G. Rougé-Maillart, MD - G41
Discloses no financial relationships with commercial entities.
Leonid I. Rudin, PhD - D26
Cognitech, Inc. (Employee)
3-D Based Scanner (Discussion of Unlabeled/Investigational Use of Product/Device)
Arnout C. Ruifrok, PhD - C47
Cognitec (Discussion of Commercial Products or Services)
Stacy Running Rodriguez, JD - W19
Discloses no financial relationships with commercial entities.
Karen S. Runyon, BA - J22
Discloses no financial relationships with commercial entities.

S

Joseph J. Saady, PhD - K45
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Robert Sadoff, MD - I4
Discloses no financial relationships with commercial entities.
Pauline Saint-Martin, MD - G86
Discloses no financial relationships with commercial entities.
Fabian M. Saleh, MD – I14, I15, I20, I21
Discloses no financial relationships with commercial entities.
Michael J. Salyards, PhD - D72
Discloses no financial relationships with commercial entities.
Richard Sampson - B110
National Science Foundation - Research Experience for Undergraduates (Grant Support)
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Discloses no financial relationships with commercial entities.
Valeria Santoro, PhD - F3
Discloses no financial relationships with commercial entities.
Nelson Santos, MPA - B142
Discloses no financial relationships with commercial entities.
Gil Sapir, JD, MSc - W12
Discloses no financial relationships with commercial entities.
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Applied Biosystems, Inc. (Discussion of Commercial Products or Services), Applied Biosystems, Inc. (Employee)
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Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities.
Christopher P. Saunders, PhD - J10
Gannon Technologies Group (Discussion of Commercial Products or Services)
Federal Bureau of Investigation (Grant Support)
Anny Sauvageau, MD - G100
SPSS Inc. (Discussion of Commercial Products or Services) – D65
Discloses no financial relationships with commercial entities – G81, G100
Vincent J. Sava, MA - H69
Discloses no financial relationships with commercial entities.
Kathleen A. Savage, PhD - B46, D17
National Institute of Justice (Grant Support)
Slobodan Savic, MD, PhD – G28, G50, G64
Discloses no financial relationships with commercial entities.

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Restek, J&W Scientific, Agilent Technologies, Thermo Electron, ASAP, (Discussion of Commercial Products or Services)
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Carl J. Schmidt, MD, MPH - K65
Discloses no financial relationships with commercial entities.

Bettina Schrag, MD - G65
Discloses no financial relationships with commercial entities.

Andre Schreiber, PhD - K54
Applied Biosystems, Inc., MDS Sciex, 3200 (Discussion of Commercial Products or Services)
Applied Biosystems, Inc. (Employee)

James W. Schumm, PhD - B154, B155
Applied Biosystems, Inc., (Discussion of Commercial Products or Services)
Bode Technology (Employee)

Melissa R. Schwandt, PhD - B161
Promega Corporation (Discussion of Commercial Products or Services)
Promega Corporation (Employee)
Automated Differex™ System, DNA IQ™ Systems (Discussion of Unlabeled/Investigational Use of Product/Device)

Ted R. Schwartz, MS - W17
Discloses no financial relationships with commercial entities.

Lisa M. Schwenk, BS - B83
Discloses no financial relationships with commercial entities.

Eugene W. Schwilke, BS - K55
Joint Analytical Systems, Phenomenex, Agilent Technologies, United Chemical Technologies) (Discussion of Commercial Products or Services)
Intramural Research Program/NIH/NIDA(Employee)

Audrey Scott, MA - H3
Discloses no financial relationships with commercial entities.

Sarah J. Seashols, MS - B102
Applied Biosystems, Inc., Qiagen Qiagen (Discussion of Commercial Products or Services)
Virginia Commonwealth University (Other Financial/Material Support)

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U.S. Chemical Safety Board (Employee)

Kristi Sellers, BS - K34
Restek Corporation (Employee)

David R. Senn, DDS
Discloses no financial relationships with commercial entities – S1

David R. Senn, DDS - F22
Mill/CertiPrep, Applied Biosystems, Inc., Phenomenex, Agilent Technologies (Discussion of Commercial Products or Services), Freezer Mill/HPLC Column (Discussion of Unlabeled/Investigational Use of Product/Device)

Richard B. Serchuk, DDS - F46
Discloses no financial relationships with commercial entities.

Joanne B. Sgueglia, BA - W16
Promega Corp., Applied Biosystems, Inc. (Discussion of Commercial Products or Services)

Christopher F. Shahzaad, MD - I22
Discloses no financial relationships with commercial entities.

Diaa M. Shakleya, PhD - K18
Discloses no financial relationships with commercial entities.

Paul Shannon, MS - BS5
Discloses no financial relationships with commercial entities.

Kaiping Shaw, MD, PhD - G42
Discloses no financial relationships with commercial entities.

Mark E. Shelly, DO - BS3
Discloses no financial relationships with commercial entities.

Katy L. Shepherd, BS - H4
CP Medical, Inc., Ethicon, Inc., Syneture, United States Surgical, Arthrex, Inc., DemeTECH, Inc. (Discussion of Commercial Products or Services)

Denise A. Shepperd, BS - C26
Discloses no financial relationships with commercial entities.

Donald C. Sherman, MSE - D48
Redlake, Inc., Diversified Technical Systems, Syscon Instruments Private, Ltd., Konica Minolta, Canon, Inc. (Discussion of Commercial Products or Services)

Jaiprakash G. Shewale, PhD - B162
Tecan, Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Applied Biosystems, Inc. (Employee)
Automation software (Discussion of Unlabeled/Investigational Use of Product/Device)

Natalie R. Shirley, MA
Discloses no financial relationships with commercial entities – H74
Forensic Sciences Foundation, Inc. (Other Financial/Material Support) – S2

Michael J. Shkrum, MD - G94
Discloses no financial relationships with commercial entities.

Gary G. Shutler, PhD - W16
Discloses no financial relationships with commercial entities.

Jennifer L. Shuttlesworth, MD - G90
Discloses no financial relationships with commercial entities.

Jay A. Siegel, PhD - B130
Discloses no financial relationships with commercial entities.

Michael E. Sigman, PhD - B35
University of Central Florida and National Institute of Justice (Grant Support)

Jerónimo Fonte Santa Silva - G9
Discloses no financial relationships with commercial entities.

Sam Simmons, MD - G62
Discloses no financial relationships with commercial entities.

Tal Simmons, PhD - H28
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Robert I. Simon, MD - I5
Discloses no financial relationships with commercial entities.

Ronald Singer, MS - W21
Discloses no financial relationships with commercial entities.

Sudhir K. Sinha, PhD - B129
ReliaGene Technologies, Inc. (Discussion of Commercial Products or Services)
ReliaGene Technologies, Inc. (Employee)

Frederick P. Smith, PhD
Department of Defense (Grant Support) – K22, K67
Sarstedt, Inc., PharmChem, Inc. (Discussion of Commercial Products or Services) – K22
PharmChem, Inc. (Discussion of Unlabeled/Investigational Use of Product/Device) – K22

James S. Smith, PhD – C25, C57, C61
Discloses no financial relationships with commercial entities.

John R. Smith, MD - I18
Discloses no financial relationships with commercial entities.

Marshall Smith, MD - I17
Discloses no financial relationships with commercial entities.

Stephanie L. Smith, BS - B27
Applied Biosysems, Inc., Qiagen, Orchid Cellmark (Discussion of Commercial Products or Services)
U.S. Postal Inspection Service (Employee)

James S. Smith, Jr., PhD - C21, C24
Discloses no financial relationships with commercial entities.

Kenneth S. Snell, MD - K65
Discloses no financial relationships with commercial entities.

David J. Snyder III, BS - D84
Discloses no financial relationships with commercial entities.

Edward A. Sobek, PhD - C55
Roche (Discussion of Commercial Products or Services)
Ready-to-Use Detection Mixes (Discussion of Unlabeled/Investigational Use of Product/Device)

Biagio Solarino, MD - G31, K12
Discloses no financial relationships with commercial entities.
Tore T. Solheim - F23
Discloses no financial relationships with commercial entities.
Ryan Sommers, BS - D33
EnCase, Genescan, Genotyper, X-Ways, Apple (Discussion of Commercial Products or Services)
Stroz Friedberg (Employee)
Richard R. Souviron, DDS - F27
Discloses no financial relationships with commercial entities.
Brian F. Spatola, MA - H10
AFIP (Employee)
Nicole A. Spaun, PhD - W10
Discloses no financial relationships with commercial entities.
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Discloses no financial relationships with commercial entities – D61, D62
National Institute of Justice (Paid Consultant) – D64
Jerry D. Spencer, MD, JD - LW6
Discloses no financial relationships with commercial entities.
Ashley Spicka - D13
Discloses no financial relationships with commercial entities.
Vina R. Spiehler, PhD - W23
Discloses no financial relationships with commercial entities.
Eric Stauffer, MS - B84, B146
Discloses no financial relationships with commercial entities.
Pamela M. Steger, MS - H43
Discloses no financial relationships with commercial entities.
Carl N. Stephan, PhD - H16
Discloses no financial relationships with commercial entities.
Fred Stephens, MPA - W4
Taser International (Discussion of Commercial Products or Services)
Joseph Stephens, MSFS - W5
Foster & Freeman, USA Inc. (Discussion of Commercial Products or Services)
Libby A. Stern, PhD - B56
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Charlotte J. Stevens, BA - G80
Discloses no financial relationships with commercial entities.
Paul G. Stimson, DDS - F26
Discloses no financial relationships with commercial entities.
Sarah E. Stojsih, BS - D41
IACP/DuPont™ (Discussion of Commercial Products or Services)
National Institute of Justice (Grant Support)
Vasilios S. Stoukas - G61
Discloses no financial relationships with commercial entities.
Peter R. Stout, PhD
Agilent Technologies, JEOL (Discussion of Commercial Products or Services) – K53
Agilent Technologies (Other Financial/Material Support) – K53
JOEL, LEAP Technologies (Discussion of Commercial Products or Services) – K58
National Institute of Justice (Grant Support) – K58
Sam D. Stout, PhD - H97
Discloses no financial relationships with commercial entities.
Kyra Elizabeth Stull, BA - H101
Discloses no financial relationships with commercial entities.
Kimberly Sturk, MFS - B40
Discloses no financial relationships with commercial entities.
James P. Subjack, JD - W19
Discloses no financial relationships with commercial entities.
Mary K. Sullivan, MSN - W20
Discloses no financial relationships with commercial entities.
Dahong Sun, PhD, MD - B97
Applied Biosystems, Inc., IncInvitek (Discussion of Commercial Products or Services)
Henry C Lee Institute (Other Financial/Material Support)
Monte Swank, BS - D18
Kauler, Rare Ideas, LLC., U3 LLC., RingCube Technologies, Inc., Guidance Software, Inc., PNY Technologies, Kingston Technology Company, Logicube, Lexar Media, Inc., Dell Inc., Microsoft (Discussion of Commercial Products or Services), Marshall University Forensic Science (Other Financial/Material Support)
Kay M. Sweeney, BS - B169
Discloses no financial relationships with commercial entities.
Henry J. Swofford - K3
Discloses no financial relationships with commercial entities.
Stephanie Swyter, DMD - F12
Adobe Photoshop (Adobe Systems, Incorporated) (Discussion of Commercial Products or Services)
Steven A. Symes, PhD - ES2, H109
Discloses no financial relationships with commercial entities.

T

Tobin A. Tanaka, BSc - J16
Quality Engineering Associates (Discussion of Commercial Products or Services)
Canada Border Services Agency (Government of Canada) (Employee)
Yingying Tang, MD, PhD - G34, G75
Discloses no financial relationships with commercial entities.
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National Institute of Justice (Other Financial/Material Support) - D30
National Archives and Records Administration (Other Financial/Material Support) - D29
Tracey Temple, MSc - D59
Cranfield University (Employee)
Claudio Terranova - G89
Discloses no financial relationships with commercial entities.
MariaTeresa A. Tersigni, PhD - H129
Discloses no financial relationships with commercial entities.
Michael Thali, MD - D25
University of Berne (Discussion of Commercial Products or Services)
University of Berne (Employee)
Christopher Thompson, MD - I1
GLG Councils (Paid Consultant)
Tracey Tichnell, BS - H107
Discloses no financial relationships with commercial entities.
Jian Tie, MD - B3
Nihon University (Employee)
Mark Timken, PhD - W6
Discloses no financial relationships with commercial entities.
Mark Timken, PhD - B52
National Institute of Justice (Grant Support)
Silicon Biosystems Slide Runner (Discussion of Unlabeled/Investigational Use of Product/Device)
Wieslawa Tlomak, MD - G44
Discloses no financial relationships with commercial entities.
Samantha S. Tolliver, MS - K16
Discloses no financial relationships with commercial entities.
Ryan C. Tomcik, BS - J26
Whatman (Discussion of Commercial Products or Services)
Richard E. Tontarski, MS - B145
Discloses no financial relationships with commercial entities
Melissa A. Torpey, MS - H126
Discloses no financial relationships with commercial entities.
Gilles Tournel, MD, PhD - D8, G71, K5
Discloses no financial relationships with commercial entities.
Lindsay H. Trammell, MA - H84
Discloses no financial relationships with commercial entities.

Tatiana Trejos, MSFS - B106
Smartwater Technologies Ltd (Discussion of Commercial Products or Services)
SmartWater Technologies Ltd (Grant Support)
Tracer and Index Chemical Tagging Systems (Discussion of Unlabeled/Investigational Use of Product/Device)
Anthony R. Trimboli, BS - B127
Discloses no financial relationships with commercial entities.
Giuseppe Troccoli, MD - I19
Discloses no financial relationships with commercial entities.
Jane Willman Turner, PhD, MD - G97
Discloses no financial relationships with commercial entities.
Steven Tvrdik, BS - G6
Iowa Office of the State Medical Examiner (Employee)

U

Douglas H. Ubelaker, PhD - H71
Discloses no financial relationships with commercial entities.
Natalie Uhl, MS - H72
Discloses no financial relationships with commercial entities.
Lars Uhrenholt, DC - G93
The European Chiropractors Union Research Fund, Foundation for the Advancement of Chiropractic Research, Denmark. University of Aarhus Research Foundation, Denmark (Other Financial/Material Support)
H. Bulent Uner, PhD - B36, G10, J5
Discloses no financial relationships with commercial entities.

V

Peter M. Vallone, PhD - B159
Qiagen, Fermentas Life Sciences, Takara Bio Inc., Applied Biosystems, Inc. (Discussion of Commercial Products or Services)
Peter Michael Vallone, PhD - W6
Discloses no financial relationships with commercial entities.
Andrew Van Es, PhD - B105, B176
Discloses no financial relationships with commercial entities.
Philip M. Van Praag, MS - C20
Discloses no financial relationships with commercial entities.
Francisco Velarde, MD - I24
Discloses no financial relationships with commercial entities.
John W. Verano, PhD - H116
Discloses no financial relationships with commercial entities.
Mool S. Verma, MS - B171
Denver Police Department (Employee)
Giovanna M. Vidoli, MSc - H106
Discloses no financial relationships with commercial entities.
Guido Viel, MD - G13
Discloses no financial relationships with commercial entities.
Bianca Vigil, MFS - H15
Discloses no financial relationships with commercial entities.
Mark D. Viner, MSc - D70
Discloses no financial relationships with commercial entities.
Richard W. Vorder Bruegge, PhD
Discloses no financial relationships with commercial entities - D75, W10
National Institute of Justice, FBI (Discussion of Commercial Products or Services) - D81
DAIS (Discussion of Unlabeled/Investigational Use of Product/Device) - D81
Sasha C. Voss, BSc - G73
Discloses no financial relationships with commercial entities.

W

Mark A. Walch, MPH
Federal Bureau of Investigation (Paid Consultant) - J8
Gannon Technologies Group (Discussion of Commercial Products or Services) - J4
Gannon Technologies Group (Employee)
FBI Laboratory (Paid Consultant)
Biometric Identification Tool (Discussion of Unlabeled/Investigational Use of Product/Device) - J4, J8
H. Chip Walls, BS - W9
Discloses no financial relationships with commercial entities - K47, W9
Agilent Techologies, JEOL (Discussion of Commercial Products or Services) - K53
Agilent Techologies (Other Financial/Material Support) - K53
Aaron R. Walters, MS - D36
Discloses no financial relationships with commercial entities.
Dennis Wang, PhD - B1
Applied Biosystems (Discussion of Commercial Products or Services)
Applied Biosystems (Employee)
Carley C. Ward, PhD - C10
Discloses no financial relationships with commercial entities.
Lauren A. Ware, BA - D44
Discloses no financial relationships with commercial entities.
Janet I. Warren, DSW - I13
National Institute of Justice (Grant Support)
Kevin A. Waters, BS - H9
Discloses no financial relationships with commercial entities.
Phillip L. Watson, PhD - G3
Discloses no financial relationships with commercial entities.
Cyril H. Wecht, MD, JD - BS6, ES1
Discloses no financial relationships with commercial entities.
Richard A. Weems, DMD, MS - F34
Imaging Sciences International (Discussion of Commercial Products or Services)
David Weinberg, JD - LW4
Discloses no financial relationships with commercial entities.
Robert Weinstock, MD - I2
Discloses no financial relationships with commercial entities.
Kurt D. Weiss, MS - C40
GM and Vetronix (Discussion of Commercial Products or Services)
Kristen Welch, MA - D1
Discloses no financial relationships with commercial entities.
William M. Welch II, JD - W20
Discloses no financial relationships with commercial entities.
Clyde A. Wells, MFS - W17
Discloses no financial relationships with commercial entities.
Heather Wert - B88
Discloses no financial relationships with commercial entities.
Roland Wessling, MSc - D42, H54
Inforce Foundation (Employee)
Carrie M. Whitcomb, MSFS - D28
Discloses no financial relationships with commercial entities.
Crystal Alana White - H11
Discloses no financial relationships with commercial entities.
Douglas White, MS - D32, D34
NIST, Apple Inc., Ruby Programming Language, Microsoft Corporation (Discussion of Commercial Products or Services) - D32, D34
NIST (Employee) - D32, D34
National Institute of Justice; (Other Financial/Material Support) - D32, D34, D35
Elizabeth Wictum, BS - B109
Discloses no financial relationships with commercial entities.
Jason M. Wiersema, PhD - H8
Discloses no financial relationships with commercial entities.

Guy Willems, PhD - F25
Discloses no financial relationships with commercial entities.
Anna Williams, PhD - D59, H30
Cranfield University (Employee)
David A. Williams, DDS - F18
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John A. Williams, PhD - H37
Discloses no financial relationships with commercial entities.
Joyce P. Williams, MFSA - D7
Discloses no financial relationships with commercial entities.
Karl E. Williams, MD, MPH - G39
Discloses no financial relationships with commercial entities.
Mary R. Williams, MS - B119
National Institute of Justice (Grant Support)
Philip N Williams, BS - D20, H19
Discloses no financial relationships with commercial entities.
Philip N. Williams, BS - D20
Federal Bureau of Investigation (Employee)
Shanna Williams, MA - W15
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Melinda K. Wilson, BA, BS - K19
University of Maryland, Baltimore (Grant Support)
Ruth E. Winecker, PhD - K48
Discloses no financial relationships with commercial entities.
Richard A. Winegar, PhD - B93
Biotage (Discussion of Commercial Products or Services)
Midwest Research Institute (Employee)
Eric S. Wisniewski, PhD - B149
Discloses no financial relationships with commercial entities.
Carl E. Wolf II, PhD - K66
Discloses no financial relationships with commercial entities.
Liqun Wong, MS - B69
Discloses no financial relationships with commercial entities.
Marnie Wood, MD - G23
Discloses no financial relationships with commercial entities.
Elaine Wooton, MFS - J29
Kubtec, MITUTOYO, Foster & Freeman (Discussion of Commercial Products or Services)
DHS Immigration and Customs Enforcement (Employee)
Diana M. Wright, PhD - W3
Federal Bureau of Investigation (Employee)
Franklin D. Wright, DMD - BS8
Fuji North America (Discussion of Commercial Products or Services)
UVIR Digital Camera (Discussion of Unlabeled/Investigational Use of Product/Device)
James Wright, MPA - I16
Threat Assessment Group, Inc. (Employee)
Susan Wright Clutter, MFS - B47
Virginia Fire Marshal Academy (Paid Consultant)

Y

John L. Young, MD - W23
Discloses no financial relationships with commercial entities.
Jorn Chi Chung Yu, PhD - B39
Sam Houston State University (Employee)

Z

Andrea Zaferes, BA - G95
Discloses no financial relationships with commercial entities.
Megan M. Zellner, BS - B43
Bonne Bell, Caboodles, L'Oreal, Maybelline, NYC, Revlon, Smackers (Discussion of Commercial Products or Services)
J. Robert Zettl, MPA - K43
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Xiang Zhang, MD - K8
Discloses no financial relationships with commercial entities.
Harry K. Zohn, DMD - F2
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SPECIAL SESSIONS

SS1 Incarcerations and Exonerations: The Key Role of the Forensic Sciences

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The crime scene has been processed. The scientific evidence is mounting. There stands one accused individual.

What evidence will connect the accused with the crime or free an innocent individual? Which pieces of evidence are significant to re-enact what transpired? Who will re-tell the story? While many individuals, ranging from the police and private investigators to the prosecuting and defense attorneys, will all be players in addressing these and other questions, none may be more influential than the forensic scientists assigned to the case. From the crime scene investigators to the forensic nurses to the physical and biological scientists, the story will take shape, the evidence will become insurmountable, and the accused will ultimately be incarcerated or exonerated.

Forensic scientists, by definition, are objective, non-advocates in crime scene, legal and medico-legal investigations. Each day throughout the world, dedicated, well-educated, and trained individuals apply their vocations in the pursuit of justice. Applying established and cutting-edge technologies, these scientific sleuths work toward one of the hallmark descriptors of science, i.e., "truth seeking." In a team-oriented fashion, each piece of a puzzle is developed and fit into the next until a scientific portrait has been developed. Based on these works of art, countless individuals have been rightly convicted or set free.

The American Academy of Forensic Sciences (AAFS) is fortunate to be the professional organization where the masters of forensic science in the United States and other parts of the world can interact; exchange ideas; perfect, improve and push forward their applied disciplines; and foster collegiality. Nowhere else will one find the cross-disciplinary practices within forensic sciences in a single forum. This year's Interdisciplinary Symposium draws on the expertise of these individuals, representing each of the sections comprising the Academy, to relate how their disciplines have been influential in the adjudication of cases, where the science was key for the proper investigation of a case or for a trier of fact to render a verdict.

The session will begin with independent presentations discussing the general role of the forensic sciences in society at large, as well as a judiciary view of the role of the forensic sciences. After this introduction, a representative from each section of the AAFS will present both general information about the section, as well as specific cases whereby their applied disciplines were significant in leading to an incarceration or exoneration of an individual(s). The program will end with the availability of the presenters for audience interaction through a question, answer, and comment period. Through the individual presentations and audience interaction, the key role of the forensic sciences in the meeting of justice will be fostered.

Incarceration, Exoneration, Forensic Sciences

SS2 Young Forensic Scientists Forum Special Session: Forensic Science in the Eyes of New and Experienced Scientists

Amanda K. Frohwein, BS, Iowa DCI Crime Lab, 2240 South Ankeny Boulevard, Ankeny, IA 50023; Jennifer W. Mercer, BS, 217 Clark Hall, West Virginia University, Morgantown, WV 26506; Jeannette M. Perr, PhD, 9641 SW 77 Avenue, #203D, Miami, FL 33156; Melissa E. Smith, BS, New York City Office of the Chief Medical Examiner, 520 First Avenue, New York, NY 10016; Jennifer M. Beach, BS, 244 Randolph Road, Apartment B, Morgantown, WV 26505; Arliss Dudley-Cash, BA, PO Box 918, Modesto, CA 95353; Robin Bowen, MA, 3040 University Avenue, Suite 3102, PO Box 6217, Morgantown, WV 26506-6217; Bruce A Goldberger, PhD, Department of Pathology, University of Florida College of Medicine, 4800 SW 35th Drive, Gainesville, FL 32608; Michael M. Baden, MD*, 15 West 53rd Street, Apartment #18B-C, New York, NY 10019; Marrah E. Lachowicz, MFS, 1809 South Street, #101-166, Sacramento, CA 95814; Linda Kenney Baden, JD*, 15 West 53 Street, Apartment 18 B/C, New York, NY 10019; Henry C. Lee, PhD*, Forensic Laboratory, 278 Colony Street, Meriden, CT 06451; Kathleen J. Reichs, PhD*, University of North Carolina - Charlotte, Department of Sociology & Anthropology, Charlotte, NC 28223; Natalie R. Shirley, MA*, University of Tennessee, Department of Anthropology, 250 South Stadium Hall, Knoxville, TN 37996; Dayle L. Hinman, BS*, Farrell & Associates, Inc., 3830 South Highway A-1-A, Suite 4, #200, Melbourne Beach, FL 32951; Lynn Kimsey, PhD*, University of California Davis, 1124 Academic Surge, Davis, CA 95616; Allison M. Curran, PhD*, MITRE, Corporation, 14101 Willard Road, Suite E, Chantilly, VA 20151; Robert H. Powers, PhD*, Connecticut Department of Public Safety, Controlled Substances/Toxicology Lab, 10 Clinton Street, 4th Floor, Hartford, CT 06424*

Throughout the past ten years the Young Forensic Scientists Forum has provided a program for a group of AAFS members ranging from students to professionals who are new to their careers in forensic science. The program has grown and changed drastically in order to provide students and scientists who have five years experience or less with the highest quality information possible. The continuing goal of this program is to provide the audience with topics relevant to their education, training, and skill levels. The event also provides a comfortable means for students and professionals with a venue in which they may communicate with experienced members and Fellows of the AAFS. The session planned for the AAFS 60th Anniversary Scientific Meeting in Washington, DC, focuses on the public role that forensic scientists play throughout their various careers with the theme "Forensic Science in the Public Eye." Speakers will provide insight into the behind the scenes "real world" forensic work that

is represented to the public through various media sources such as forensic science television shows, fictional novels, and high profile casework consultations. Following the day-long 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 event will allow young and emerging scientists to mingle with peers as well as established members of the AAFS in a comfortable setting.

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 with a CV/resume review and presentations by forensic scientists ranging in experience from entry level positions through supervisory/laboratory director level positions. These presenters will focus on a variety of topics relating to getting into the field and to the daily work of a forensic scientist, and will share their knowledge with participants through an open question and answer forum discussion.

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 provided 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 a career.

YFSF, Special, Session

ES1 Significant Avhievements and Contributions by Forensic Scientists to the International Community: Medical, Scientific, Legal, Societal, and Academic

Cyril H. Wecht, MD, JD, 1119 Penn Avenue, #404, Pittsburgh, PA 15222-4205; Henry C. Lee, PhD*, Forensic Laboratory, 278 Colony Street, Meriden, CT 06451; and Michael M. Baden, MD*, 15 West 53rd Street, #18B-C, New York, NY 10019*

The goal of this presentation is to inform AAFS members about the significance and importance of applying forensic scientific investigative principles on an international basis in order to stimulate and enhance educational, governmental, medical, legal, and forensic scientific programs and endeavors.

This presentation will impact the forensic science community by encouraging AAFS members and forensic scientists in other nations to utilize their professional expertise and experience on a broad international basis whenever appropriate opportunities are presented. Enhancement of academic programs, development of adequate technological facilities, application of scientific principles in the resolution of highly controversial governmental matters – all such efforts would contribute significantly to the pursuit of civil and criminal justice, as well as to the health, general welfare, and physical safety of people throughout the world.

In an era of dynamic, significant, and sometimes incredible technological discoveries that have truly revolutionized our daily lives, the overall field of forensic science has played a prominent role. The civil and criminal justice systems are relying more and more on forensic scientific analyses, reports, and testimony to adjudicate everything from child custody cases to homicides. To a great extent, matters that as recently as 20 years ago were determined in subjective interpretive fashion are now being analyzed and resolved in a far more objective and scientific manner by appropriate, well-trained, highly skilled experts.

From non-descript street crime to international homicidal poisoning; from elementary school introductory courses to post-graduate university programs; from simple photographs and charts to sophisticated re-creations of accidents and death scenes; from blind biopsies to virtual autopsies – all of these dramatic changes have occurred in only a quarter of our expected lifetimes. The forensic scientist is often the most important individual in all these endeavors, either as the originator of the investigative process, or as the professional person called upon to apply techniques from related medical and scientific fields.

As international geographic boundaries have become less provincial and more open insofar as the utilization of experts is concerned, the globalization of forensic science is evolving to an extent that few people would have ever predicted a generation ago. Whether the tasks involve identifying skeletal remains and determining the cause of death of massacred victims in a war-torn country or following natural disasters like Hurricane Katrina and tsunamis; investigating the deaths of civilians in Iraq when murder charges are filed against U.S. soldiers; assisting public health authorities and medical personnel in the epidemiological aspects of highly infectious disease processes in order to curtail or prevent further deaths; educating young physicians, scientists, attorneys, law enforcement officers, military personnel, and other groups about the ways in which their future professional activities can be enhanced and facilitated by the timely and appropriate use of various forensic scientists – there can be no doubt about the very important and significant ways in which the members of the American Academy of Forensic Sciences and its sister organizations in other countries throughout the world can make vital contributions to the health, well-being, and safety of society generally and in countless specific situations.

Educating young forensic scientist graduates; providing information about recent, sophisticated, and relevant developments to practicing colleagues; and advising academic, governmental, and private laboratory agencies regarding the need for expanded or new facilities are significant specific areas of emphasis for experienced forensic scientists functioning on an international level.

Criminal perpetrators identified and innocent people exculpated via DNA testing; unsuspected diseases determined by meticulous autopsies; acts of terrorism detected and investigated in timely fashion; emotional and mental health problems successfully dealt with through effective psychiatric intervention; attorneys, judges, and potential jurors educated in order to deal with legal issues in a more reasoned and educated fashion – all of these societal benefits, unrecognized and unappreciated as they may be at times, are accomplishments that we in the forensic science community can be justly proud of.

The speakers will discuss and illustrate numerous specific examples of these kinds of positive endeavors through presentations of their own professional experiences in the United States and in various other countries around the world. Important cases will be highlighted to demonstrate how forensic scientists have made significant contributions to modern day society. Within this context, the authors will describe how forensic scientists have played a key role in defusing potentially explosive national and international political controversies by objectively resolving emotionally-charged issues in highly publicized cases.

Globalization of Forensic Science, International Forensic Scientific Controversies, Development of Forensic Scientific Programs

ES2 Suitcase Man: The Investigation, Forensic Analysts, and Prosecution of a Homicide With Postmortem Dismemberment

Wendy M. Gunther, MD, Office of the Chief Medical Examiner, Tidewater District, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510-1046; and Steven A. Symes, PhD*, Mercyhurst Archaeological Institute, Mercyhurst College, 501 East 38th, Erie, PA 16546-0001*

After attending this presentation the attendee will understand the difficulties presented by postmortem dismemberment in investigation of a homicide with dispersal of remains in a different state without evidence of the locale of the crime. Attendees will comprehend the array and types of forensic evidence required; will appreciate the relative roles of forensic pathology and forensic anthropology in concluding that dismemberment occurred following death, without confounding the cause of death; and recognize and evaluate the challenges to prosecution presented by utilizing only circumstantial evidence in obtaining a conviction for homicide.

This presentation will impact the forensic science community by assisting forensic scientists and jurisprudence experts in evaluating how a complex case of homicide with postmortem dismemberment, unknown crime locale, decomposition, unsuspected drug involvement, ballistic evidence, and the need for questioned document analysis was investigated and prosecuted; increasing understanding the forensic work required in a case of dismemberment; comprehending evidence of antemortem versus postmortem dismemberment; and assisting forensic scientists and lawyers to understand the nature of a homicide prosecution based chiefly on circumstantial evidence.

The discovery of a suitcase floating in the Chesapeake Bay containing a pair of fresh human lower legs initiated investigation into a complex homicide which proved very difficult to resolve, and yet which concluded nearly three years later with a conviction for murder. The victim's body was recovered in three parts in a matched set of suitcases found by the Chesapeake Bay, each part in a different stage of decomposition (none, moderate, greater than moderate). The investigation was made more difficult by the absence of any indication of the locale in which the homicide was committed, and by no initial knowledge of the identification of the deceased. The broadcast of an artist's depiction of the decomposed face resulted in identification which caused the investigation to shift focus as well as investigating personnel from the state where the remains were found to the state in which the decedent lived and presumably died. The exact locale of the homicide was never definitively proven. Death was due to fatal gunshot wound injuries, making it likely that dismemberment was postmortem. However, there was a discrepancy between the time the decedent was last seen alive and the time the fresh parts were found, which after investigation suggested an unusual complication: that the decedent was alive but drugged unconscious with chloral hydrate for a period of hours to days before the fatal shots.

The investigation and prosecution of this case was hampered by the actions of the prime suspect which may have been the cause for the absence of evidence at the probable locale and the letters which occasioned the need for a questioned documents examiner. Prosecution was also hampered by the lack of direct evidence, with mostly circumstantial evidence remaining, and by the long time interval between the discovery of the body and the trial. Key pieces of evidence included the records of the gun shop where the weapon was purchased, telephone records, prescription records, EZ Pass records from the Atlantic City Expressway, Internet searches on the defendant's home computer (chloral hydrate, how to commit murder, undetectable poisons), chemical analysis of the garbage bags in which the body was found, and the presence of hairs in the suit cases that mitochondrial DNA analysis revealed matched both the defendant and the victim. It was this combination along with the forensic pathological and anthropological findings that made the evidence compelling.

This presentation describes the discovery of the parts of the individual initially known only as Suitcase Man, the autopsy, the identification, the investigation, the forensic anthropologic analysis, the results of ballistic and questioned document analysis as presented during the prosecution, and the evidence utilized by attorneys during the two month trial which resulted in conviction of the defendant.

Homicide, Dismemberment, Suitcase

BREAKFAST SEMINARS

BS1 Cracking the Zodiac Cipher

Daniel B. Olson, MSFS, FBI, 2501 Investigation Parkway, Quantico, VA 22135*

The goal of this presentation is to educate the audience regarding the cryptanalysis examinations conducted during the investigation of the infamous Zodiac serial killer.

This presentation will impact the forensic science community and/or humanity by educating the audience regarding the unsolved Zodiac ciphers, in hopes that a solution will some day be found.

The infamous Zodiac serial killer terrorized the San Francisco Bay area with a series of murders, letters to newspapers, and mysterious ciphers. The solution to the first cipher message eluded the best code breakers in law enforcement and the military only to eventually be broken by a husband and wife team of amateur cryptanalysts. The three ciphers that followed were never solved and remain on the "Top 10 Unsolved Ciphers" list at the FBI Laboratory's Cryptanalysis & Racketeering Unit. This interesting presentation will introduce the audience to the Zodiac ciphers, both solved and unsolved.

Zodiac, Cipher, Cryptanalysis

BS2 Managing in the Forensic Sciences: Practicalities & Politics

Elizabeth A. Laposata, MD, Forensic Pathology & Legal Medicine, 245 Waterman Street, Suite 100, Providence, RI 02906*

Attendees at this presentation will gain an understanding of some new managing principles and will be able to improve work effectiveness, both at an individual and organizational level.

This presentation will impact the forensic science community by providing knowledge of ways to improve management in forensic sciences which should translate into improved forensic services for the community.

A career in the forensic sciences involves not only mastering the subject matter of a discipline, but also working successfully in an environment that requires accountability, strategic-decision making, ethics in public relations, and the ability to influence supervisors and key policy makers.

Those in government are accountable for producing results. Designing and using outcome measures in work can provide hard data to show that programs and strategies are truly working. Alternatively, these measures warn of potential 'bad news' early on. One example of the successful use of outcome measures is the Compstat Process (computer comparison statistics) instituted by the NYPD in 1994. It is credited with slashing overall crime in New York City and is a mainstay of several successful government agencies.

However, good decision making is at the heart of successful strategies. Making good decisions is not a one time only event but is a continuous process. Producing a well tested decision involves setting up a process for generating multiple alternatives and fostering a robust exchange of ideas about those alternatives. Some common errors in decision-making involve biases such as the 'Prism Effect' of recalling only analogies that confirm present thinking and the 'Anchoring Effect' where the mind latches on to what worked out well in the past even if it worked out only by chance.

Ethical questions and dilemmas are also inherent in the public relations of forensic scientists. The ethical responsibility to be competent in the field is easily understood and accepted. However, recognizing core ethic issues in other work situations may be difficult. Several fundamental principles called the 'Public Relations Pillars' can help clarify and assess all sides of an ethical issue. Further, the 'Potter Box' is a decision making model that provides an organized approach to making defensible ethical decisions.

Finally, the results developed by accountability practices, sound decision making, and ethical analyses must be delivered to those who make policy such as supervisors, elected officials, or other stakeholders. Learning the concepts and language known as framing can help communicate ideas without attacking others. Being ready to make the most of a chance moment with a boss or lawmaker requires developing a message that cuts through the clutter, understanding potential biases, and knowing how to drive the message home.

Government, Management, Decision-Making

BS3 Human Identification in a Post 9/11 World: Attack on American Airlines Flight 77 and the Pentagon - Identification and Pathology

Craig T. Mallak, JD, MD, and Mark E. Shelly, DO, Armed Forces Medical Examiner's Office, 1413 Research Boulevard, Building 102, Rockville, MD 20850*

The goal of this presentation is to highlight the contributions of dentistry, anthropology, fingerprinting, DNA, and radiology. The presentation will then go inside the mortuary, showing every step in the identification process and explaining the rationale for the identifications and examinations.

This presentation will impact the forensic science community by providing an overview of forensic human identification, discussing the relative strengths and weaknesses of the various forms of presumptive and scientific human identification.

On September 11, 2001, American Airlines Flight 77 was hijacked by five terrorists as part of a coordinated attack on the United States that also involved the hijackings of American Airlines Flight 11 (which was flown into the North Tower of the World Trade Center), United Airlines Flight 175 (which was flown into the South Tower of the World Trade Center), and United Airlines Flight 93 (which crashed in a field in Shanksville, Pennsylvania). AA Flight 77 was intentionally crashed into the Pentagon, killing all 64 people on board the aircraft (terrorists, flight crew, and passengers) and 125 people (military and civilian) in the building. The fact that this was a terrorist attack targeting the nerve center of the U.S. Department of Defense made the identification and handling of the human remains significantly different than a "typical" mass disaster.

The responsibility to identify and autopsy each of the decedents fell to the Office of the Armed Forces Medical Examiner, part of the Armed Forces Institute of Pathology, headquartered in Washington, DC. All of the human remains, of which there were more than 2000 separate specimens, were moved to the U.S. Air Force Port Mortuary at Dover AFB, Delaware, for evaluation. There, a multidisciplinary team of pathologists, dentists, anthropologists, fingerprint specialists, radiologists, DNA technologists, photographers, morticians, and support personnel used a systematic, stepwise approach to ensure that every scientifically available method was utilized to maximize the number of victims that could be positively identified, re-associated, and returned to the families.

Following approximately two and one half weeks of remains processing and two months of DNA analysis, 183 unique identities were generated from the remains of those killed in the attack on the Pentagon, yielding 178 positive identifications. Some remains for each of the terrorists were recovered, as evidenced by five unique postmortem profiles that did not match any antemortem material provided by victims' families. No identifiable remains for five of the victims known to have been killed in the attack were recovered.

9/11, Mass Fatality, Terrorist Attack

BS4 Maximizing Forensics Advocacy: Making "I'm From the Government and I'm Here to Help..." Work

Peter M. Marone, MS, Department of Forensic Science, 700 North 5th Street, Richmond, VA 23219; Barry A.J. Fisher, MS, MBA*, Scientific Services Bureau, Los Angeles County Sheriff's Department, 2020 West Beverly Boulevard, Los Angeles, CA 90057-2401; Beth Lavach*, ELS & Associates, 208 East Duncan Avenue, Alexandria, VA 22301; and J.C. Upshaw Downs, MD, Georgia Bureau of Investigation, CRCL, 925A Mohawk Street, Savannah, GA 31419*

This seminar will familiarize attendees with the present state of forensics resources at the local, state, and national level; will introduce attendees to present ongoing advocacy efforts on behalf of the national forensics community; and will present proven successful advocacy methods.

By reviewing the needs and ongoing efforts on behalf of the forensics community, and by introducing attendees to proven successful advocacy methods, the active forensics practitioner will be able to achieve maximal benefit in challenging funding entities to better resource the forensic disciplines at the local, state, and national levels.

The nation's forensic science delivery system remains highly fragmented and in many, if not most or all areas, woefully under funded. Most forensic services are delivered primarily at the state and local level, leading some to question the level of the playing field from region to region. To this end, the National Academy of Sciences is involved in an in-depth study on "Identifying the Needs of the Forensic Sciences Community" which is specifically charged with evaluating the present and future resource needs of the forensic science community, to include state and local crime labs, medical examiners, and coroners.

The national situation is directly impacted by the local picture, as pointed out by former Speaker of the United States House of Representatives, Tip O'Neil, in demonstrating how Washington's actions are directly driven by the "folks back home" in the cities and counties, "All politics is local." The question for the forensics practitioner and/or administrator is then how to best make an apparent shortfall in lab resources matter to those who might be able to make a difference.

As scientists, forensic practitioners may be unfamiliar and/or uncomfortable with advocacy efforts, preferring to leave funding issues to those decision makers. The danger in passive acceptance by inaction is self-evident in the resourcing status of the nation's crime labs and medical examiner/coroner offices. Despite the tremendous and continuing public interest in forensics (as evidenced by the fact that two CSI shows remain in the 2007 annual top ten and two of the top three non-reality shows are forensic sciences features), the appropriations have failed to keep pace at local, state, and national levels.

A brief review of national advocacy efforts for forensics and the present status of this work will serve as an introduction. The majority of the session will be devoted to a "how to lobby" primer presented by a professional Washington lobbyist and former Congressional staffer and by active forensic practitioners. Useful tricks of the trade which have proven successful will be shared, including tips on how to get elected officials to at least hear a point of view. The ultimate goal by the end of the seminar will be to have attendees ready to meet with their respective Washington delegations in order to begin to make a difference.

Advocacy, Politics, CFSO

BS5 Bringing Forensic Science to the Battlefield: An Exploration of the Emergence of Forensic Techniques in Evaluating Evidence in Iraq and Afghanistan

Paul Shannon, MS, U.S. Embassy, Baghdad, DOJ/FBI/Legal Attache, Baghdad, IRAQ*

After attending this presentation, attendees will understand some of the forensic techniques being introduced into the military theater in the current wars in Iraq and Afghanistan.

This presentation will impact the forensic science community by providing specific information on several cases in which forensic science techniques have been used to identify individuals responsible for attacks on American troops, as well as crimes by our U.S. troops against the citizenry of the native people.

The speaker is a special agent with the Federal Bureau of Investigation with over 20 years experience and is a fingerprint examiner. He is currently stationed at the American Embassy in Baghdad where he is responsible for the oversight of the development and use of forensic techniques in identifying individuals involved in insurgent activity. He has worked a number of crime scenes in both Afghanistan and Iraq in the recent years.

Specializing in violent crime for most of his career, Mr. Shannon is extremely experienced in crime scene work. After 9/11, he initiated the FBI's known and suspected terrorist fingerprint database. In that capacity, he was the expert who fingerprinted Saddam Hussein after he was found and removed from his underground hiding place. He has conducted FBI missions in Afghanistan, Pakistan, the Philippines, Iraq, and numerous other venues. He initiated the process of trace evidence exploitation in combat theaters of terrorist devices such as Improvised Explosive Devices and car bombs. Mr. Shannon was the FBI detailee to the White House in 2005, and he currently is the FBI's Assistant Legal Attaché at the U.S. Embassy in Baghdad.

Although many of the mission activities of law enforcement and military overlap, historically, forensic techniques have not been used in combat theaters. Requirements by the military for rapid results of forensic studies have resulted in exceptionally quick turn around times, in terms of hours or a few days, even with DNA matching studies. The companies that provide equipment and reagents for the military operation have had to dramatically shorten the time in which results are available. In the near future, these reliable and quick techniques in standard law enforcement may be implemented in this country.

While rapid turn around has not been a feature of crime labs in the local and state law enforcement investigations, the techniques developed for the military theater will undoubtedly become more economic with passing time. A rapid turn around time will further accuracy of the investigations, enhancing the ability of investigators to follow the correct leads, providing more efficient use of resources. Hopefully, with an understanding of how the rapidity of the turnaround time is helpful, government leaders will be willing to appropriately fund the crime labs that are already in existence.

Iraq, Military, Forensics

BS6 Memorial Hospital Deaths (Hurricane Katrina) — Forensic, Medical, Legal, Ethical, and Societal Perspectives

Cyril H. Wecht, MD, JD, 1119 Penn Avenue, #404, Pittsburgh, PA 15222-4205*

This presentation will explore the medical principles; bioethical concepts; homicide statutes; other applicable guidelines and regulations concerning emergency healthcare.

A review and analysis of the Memorial Hospital deaths is a multi faceted study of humanity. The roles of various forensic scientists, physicians, and attorneys in the most dire extenuating circumstances of a life threatening nature must be intellectually understood and fully appreciated. This discussion will provide an appropriate and necessary background for the proper handling of similar situations in the future anywhere in the world.

Hurricane Katrina struck the New Orleans area late Sunday evening, August 28, producing an indescribable series of catastrophic events. Among the most seriously compromised situations were various healthcare facilities, especially those housing elderly patients with severe medical problems. With no water or electricity, a limited amount of food, and essentially no lines of direct communication with the outside world, most physicians and nurses sought refuge and left these institutions. Only a few remained behind. Dr. Anna Pou was such a courageous and caring physician at Memorial Hospital.

On Thursday morning, September 1, helicopters were hovering over the rooftop of Memorial Hospital, waiting to evacuate seriously ill patients, especially those on the seventh floor, a tenet-owned healthcare facility. Within a three and one half hour period that morning, nine patients suddenly died. All had been scheduled for evacuation that day.

Months later, the autopsy protocols and postmortem toxicology reports were reviewed. In each case, lethal levels of morphine were found in combination with Versed, and in some of the cases, other CNS-depressant drugs. The Louisiana Attorney General then filed charges against Dr. Pou and two nurses who were working with her that day. In March, 2006, the District Attorney of New Orleans convened a grand jury concerning these deaths. Five months later, on Tuesday, July 24, the grand jury concluded that no criminal charges should be filed against Dr. Pou. The two nurses had been granted immunity in exchange for their testimony.

The Attorney General had formally consulted several forensic scientists, each of whom agreed on the cause of death, acute combined drug toxicity. The forensic pathologists opined that the manner of death was homicide. Not one of the expert consultants was called to testify before the grand jury, nor was Dr. Pou.

What basic medical and legal principles should be applicable in this kind of situation? What are the ethical, moral, and societal considerations? Was justice served? Is special legislation required by the states and federal government for officially declared catastrophic emergencies that would permit medical personnel to engage in active euthanasia?

These questions and several other highly controversial and provocative issues relating to the Memorial Hospital deaths will be discussed and should be of significant relevance and pragmatic concern to forensic scientists, attorneys, and many other professionals throughout the world.

Memorial Hospital, Euthanasia, Homicide

BS7 The Parachute Case

Frederick H. Panhorst, MSM, and David A. Flohr, MSFS*, U.S. Army Criminal Investigation Laboratory, 4930 North 31st Street, Forest Park, GA 30297*

After attending the presentation, attendees will become more aware that television shows depicting crimes and the forensic sciences, even when based upon actual incidents, must take liberties in the interest of time and drama. True crime processing may make the actual case seem somewhat dull and uninteresting.

This presentation will impact the forensic science community and/or humanity by reinforcing the need for a multidisciplinary approach and communication between the investigators and forensic examiners.

On September 30, 2003, the CBS television show, *NCIS* broadcast its second show, "Hung Out to Dry." This episode depicted the death of a young U.S. Marine whose parachute failed to open, and the subsequent investigation and forensic work. It was based loosely upon an actual criminal case submitted by the Naval Criminal Investigative Service (NCIS) to the United States Criminal Investigation Laboratory (USACIL), in which no deaths occurred.

Although neither the NCIS nor USACIL have quite the talent or breadth of expertise as depicted by the special agents and laboratory examiner in the television show, the case was successfully investigated, examined, and prosecuted. Excerpts from the show will be presented, with a commentary of exactly what really happened. Of particular interest is the fact that the *NCIS* version depicts a multidisciplined forensic examiner working alone, while the examiners at USACIL were from the disciplines of trace evidence, firearms and tool marks, forensic documents, latent prints, and DNA. The USACIL examiners relied heavily upon other members of their discipline, interaction with each other, and the investigators. USACIL trace evidence examiners were able to point out a misconception of how the parachutes were tampered with, and the subsequent reorientation of the investigation. The aspect of dealing with a "limited population" and how it impacts on the investigation and the evidence submitted will be discussed.

Multidiscipline, Limited Population, Investigations

BS8 Thomas Krauss Memorial Bite Mark Breakfast: Current Developments in Photographic Technology for Bite Mark Documentation

Gregory S. Golden, DDS, 8577 Haven Avenue, Suite 105, Rancho Cucamonga, CA 91730; and Franklin D. Wright, DMD*, 1055 Nimitzview Drive, Cincinnati, OH 45230*

This presentation will inform attendees of current developments in photographic technology for bite mark documentation.

Attendees will take home a new understanding of available advanced photographic techniques.

Technological advances in digital photographic equipment and its applications to forensic investigation are continuously changing the state of the science. Attendees of this presentation will receive updated information on some of the most current digital cameras, lenses, and lighting options for advanced photographic techniques in forensic investigation with an emphasis on bite mark documentation.

The applications of Alternate Light Photography, Infra-Red, and Reflective Ultra-Violet techniques allow the forensic investigator to see details not only in bite mark and wound patterns, but also tattoos, questioned documents, and surveillance that would otherwise be unseen with the naked eye or with conventional color or black and white

photography. The impact of advanced photographic techniques is especially useful in the field of Injury Pattern Analysis, wherein bite mark investigation falls.

Previous digital camera chips (CCD and CMOS) were designed to filter out and block the UV and Infra-red ends of the non-visible spectrum. The authors have participated in the development of newly developed digital cameras designed for the forensic industry, as well as the fine arts. The authors will present recent personal photographic research completed with digital cameras that have been specifically modified by the manufacturer to capture images using non-visible wavelengths of the light spectrum. As more usage in the public and forensic domain becomes prevalent, it is anticipated that more applications for these cameras will be discovered.

Additional topics will include new forensic light sources available for Alternate Light and Infra-Red photography, quartz lenses, and accessories that will help facilitate the forensic photographer in accomplishing his work. The authors will also present casework wherein all of the aforementioned equipment has been employed to demonstrate the results of their research.

Bite Mark, Photography, Odontology

LUNCHEON SEMINARS

L1 "Crime Scene" Inside the World of Real CSIs

Connie M. Fletcher, PhD, Loyola University, 6525 North Sheridan Road, Chicago, IL 60626*

Blood, fluid, fiber, hair, tissue prints – every contact leaves a trace at a crime scene. Connie Fletcher will present what happens at the scene and in the crime lab, starting with discovery of the crime through criminal trial.

This presentation will take the audience into the world of the forensic experts through first hand stories. Through it all, one Sherlock Holmesian premise unites what they do and what it does to them: Every contact leaves a trace.

Real crime scene investigation is vastly more complicated, arduous, bizarre, and fascinating than televisions streamlined versions. Most people who work actual investigations will tell you that the science never lies – but people can. People may also contaminate evidence or not know what to look for in crime scenes that typically are far more chaotic and confusing, whether inside or outside than on television.

Forensic experts will tell you that the most important person entering a scene is the first responding officer – the chain of evidence starts with this officer and holds or breaks according to what gets stepped on, or over, collected or contaminated, looked past or looked over, from every person who enters or interprets the scene, to the crime lab, and all the way through to trial. Forensic experts will tell you the success of a case can depend on any one expert's knowledge of quirky things, including criminals' snacking habits at crime scenes; "Nature's Evidence Technicians." These include the birds and rodents that hide bits of bone, jewelry, and fabric in their nests; the botanical evidence found in criminals' pants cuffs; baseball caps as prime DNA repositories; the tales told by the application of physics to falling blood drops; and "The Rule of the First Victim." First-time criminals' tendency to strike close to work or home.

Discovery, Verdict, Crime Scene

L2 Prospective Risk Analysis of Health Care Serial Killers

Katherine Ramsland, PhD, DeSales University, 2755 Station Avenue, Center Valley, PA 18034; and Zachary R. Lysek, BA*, Northampton County, Coroner's Office, 669 Washington Street, Easton, PA 18042*

After attending this presentation, attendees will possess a useful list of behavioral red flags that provide a guide for documenting a potential health care serial killer (HCSK). Attendees will also learn how these offenders exploit hospital systems and will recognize the need for an institutional risk assessment plan.

This presentation will impact the forensic science community and humanity because it provides an analytical way to address a public danger. The recent studies devoted specifically to HCSKs list statistics and an analysis of their methods and motives.

Thus, it's possible to develop a risk assessment program with practical benefits for administrators of health-care facilities. This will in turn assist law enforcement personnel conducting an investigation and prosecutors who must take such cases to court. In addition, it provides a basis for criminologists to refine present understanding of this offender subtype.

A comprehensive analysis of confirmed cases of HCSKs to date offers a way to develop a pro-active approach to the problem of serial murder in health-care facilities. Such cases have increased in recent decades, and while investigations can be difficult, several studies provide a list of key traits and behaviors that can frame an assessment program for facility administrators who suspect they employ such a person. This list can also assist co-workers of such offenders and law enforcement officers who investigate them. The recent case of Charles Cullen provides a model.

In 2003, male nurse Charles Cullen voluntarily admitted that over the past 16 years in ten different health-care institutions in New Jersey and Pennsylvania, he intentionally took the lives of 30-40 patients. At the conclusion of a two-year investigation, including Cullen's review of 240 files, he had admitted to 29 murders and six attempted murders. Both authors had some degree of participation in this case, from before he was arrested to his detailed confession. Cullen's MO of manipulating drug records, working on quieter shifts, injecting patients who might not raise an alarm, and moving around from one facility to another is similar to that of other nurses convicted of multiple murder, including those from other countries. Thanks to professionals who have recognized that a health-care serial killer is a specific type of offender, and have collected information specific to their methods, it is now clear that certain personality traits and behaviors seen in these offenders during their crimes stand out. A checklist of the most common behaviors offers a practical tool for administrators, prosecutors, and investigators who might be involved in a future case.

Recognition of the possibility of a killer in a facility is the first step. Then it's important to know the signs. Among them is a statistically measured higher death rate when the suspected HCSK is on shift, unexpected clusters of deaths and unexpected symptoms for specific patients who have died, patient complaints about the suspected person's treatment, and macabre nicknames. While no single item is sufficient to place someone under suspicion, several in a constellation should be alarming. Among the red flags for spotting potential HCSKs are that the suspected person has moved around from one facility to another, is secretive, has a history of mental instability, has lied about personal information, and has a substance abuse problem.

Identifying offenders quickly requires documenting patterns of behavior and finding physical evidence that links a suspected individual to the crimes. People in key positions for spotting these offenders will benefit from a comparative analysis of prior cases.

Health-Care Serial Killer, Risk Assessment, Serial Murder

WORKSHOPS

W1 Transition Analysis: A New Approach to Skeletal Age Estimation for Anthropologists

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By the close of the workshop, participants will be familiar with the method, the computer program for generating age estimates, and the scoring procedure for recording age-related changes used in the program.

This presentation will impact the forensic science community by addressing several persistent problems with skeletal age estimation methods, including difficulties in determining the ages of people older than about 50 years and the need for estimates (i.e., confidence intervals) generated from the particular mix of skeletal characteristics displayed by individual skeletons.

Several persistent problems with skeletal age estimation are addressed by a newly developed method referred to as Transition Analysis. The procedure introduced here allows osteologists to determine the ages of older people (above 50 years old), to generate unique age estimates for each skeleton based on its individual mix of characteristics, and to combine in a quantitatively rigorous fashion different age-informative characters to produce a single estimate. The workshop covers the logic behind Transition Analysis, and presents the results of validation studies. A computer program for generating ages is demonstrated, and scoring procedures for newly defined age-related changes in the skeleton are described. By the end of the workshop, which has both lecture and demonstration components, attendees will be familiar with the method, the computer program, and the trait scoring procedure.

Transition Analysis is based on grossly observable age-progressive changes in the adult pelvis and cranium. Five parts, or "components," of the pubic symphysis and nine aspects of the sacroiliac joint area of the ilium are coded, as are five vault and facial sutures. The use of a component approach, as opposed to one based on anatomical units in their entirety (such as the overall appearance of the pubic symphyseal face), allows for a fuller description of morphological changes that occur in all of their complexity. Furthermore, it does not require that various parts of a single anatomical unit, such as the pubic symphysis, age in lockstep.

Age estimates, both confidence intervals and point estimates, are generated from multiple age-progressive (unidirectional) skeletal changes through the combination of likelihood curves for stages within the various pelvic components and cranial sutures. Estimates can be derived from both complete and incomplete sets of observations. That is, the method makes maximum use of whatever happens to be present, a requirement of forensic applications where much of the skeleton might be poorly preserved or missing.

Age-specific probabilities of transition from one stage to the next are derived from 686 known-age skeletons from collections in the United States and Portugal. Age estimates are based on likelihood curves for each stage in the various pelvic components and cranial sutures.

Age estimates are computed automatically by a Windows-based computer program using the component scores. To generate an age estimate, the user enters the skeletal data (as much as is observable), as well as the skeleton's sex and ancestry (white or black). The choice of prior distribution has an effect on skeletal age estimates, and the program provides users with three choices: uniform (non-informative); preindustrial (17th century Danish parish records), or modern homicide (United States CDC data).

Validation work shows that confidence intervals, in general, get wider in middle age, although the trend reverses in old age. Point (maximum likelihood) estimates correspond closely to actual age up to about 50 years, beyond which there is a considerable dispersion of points until about 80 years when the accuracy of estimates improves once again (confidence intervals are correspondingly narrower in the elderly). The choice of prior distribution has little noticeable effect on age estimates until the upper end of the lifespan is reached.

The present version of Transition Analysis yields age estimates ranging from the late teens to the maximum human lifespan. In the future, the basic approach can be extended to age-progressive changes in other parts of the adult skeleton. In fact, the validation work shows that more work by the osteological community is needed to define traits characteristic of the late 40s into the 70s.

Age Estimation, Human Skeleton, Transition Analysis

W2 Recovery, Examination, and Evidence of Decomposed and Skeletonized Bodies: An Anthropological and Entomological Approach

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Upon completion of this workshop, the participant should be able to recognize bioenvironmental evidence, properly collect and preserve such evidence, and record supplementary data required for later analyses.

Successful interpretations of various types of forensic evidence are crucial to the solution of most death investigations. Sound analyses of bioenvironmental evidence from outdoor scenes are dependent on proper collection and preservation. This workshop will impact the forensic community by providing the necessary background for these activities.

One of the most challenging cases faced by any forensic scientist or investigator is that of the badly decomposed or skeletonized body. It is a common misconception that such remains, in particular those discovered outdoors in a field or wooded area, provide little useful information concerning the circumstances of death. However, through the applications of the techniques from the fields of anthropology and entomology, combined with pathology, significant data can be obtained. The outdoor death scene is quite unique, as the remains and associated evidence can be viewed as temporary alterations to the ecology of the immediate area. Methods and techniques for the recognition of the "bioenvironmental evidence" will be presented during this workshop. The body in an outdoor situation is exposed to a number of often unpredictable events that will serve to complicate the recovery process. The worker must be familiar with the various changes that take place during the decomposition process and the manner in which climatic factors may serve to alter both the rates of decomposition and the gross appearance of the remains. During this workshop, the changes that take place to the remains from the fresh stage

of decomposition through complete skeletonization will be presented. In like manner, the materials available to the forensic pathologist from a body recovered during the mid to later stages of decomposition will differ from what might be available from remains discovered indoors under more controlled conditions. Techniques employed to obtain the maximum data from these remains will be presented. In an outdoor scene and in many indoor scenes, insects and other arthropods are major factors in the alteration and decomposition of the body. Insect invasion of a dead body in an outdoor habitat often begins within minutes following death and continues past the point at which grossly observable changes to the body take place. By analyses of these organisms and their activities, valuable information can be gleaned concerning the circumstances of death. In order to successfully use this information, the insects must be recognized, collected and properly preserved. The use of insects to provide an estimate of the period of time since death or postmortem interval will be discussed and illustrated. This will be done through a series of case studies, beginning with cases having postmortem intervals ranging from days to months and finally years. The techniques employed differ depending on the stage of decomposition involved and these will be discussed. Also presented will be the use of insects in determining postmortem movement of the body, wound assessment, as sources for DNA, as alternate specimens for toxicological analyses, and as indicators of the crime scene habitat. Additionally, there has recently been an increase in the cases of insects as evidence in cases of abuse and neglect involving infants and the elderly. These cases often involve the phenomenon of myiasis or feeding by maggots on living tissues as well as feeding by ants and cockroaches. Dealing with these cases requires knowledge of the species involved and their life cycles. Basic to the use of entomological evidence is the proper collection and preservation of the specimens. If this is not done properly, the data become useless. During this workshop, the participants will learn simple but effective techniques for the collection, preservation and documentation of entomological evidence. This workshop is designed to be presented at an intermediate level, with an overview of anthropological and entomological techniques, followed by recent advances in these areas of research. Each participant will receive a manual covering the materials presented.

Decomposition, Entomology, Anthropology

W3 International Forensic Automotive Paint Data Query (PDQ)

Diana M. Wright, PhD, Federal Bureau of Investigation, FBI Laboratory Division, Chemistry Unit, Room 4220, 2501 Investigation Parkway, Quantico, VA 22135; Denis Lafleche*, Royal Canadian Mounted Police, 15707 - 118th Avenue, Edmonton T5V 1B7, Alberta , CANADA; and Andria L. Hobbs, MSFS*, Federal Bureau of Investigation Laboratory, 2501 Investigation Parkway, Chemistry Unit, Room 4220, Quantico, VA 22135*

Upon completion of this workshop, the participant should be able to effectively utilize the Paint Data Query program for three distinctly purposes: (1) generating potential manufacturer, make, model, assembly plant, and year information for questioned paint recovered from items collected from hit-and-run incidents, (2) conducting a significance assessment for paints from known-to-questioned comparisons that may then be used to lend weight to that evidence in court, and, (3) maintaining and enhancing professional expertise and understanding of automotive paint systems as a result of having a searchable database that support more that 15 000 paint systems and contains pigment/binder information and infrared spectra for over 55 000 individual paint layers.

This presentation, along with regular submissions to the database, will impact the forensic science community by granting attendees the ability to participate in the Paint Data Query program, thereby allowing them to conduct effective make-model-year automotive paint searches for investigative lead information.

For more than thirty years, the Royal Canadian Mounted Police (RCMP) has been gathering chemical and color information on automotive paints. Beginning in the 1970's, systems for classifying, storing and receiving that data for manufacturer, make, assembly plant, and year determination were developed by the Royal Canadian Mounted Police. PDQ is the most recent PC - Windows based version of the RCMP's automotive paint classification system for domestic and foreign (Australia/New Zealand, Japan and European) vehicle coatings. PDQ is not a population database but a representative database. As such, it is used as a tool to present the paint examiner with possible sources for a paint system based on a searchable text based query program. The number of samples, which an examiner would then have to compare in order to affect a manufacturer, make, model, assembly plant, and year determination, is reduced to those which most closely match the chemistry, color, and/or source information that were utilized for the query. The RCMP and/or the FBI maintain the original paint samples. As necessary, sample splits may be obtained for a side-by-side examination and comparison with a questioned paint.

The PDQ workshop is designed to be a hands-on training session in which the attendees will receive instruction in the organization of the database, will practice classifying paint systems, will enter queries into PDQ, and will gain the basic interpretive skills necessary for evaluating the results obtained from a search. Having an understanding of the program and confidence in the query parameters entered, the paint examiner will be able to provide an accurate assessment of possible sources for a questioned paint, utilize the database for making significant assessments for paints in K/Q comparative situations, and utilize the database for maintaining their understanding of the structure and chemistry of modern automotive paints. Prior training and practical experience in paint analysis and FTIR (Fourier transform infrared spectroscopy) paint examinations and classifications are required.

Attendees wishing to keep PDQ must be from a recognized police agency, sign a non-disclosure confidentiality agreement upon registration, and agree to annually contribute 60 original full layer automotive paint samples to the PDQ Maintenance Team for analysis and inclusion into the database. In addition, each attendee should bring a laptop computer with the following minimum requirements: Pentium with WIN95, CD-ROM, 64 MB RAM and 50 MB free HD space. Finally, full utilization of PDQ requires the purchase or acquisition of a spectral search software such as Bio-Rad Sadtler SearchMaster/Know-it-All or a Galactic Spectral ID software, dye glossy and matte Munsell Color books and Refinish Paint books (i.e., Dupont or Pittsburgh Paint Group...). These items are not provided with the workshop.

Paint Data Query (PDQ), Automotive Paint Database, Hit-and-Run Vehicle Identification

W4 Analysis of Police Officer Use of Force Deaths: A Multidisciplinary Approach

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The goals of this workshop are to provide attendees with a multidisciplinary view of several issues involved in police-associated deaths; to review appropriate and acceptable use of force in contrast to excessive force; to discuss investigative techniques to facilitate the

investigation of such cases; and to discuss case scenarios where force was used.

This presentation will impact the forensic science community by exposing attendees to law enforcement training in the use of force as well as medical and legal perspectives on the appropriateness of the application of such force and subsequent investigation and legal resolution. In so doing, the attendee will gain insight and be better positioned to work on any such cases under their jurisdiction.

Given that an officer's sworn duty is to protect the citizens served, fatalities involving police agencies can create significant community concerns including appropriateness of the act and possible alternatives. Deaths involving the use of force by law enforcement officers can be among the most emotionally charged cases worked by a forensics professional. Practitioners in all disciplines – and on both sides – can expect to have their work and judgments highly scrutinized and potentially presented in a most unflattering light. The irony is self-evident in that when police use of force (PUF) is employed, and particularly in lethal scenarios, the time available to the officer in making a use/don't use decision is usually minimal. The luxury of hindsight is unavailable in the heat of a conflict.

Using a multidisciplinary approach, including law enforcement, forensic pathologists, and legal perspectives, to review the fundamentals of PUF cases culminating in case scenarios, the panel will challenge the audience to consider appropriateness and extent of possible casework and testimony in such cases.

The Law Enforcement Perspective: "Hindsight is good, foresight is better…." — Evan Esar.

The basics of training provided to officers is reviewed, including available force options, including impact weapons, less-lethal technologies, and firearms. The primary focus of the discussion will be on officer-involved shootings. The question of prime import in a PUF case review, from the agency's perspective, is the objective reasonableness standard – that is "was this a justifiable act" in the eyes of a reasonable person? Eye-witness accounts often stir the pot of controversy in PUF cases, with allegations replacing substantive proof. T hus, perception is a key element in seeking truth.

The Medicolegal Perspective: As the final observer of an individual decedent, the medical examiner is (hopefully) in the best position to determine the true cause and manner of death. Some might question if medical examiners are too willing to attribute deaths during PUF to excited delirium, positional asphyxia, or cocaine overdose. Likewise, much concern has been raised over the use of electro-muscular disruption devices and attribution of death due to their use. In-custody deaths (whether suicide or due to natural disease) can likewise become controversial and litigious, requiring (at least in some instances) a considerable skill set to end at an amicable resolution satisfying to all parties. Finally, the relationship between forensic scientists and police agencies has caused some concern regarding potential real or perceived conspiracy. The various modalities are reviewed from the perspective of the medical examiner, who is ideally intended to be a neutral party.

The Legal Perspective: In the legal arena, the difference between civil and criminal and burdens of proof can be dramatic. "Competing" experts may express profound differences of opinion – posing a potential dilemma when both experts are well-qualified. Furthermore, some skeptics allege practitioners on the "fringe" may say almost anything, if the price is right.

An International Perspective: The United States is not unique in encountering allegations of excessive PUF resulting in death. An overview of the nature of the problem in the United Kingdom is presented, including their process for investigating custody deaths (coroner's inquests and the role of the Independent Police Complaints Commission). Finally, the effects on the Human Rights Act and the European Charter on Human Rights on the scope of PUF case investigations with examples of recent case law will be discussed.

Case Studies: Police custody related deaths are often viewed by the community as code for "excessive force" or "acceptance of discriminatory practices." Utilizing a case study format, several deaths at the hands of law enforcement personnel resulting in high profile media coverage and civil litigation are presented from a civil plaintiff's point of view with multidisciplinary panel and audience.

Law Enforcement, Force, Death

W5 The Applications of Color Analysis and Light Theory in the Forensic Examination of Documents

Joseph Stephens, MSFS, Danna Bicknell, MSFS*, and Gerald M. LaPorte, MSFS*, United States Secret Service, 950 H Street, NW, Washington, DC 20223; Ted M. Burkes, BS, FBI Laboratory, 2501 Investigation Parkway, Room 2158, Quantico, VA 22135; and Bridgette T. Frost, MFS, FBI Laboratory, 2501 Investigation Parkway, Questioned Documents Unit, Quantico, VA 22135*

The objective of this workshop is to enhance the ability of the forensic document examiner to utilize color and light analyses to gain the maximum information possible in the examination of evidence.

The workshop will impact the forensic science community by providing participants with additional theoretical knowledge in the areas of light and color theory. As a result, attendees will have a better understanding of these topics when applied to forensic document examinations.

The analysis of color and the applications of light theory are powerful tools available to the forensic scientist to utilize in the examination of evidence. The use of color and light can be a principle component in isolating properties of specimens, in better visualizing regions of interest in a document, in elucidating characteristics of a sample that may otherwise go undetected, and in distinguishing items of evidence from one another.

A discussion of the applications of color analysis in the forensic examination of documents will be presented in workshop format. The objective of this workshop is to enhance the ability of the forensic document examiner to utilize color and light analyses to gain the maximum information possible in the examination of evidence. Topics covered will include principles of color theory; specifically how humans perceive color, the components and properties of color, as well as methods for its measurement and quantification. Concepts such as light sources, illuminants, modes of measurement, color scales, and the effect the object and observer have upon the perception of color will all be discussed.

Instrumentation commonly utilized by the forensic document examiner will be explored, including the Video Spectral Comparator from Foster & Freeman, UV/VIS spectrophotometers, and polarized light microscopy, along with newer techniques such as hyperspectral contrast imaging. Rudimentary systems will be constructed to better illustrate concepts and to enhance visualization and understanding of the mechanics of these instruments. Software packages commonly utilized in these analyses, such as Adobe Photoshop, will be examined, with particular emphasis on the capabilities and limitations of these programs for the forensic document examiner. Practical problems will be presented, allowing for participants to apply the principles taught in the workshop to real-world examples. Finally, the impact of these examinations and the conclusions that can be rendered from these analyses will be discussed.

Questioned Documents, Color, Light

W6 Human DNA Quantification Using Real-Time PCR Assays

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The goal of this presentation is to familiarize workshop attendees with the fundamentals of qPCR theory and analysis/interpretation of results. The workshop will provide a forum to discuss qPCR techniques and how qPCR assays can be best utilized in a forensic laboratory. The information presented will assist attendees in understanding how the assays were validated within a laboratory. This workshop is intended for current users as well as those considering qPCR as a method for DNA quantitation.

This workshop will impact the forensic science community by providing an opportunity for attendees to be exposed to various forensic qPCR assays. Information presented in the presentation will impart validation experience to the forensic community. The program will also provide an opportunity to present specific questions about qPCR assays and how confidence in results can affect workflow decisions.

Over the past few years many forensic laboratories have migrated to the method of quantitative real time PCR (qPCR) to determine sample DNA concentrations. Successful multiplex STR (short tandem repeat) amplification requires a specific range of input DNA. Quantitation is an essential step in the process of STR typing as well as other downstream forensic applications. qPCR methods can provide a rapid and robust means for determining the amount of DNA in an extract. Specialized qPCR assays can provide additional information as to the extent of sample degradation and presence of inhibitors.

The basics of quantitative real time PCR will be covered in direct relation to forensic DNA analysis. Various qPCR assays for quantifying human nuclear (total and male specific) and mitochondrial DNA will be discussed. A general overview of real time PCR instrumentation will also be presented. Theory and practical implementation of qPCR assays in a forensic lab will be discussed. In addition to the quantitation of human DNA, real-time PCR can be applied to a number of forensically useful examinations. Assays will be presented which assess the degree of degradation, provide SNP (single nucleotide polymorphism) screening, detect mRNA for tissue determination and determine if a DNA extract is of human origin. There will be a general focus on assay design, data analysis, troubleshooting, and general validation issues in the presentations.

The attendees will receive an overview of qPCR methods in a forensic context. The discussion of various unique qPCR assays will be covered. The goal is to familiarize workshop attendees with the fundamentals of qPCR theory and analysis/interpretation of results. The workshop will provide a forum to discuss qPCR techniques and how qPCR assays can be best utilized in a forensic laboratory. The information presented will assist attendees in understanding how the assays were validated within a laboratory. This workshop is intended for current users as well as those considering qPCR as a method for DNA quantitation.

Topics include:

- Instrumentation
- Fundamentals of PCR (in relation to qPCR)
- Chemistry of assays
- Data curve analysis
- Proper use of a calibrant DNA material
- Application of qPCR assays in a forensic workflow
- Total human, mitochondrial DNA and Y specific assays
- Inhibition and degradation
- General troubleshooting and validation

The above topics will be covered in varying degrees as applicable in each of the speaker presentations.

This program will provide an opportunity for attendees to be exposed to various forensic qPCR assays. The workshop is intended to provide useful information to practitioners of qPCR methods. Information presented in the presentation will impart validation experience to the forensic community. The program will also provide an opportunity to present specific questions about qPCR assays and how confidence in results can affect workflow decisions.

Real-Time PCR, DNA Quantitation, qPCR

W7 Sex-Related Homicide Investigation: Significance of Pornography, Signature Analysis and Modus Operandi

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After attending this presentation, attendees will understand the role of fantasy in sex-related murders; be able to collect and preserve physical evidence in sex-related death investigations; be able to determine the M.O. and Signature characteristics at crimes scenes left by sex-murderers; and be able to understand the follow-up investigative procedures involved in rape, sodomy, lust murder, and serial murder investigations.

Based on the experience and education of the two presenters, the forensic community will benefit and be better informed of the proper procedures for investigating sex-related murder cases.

The Practical Homicide Investigation® and Sex-Related Murder Workshop will expand upon last year's workshop entitled "Practical Homicide Investigation." In the 2008 workshop, Commander Vernon Geberth and Dr. Robert Keppel will integrate and illustrate the tactics, procedures and forensic techniques of practical homicide investigation to the investigation of sex-related murders. For homicide detectives, the book Practical Homicide Investigation® has been recognized as the benchmark and "Best Practice" model for professional death investigation. Contained within are protocols for detectives to follow in dealing with various types of death investigation. Now, the presenters will focus more narrowly on the often-troubling sex-related investigations. After experiencing the first workshop section, attendees will understand the investigative significance of fantasy in sex-related murders and procedures involved in the collection and preservation of physical evidence in sex-related death investigations. Following that presentation, a historical review of *Modus Operandi* and Signature cases and analysis procedures for determining the M.O. and signature characteristics of sex-murderers will take place. Specifically, follow-up investigative techniques will be given regarding rape, sodomy, lust murders, and serial murder investigations. And finally, a discussion will take place where the audience of attendees may ask questions of the presenters. The overall goal of the workshop is to provide comprehensive and practical information that will serve as an investigative guide to the investigation of sex-related murders as well as serial homicide.

Sex-Related Murder, Significance of Fantasy, Signature and M.O.

W8 Current Topics in Pediatric Forensic Medicine: Beyond Abusive Head Trauma

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The goal of this workshop is to present new information and reinforce existing knowledge regarding deaths occurring in the pediatric age group other than those due to abusive head trauma of the shaken-impact type. Upon completion of this workshop the participant will have a better understanding of investigation of these deaths including those which occur related to birth injury and neonaticide, homicidal asphyxia, accidental asphyxia (and recognition of unsafe sleep environments), the roulettes (Russian and suffocation), and natural diseases which are difficult to diagnose at routine autopsy alone (metabolic disorders and cardiac channelopathies). In addition the participant will have an understanding of the ways that fractures can be demonstrated and evaluated postmortem. Understanding the differences between pediatric patients and adults regarding metabolism of drugs and the significance of these differences in prescribing and hopefully in preventing death is also a goal. Finally the participant will recognize the importance of adequate death investigation in cases of potentially inheritable natural disease in the hope of preventing other deaths, as well as the preventive role of screening for some inherited disorders at birth and prior to participation in athletics.

The presentation of this workshop will impact the forensic science community by focusing attention on the area of pediatric forensic medicine and the importance of thorough investigation of these deaths not only for the appropriate classification of the cause and manner of death, but for complete documentation of injuries which may provide information about the circumstances surrounding the death and possible contributory mechanisms. In addition, recognition of risk factors in some of these deaths may aid in the prevention of future deaths. These include recognition of factors which may result in birth trauma and neonaticide (including characteristics of the perpetrators), recognition of unsafe environments which place a child in danger of accidental death including unsafe sleep environment, self inflicted injuries, and natural disease with hereditary components. Recognition of these factors may lead to policy changes designed to positively impact public health by preventing future injuries and deaths.

Deaths in the pediatric age group (less than 18 years of age) represent a significant number of the cases that any death investigation system is required to accept and investigate. Many of these are due to intentionally inflicted injury at the hands of another person (homicide) often due to head injury. While much research and many lectures have been dedicated to abusive head injury particularly of the shaken-impact type, these cases are but one of the many types which are placed in the hands of the forensic pathologist and death investigator for proper evaluation and certification. Deaths in the pediatric age group begin with birth and continue through late adolescence. This workshop will address a variety of these deaths beginning with birth trauma, followed by a discussion of neonaticide and maternal filicide and will continue with presentations on deaths related to asphyxia with topics including unsafe sleep environments, accidental asphyxia of various causes and homicidal asphyxia. More overt evidence of child abuse will be addressed in lectures on burns and cutaneous evidence of injury as well as postmortem detection and evaluation of fractures using multiple methods including radiography, gross examination and histology. Information regarding investigation of deaths in older children and adolescents including Russian roulette and suffocation roulette (or the "Choking game") will be provided. Discussion of deaths due to natural disease which may be difficult or impossible to diagnose by autopsy alone such as various metabolic disorders and inherited arrhythmias will be included. Metabolic defects primarily those in the beta oxidation of fatty acids have been known to produce disease in humans for over 20 years now and many states are including tests for these defects in the newborn screening which will also be briefly discussed. Diagnosis of inherited arrhythmias which have no morphologic correlate obviously are impossible based upon routine autopsy alone; however, postmortem testing is now available though costly. Discussion of these disorders particularly the cardiac channelopathies including the importance of recognition will be included in this program. Possible alternatives to postmortem testing, counseling recommendations and the increasing role of preparticipation screening in athletics will also be briefly addressed. Some of these inherited arrhythmias may be simulated or exacerbated by certain drugs. Drug related deaths in the pediatric age group are potentially preventable, as many of the aforementioned deaths are, and the program will conclude with a lecture on pediatric toxicology. Emphasis on the difference between children and adults regarding drug metabolism, etc. may provide insight into some cases of drug-related pediatric deaths and possible prevention of these in the future.

Pediatric Forensic Medicine, Screening, Death Prevention

W9 Chemstation® Productivity Workshop

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This program is a "hands-on" course using laptops pre-loaded with Chemstation® software so that participants can follow along with the instructor. This workshop is designed to assist existing gas chromatography/mass spectrometry (GC/MS) operators maximize performance and data quality in the forensic and toxicology laboratory.

This presentation will impact toxicology and all other fields conducting GC/MS analysis by providing operators with a better understanding of the software tools that they rely upon in order to maximize sample throughput and ensure data quality.

Introduction: In high throughput laboratory environments, it is often difficult for operators to find the time to refresh their knowledge about the instrumental and software tools that they rely upon or to learn new tricks/tips that could result in faster results or better data quality. Additionally, this training, which must often be purchased from the instrument manufacturer, can be costly particularly if travel is involved. This workshop will provide both a review of basic GC/MS Chemstation operation along with more advanced topics.

The morning of the workshop will focus on topics such as:

- Creating a method including appropriate GC parameters including split, splitless, pulsed and ramped flows, and appropriate MS parameters including scan, selected ion monitoring, electron multiplier voltage, threshold and a/d (analogue to digital).
- Setting up *Sequence Tables* and importing sequences using Excel.xls and comma separated variable files.
- *Data Analysis* manipulation of data files including integration, extracted ions, obtaining spectra, library searching, overlays and labeling.
- Building a *Quant* data base including appropriate ion selection, integration parameters, and use of *EasyID* and *QEdit* to update the method and review results.
- Processing individual data files against the method and review/troubleshoot their integrity.

- Batch sample processing using the *Dolist* command/function and *Runmethod*.
- Basic report generation
- Creating user libraries

The afternoon session will address more advanced ChemStation topics such as:

- Custom reporting capabilities including creation of *Target* style reports
- Building calibration curves for loading dual signals i.e. using an FID (flame ionization detection) or NPD (nitrogen phosphorus detection) in tandem with an MS detector.
- Automated *SIM/Scan* setup using an existing quant database and demonstrating quantitation on single or both signals. Explanation of how *SIM/Scan* works.
- Benefits and setup of *Retention Time Locking* with presentations of maintaining the same retention time across multiple instruments and with column maintenance.
- Introduction to *Drug Quant* features which is included in Chemstaion.
- Data deconvolution and library searching using combined Chemstation, AMDIS (Automated Mass Spectral Deconvolution and Identification System) and NIST (National Institute of Standards and Technology) software.
- Execution of macros including command driven, menu insertion, custom addon.mac, custom deuser.mac and use of the "hammers"
- The use of the *Method Translator* which is a user contributed software which allows one to obtain parameters to convert a method to a faster method.

Method: This workshop is a hands-on course. Laptops are provided, pre-loaded with Chemstation software, and example macros and data files so that participants can follow along with the instructor.

Chemstation®, Productivity, GC, GCMS

W10 Image Processing and Image Comparison

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Upon completion of this workshop, the participant will have a better understanding of how to incorporate proper procedures for handling image and video evidence into their law enforcement activities. Participants will have an introduction to the principles of photographic comparison of images and have hands on practice performing basic comparisons. Participants will also be provided with guidelines for image processing and how to document those processes.

This presentation will impact the forensic science community by providing an overview techniques used in Forensic Image Analysis. Images and video are more abundant than ever before and law enforcement is dealing with this upsurge of image evidence, including digital image files, analog video, digital video, film negatives, etc. Such evidence is intrinsic to law enforcement today. Crime scenes, suspects, and evidence are photographed to document steps in an investigation. Surveillance images are seized and processed in order to reconstruct events and help identify criminals. Some images, such as latent print photographs, are processed and then analyzed to individualize suspects. Analyses conducted on these images are frequently crucial to the successful completion of an investigation. Many of these images, and their analyses, ultimately find their way into the courtroom for use at trial.

Once images and videos have been acquired in an investigation, they must be processed and analyzed to produce results meaningful to an investigation. Topics of forensic image analysis include photographic comparison, which involves comparisons between the depicted content of images or between the depicted content of images and items of physical evidence, and image enhancement (i.e., image processing). Attendees will learn about forensic image analysis and the range of analyses it encompasses. An overview of the principles of photographic comparison will be discussed.

Guidelines for image processing have been developed by the Scientific Working Group on Imaging Technology (SWGIT). Attendees will learn about SWGIT's recommendations regarding what sort of processing steps are most useful in a forensic setting and how to document those steps. These "Best Practices," serve to ensure that the testimony offered by imaging experts is supported by practices as rigorous as those applied in other forensic disciplines.

The use of image processing in the analysis of patterned injury of the skin, with emphasis on child abuse and as an aid in image analysis in forensic pathology, will be discussed. The interpretation and recognition of image processing artifacts and image quality issues in forensic pathologic evaluation will be demonstrated.

Biometrics is a buzzword in forensics today. These automated means of recognizing an individual by their characteristics and behavior have proved beneficial with fingerprints in law enforcement, but the recognition of individuals by their faces or ears for use in court is still a manual task done by photographic comparison. Facial comparison and the specific issues associated with comparing humans will be discussed. Additionally, attendees will learn about the specifics of ear comparisons and the uniqueness of the human ear.

Similarly, photographic comparisons of objects will be reviewed and numerous case examples will be demonstrated. Attendees will receive hands on practice performing basic object and person comparisons.

Another type of photographic comparison involves comparing a camera with images possibly taken by that camera. The ability to associate images with a specific camera, camera model, or even manufacturer is a valuable tool in forensic science in cases such as homicide, kidnappings, and child abuse. An example of such a case, and the techniques used, will be demonstrated.

Statistics are important in photographic comparisons and allow a practitioner to assign numerical probabilities to their results. One type of comparison that lends itself to statistical analysis involves analysis of patterned clothing. Specifically, the comparison of a questioned camouflage garment with a known one can lead to the individualization of such clothes. A method that has been developed to determine the statistical uniqueness of a camouflage article of clothing will be presented.

Lastly, a summary of forensic image analysis will be presented including reference materials and sources for further investigation.

Imaging, Image Processing, Digital Evidence

W11 Forensic Toxicology: A Historical Perspective

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The goal of this workshop is to provide an overview of the history and development of forensic toxicology, particularly postmortem forensic toxicology, forensic urine drug testing, and human performance forensic toxicology.

This workshop will impact the forensic sciences by instructing new and veteran forensic scientists regarding the development of the field of forensic toxicology.

The workshop will provide an overview of the field of forensic toxicology and how it has evolved to its current state. Topics will include the history and development of postmortem forensic toxicology, forensic urine drug testing, and human performance forensic toxicology.

All three disciplines have developed with the goal to provide quality analytical results and supportive expert testimony in the judicial system. This workshop will not only address the unique histories of these disciplines, but also the initial challenges that have led to universal standard of practices among all three disciplines. The use of chain-of-custody and a dual-testing methodology (*i.e.*, confirmation of all positive screening results by a more specific methodology) are commonplace today, but it is interesting to see what the standard practices once were and how we have progressed to our current standards.

Postmortem forensic toxicology is the oldest of the three disciplines with a primary role of aiding forensic pathologists in the determination of cause and manner of death. Forensic urine drug testing, also called workplace drug testing, was instituted in the United States in the early 1970's by the military in order to address growing concerns of drug use and its affect on combat preparedness. Since then, many other workplace environments have adopted drug-free policies in both the public and private sector. Human performance forensic toxicology, also known as behavioral toxicology, helps assess the influence of drugs on behavioral changes. The most common example is the deleterious effect of ethanol on driving performance. More recently, programs have been designed to address the dangers associated with behavioral changes due to other psychoactive drugs and their effects on driving and other tasks.

Forensic toxicologists have a wealth of information and technology at their fingertips. The advent of capillary chromatography interfaced with mass spectrometry and tandem mass spectrometry has facilitated drug and drug metabolite detection to picogram and femtogram limits. Methods for the detection of drugs and toxins in hair, sweat, and saliva are becoming routine. But how were these achievements accomplished? This workshop hopes to instruct both the novice and veteran toxicologist regarding the challenges facing forensic toxicologists and the subsequent need for sophisticated analytical methodology.

Before sophisticated equipment like tandem mass spectrometry was available, how were drugs and toxins analyzed? This workshop aims to inform toxicologists about previous methodology and the associated pros and cons. The idea of analyzing 20 milliliters of blood for one drug is a concept that was at one time required and now totally foreign. The ingenuity of forensic toxicologists allowed for comprehensive analyses without advanced technology. This ingenuity brought with it multiple detection methods and analytical protocols.

Even with the most accurate and precise results obtained with the most sophisticated instrumentation, proper interpretation of these results can only be accomplished by an expert familiar with this field. The speakers presenting at this workshop were chosen due to their wealth of knowledge of forensic toxicology. This workshop intends to instruct the attendee regarding problems faced when interpreting analytical data, as well as the intricacies of courtroom testimony.

Postmortem Forensic Toxicology, Human Performance Forensic Toxicology, Workplace Drug Testing

W12 Angst or Ecstasy: Consulting/Expert Witness Compensation

Gil Sapir, JD, MSc, PO Box 6950, Chicago, IL 60680; Bruce M. Lyons, JD*, 600 North East 3rd Avenue, Fort Lauderdale, FL 33304; and Ann Murphy, BS*, Sacramento County District Attorney Crime Lab, 4800 Broadway, Suite 200, Sacramento, CA 95820*

The workshop furnishes simple, effective, utilitarian methods of obtaining compensation without angst, aggravation or agitation for rendered consulting expert services. Upon completion of this workshop, attendees should have a practical knowledge of predicaments and situations usually encountered in attempting to collect fees from principals and attorneys. Practical skills for the consultant's mental and financial self-preservation, including establishing a mutually beneficial professional relationship, will be discussed.

The workshop will impact the forensic community by facilitating productive professional relationships through mutuality and financial compensation, based upon proven practical and effective methods of payment for consulting and testimonial experts. The overall result is better preparation, increased harmony, less animosity and a reduction in potential lawsuits to collect unpaid fees.

Cardinal business requirements of being an expert witness, including maintaining proper records, establishing the basis for compensation, factors in determining fees, charging for services, preparing a services contract and billing statements are integrally explained. Fee schedules, service contracts, engagement letters, work-product protection, agency relationships, business standards, handling of funds, financial prudence, accounting methods, billing, and compliance with legal and evidentiary standards will be reviewed. Fundamentals of contract law and collection practices (including filing a civil complaint on one's own behalf) are essential subjects. For example, ensuring fee collection where the consultant or expert witness, and not the client, resides is a primary consideration. Relevant established legal methods and skills for getting paid without hiring an attorney will be addressed.

Should a law suit ensue and the quantity or quality of the person's work is questioned, preparing to establish services rendered and its value is important. Appropriate means of proving performed work without succumbing to potential blunt trauma or a vivisection on cross examination will be provided. "Failure to prepare is a preparing to fail." - John Wooden.

The workshop is applicable to both novice and experienced occupational expert witnesses. Reference and source material including sample documentation will be distributed.

Expert Witness, Compensation, Fees

W13 A Day of S & M (Stamps & Money - What Were You Thinking?)

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The goal of this workshop is to provide informative behind-the-scenes tours for forensic document examiners at two Washington, D.C. landmarks: The Bureau of Engraving and Printing and the Smithsonian Institution's National Postal Museum.

These guided tours will impact the forensic science community by educating forensic document examiners in the methods of printing and quality assurance procedures utilized in the production of US currency and the history and forensic value of documentary evidence associated with the US mail. This training will enhance a document examiner's knowledge of a variety of security printing methods, historical dating milestones in postal documentation, and forensic examinations of mailed documents.

Attendees will enjoy a full day of guided tours of the Bureau of Engraving and Printing (BEP) and the Smithsonian Institution's National Postal Museum. These tours will be geared specifically toward the interest of forensic document examiners. At both locations, document examiners will be divided into small groups to allow for a better learning environment. At the BEP, forensic document examiners will take a "floor tour" and get up close and personal with the physical printing and quality assurance procedures for printing US currency. At the National Postal Museum, forensic document examiners will receive an interpretative tour of the history of stamps, envelopes, and other postal elements, as well as a look at the forensic role in investigations by the United States Postal Inspectors.

At the BEP, document examiners will see millions of dollars being printed while they walk through the various steps of currency production that begins with large, blank sheets of paper and ending with wallet-ready bills (sorry, no samples allowed). As the U.S. Government's security printer, the BEP is responsible for the design, engraving, and printing of all US paper currency. The BEP was established in 1862 and moved to its present site in 1914. Currency production methods have changed drastically since its opening, when just six people separated and sealed notes by hand in the basement of the Treasury building. Though the BEP currently utilizes some 21st century printing, production, and examining technologies, their engravers continue to use the same traditional tools that have been used for over 125 years – the graver, the burnisher, and the hand-held glass. The element of the mission of the BEP is to design and manufacture high quality security documents that deter counterfeiting. The BEP's practices and procedures in producing security documents will assist forensic document examiners in making determinations regarding document authenticity.

The National Postal Museum features exciting interactive exhibits about postal history and stamp collecting. The museum was created by an agreement between the Smithsonian Institution and the United States Postal Service in 1990 and opened to the public in 1993. The National Postal Museum is divided into galleries that explore America's postal history from colonial times to the present. The museum has exhibits displaying how the mail is transported, the importance of letters, and spotlighting the creation and wondrous diversity of postage stamps. Document examiners will be guided by the museum's very knowledgeable educational staff through the museum's exhibits and collections of stamps, envelope making machines, and caches. Mail connects families and friends, businesses and customers, government and citizens, as well as scam artists and criminals. The mail is used every day to carry information, goods, and valuables into our homes and offices and, unfortunately, is used to carry weapons of mass destruction, threatening letters, and terrorist communications. For that reason mail often ends up under the microscope of the forensic document examiner. One exhibit that will be of special interest to document examiners will be "Postal Inspectors: The Silent Service." This exhibit is a spotlight on one of the oldest federal law enforcement agencies and its role in fighting crime, from the earliest days of our nation to today. The forensic document examiner will learn about important postal history milestones, which could be crucial in dating documents, and gain greater insight into the role of forensic science in protecting the mail and the postal system.

Engraving, Printing, Stamps

W14 Postmortem Toxicology: Interpretation of Drug Concentrations in Hair

Christine Moore, PhD, Immunalysis Corporation, 829 Towne Center Drive, Pomona, CA 91767; Timothy P. Rohrig, PhD*, Sedgwick County Regional Forensic Science Center, 1109 North Minneapolis Street, Wichita, KS 67214; Daniel S. Isenschmid, PhD*, Wayne County Medical Examiner's Office, 1300 East Warren Avenue, Detroit, MI 48207; Laureen Marinetti, PhD*, Montgomery County Coroner's Office, Miami Valley Regional Crime Lab, 361 West Third Street, Dayton, OH 45402; and Susan Paterson, PhD*, Imperial College London, Division of Investigative Science, Charing Cross Campus, St. Dunstan's Road, London, W6 8RP, UNITED KINGDOM*

After attending this workshop, the attendees will be able to screen postmortem hair specimens for multiple drugs; be able to confirm specific drugs in hair using bench-top instrumentation; observe the correlation between standard toxicology results and drug concentration in hair specimens using multiple cases from different postmortem laboratories; and understand how simple analysis of hair specimens can help in the interpretation of autopsy cases and understand how routine hair testing is being incorporated into postmortem testing in some laboratories.

This workshop will impact the community by offering a different perspective on the analysis of hair specimens collected at autopsy.

Traditionally, forensic toxicology involves the analysis of drugs and poisons in biological fluids, such as blood, bile, urine, vitreous humor and/or tissues, such as liver, heart, etc., taken at autopsy, and the interpretation of the concentrations detected as they relate to a cause of death. The identification and quantitation of toxic chemicals and their metabolites in biological specimens must continually evolve so that laboratories can meet challenges presented by newer drugs and matrices that require increasingly lower thresholds for detection. In this workshop, five speakers will discuss and present practical applications for the testing of hair as well as standard biological tissues in autopsy materials, and discuss whether or not the analysis of hair may be useful in some postmortem situations.

The introduction by Dr. Timothy Rohrig, will discuss prescription drugs for pain management, the development of tolerance to these medications, and mechanisms by which such high concentrations of these drugs can be incorporated into hair samples. After the presentation, attendees will understand the development of tolerance to pain drugs.

The second presentation, by Dr. Christine Moore, will then focus on the practical nature of analysis including the use of enzyme linked immunosorbent assay (ELISA), solid phase extraction and chromatographic bench-top mass spectral confirmatory assays for the detection of a wide range of drugs in hair, with specific emphasis on ease of implementation into a laboratory setting. After the presentation, the attendees will be able to screen postmortem hair specimens for multiple drugs and be able to confirm specific drugs in hair using standard bench-top gas chromatography or liquid chromatography coupled to mass spectral instrumentation.

Dr. Daniel Isenschmid (Wayne County Coroner's Office) and Dr. Laureen Marinetti (Montgomery County Coroner's Office) will then present actual case samples where routine toxicology of standard specimens was carried out in addition to hair analysis. The results will be presented, and the utility of the hair results to provide helpful information with cause of death interpretation will be discussed. After these

presentations, the attendee will be able to observe the correlation, if any, between standard toxicology results and drug concentration in hair specimens using multiple cases from two different postmortem laboratories. Further, attendees will understand the extent to which some drugs incorporate well into hair.

The final presentation by Dr. Susan Paterson will further extend the range of drugs, which can be detected in postmortem hair samples. Dr. Paterson will report on their laboratory's on-going analysis of samples. Specifically, how their pathologists have used, and continue to use, hair analysis results in order to interpret other toxicological findings. Attendees will understand how simple analysis of hair specimens can help in the interpretation of autopsy cases and how routine hair testing is being incorporated into postmortem testing in some laboratories.

The focus of this workshop is to explore the practicalities of testing postmortem hair, and the situations where results may be useful in helping with cause-of-death interpretation.

Autopsy Samples, Hair Specimens, Pain Management Drugs

W15 Measurements, Statistics, Terminology, and Quantitative Methods: Uses and Interpretations in Physical/Forensic Anthropology

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The goal of these presentations is introduce and reacquaint the participants to the use linear and 3-D measurements, quantitative methods, statistics and its associated nomenclature in the practice of forensic anthropology. The goal is also to provide a brief background of current methods such as linear vs. quadratic discriminant function their use and possible misuse. Importantly, how do these analyses and others and the subsequent reporting of results affect *Frye, Daubert*, and accreditation processes.

This workshop will impact the forensic science community by providing the participant with current views on the proper or appropriate use of statistics, terminology and their impact on day to day reporting of results.

The use of quantitative statistical methods in physical and forensic anthropology has grown from simple indices describing limb proportions, body size and other uni-dimensional differences to multi-variable analyses of variance and deriving linear and quadratic multi-discriminant formulae. This trend toward ever increasing complexity requires a reasonable background in basic probability theory to advanced or specialized knowledge in population biology. Qualitative or non-metric approaches have an equally long history and have been employed by physical anthropologists to examine character states primarily between groups to maximize their similarity or dissimilarity. More recently, the exploration and integration of 3-D data into standard analyses of human craniometric variation for research has become commonplace in laboratory practice and issues have arisen as to repeatability and error for these measures as they may be applied in the forensic arena.

In light of the advent and employment of new statistical methodologies, both metric and non-metric, in forensic anthropology; opportunities for laboratory accreditation; and the prevalence of *Daubert* and *Frye* hearings, it is critical to revisit the theory underlying each of these techniques. Such an examination will allow a review of the original meaning and application of terminology that may or may not currently be used appropriately. Specifically, common, but possibly misunderstood nomenclature will be appraised such as 'test', 'probability', 'significance', 'discrimination', 'likelihood', 'identification', 'error', 'power', 'variance', 'accuracy', 'precision', and 'correlation' to clarify their meaning using data sets and methods frequently used in forensic anthropological research and case reports. Additionally, the issue of 'uncertainty of measurement' will be addressed, how it is reported, how should it be reported, and what are the current National Institute of Standards and Technology (NIST) recommendations. Moreover, there will be a review and demonstration regarding 'how to measure' by defining linear measures and revisiting standard practice. Each topic presented will incorporate these concepts throughout and stress the importance of not only 'what do the results mean' but how to appropriate apply them and to recognized their limitations. It is hoped that by reviewing the strengths and weaknesses of each technique in its historic and current context a better understanding of proper use will be attained and that potential misapplication of these methods will be avoided.

Statistics, Terminology, Accreditation

W16 DNA Mixture Interpretation: Principles and Practice in Component Deconvolution and Statistical Analysis

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The goal of this workshop is to teach participants the basic principles behind DNA mixture interpretation and then work through multiple mixture examples manually and with computer programs.

As forensic DNA scientists try to get information from difficult samples that are degraded or diminished in amount, they are faced with results that are often challenging to interpret. Mixtures and partial profiles are becoming more common as investigators increasingly request analysis of evidence from burglaries or touch evidence. Examples will be worked illustrating the statistical approaches used following mixture deconvolution. The status of software solutions for mixture interpretation will be examined.

DNA mixture interpretation represents an important and time-consuming aspect of forensic DNA casework analysis. This presentation will impact the forensic science community by helping participants gain a better understanding of the principles used to solve DNA mixtures, and the subsequent reporting of results.

Mixtures exist when two or more individuals contribute to the biological evidence being analyzed. The ratio of the components as well as the total amount of DNA available and alleles present makes deconvolution of mixture contributors challenging at best in many situations. The International Society of Forensic Genetics (ISFG) has issued nine recommendations covering basic principles for mixture interpretation. The principles in ISFG recommendations will be reviewed and discussed in the context of specific examples. In addition, different statistical approaches for

mixture interpretation and reporting including probabilities of exclusion and likelihood ratios will be compared and contrasted. This workshop will cover the basics of mixture interpretation, statistical analysis with worked examples, a review of available software tools for mixture analysis, suggestions for preparing interpretation guidelines, and advice on training analysts to consistently interpret DNA mixtures.

DNA Mixture, Short Tandem Repeat, Statistical Analysis

W17 Documentation, Collection and Examination of Fabric Impressions

Ted R. Schwartz, MS, Westchester County, Forensic Lab, 10 Dana Road, Valhalla, NY 10595; and Clyde A. Wells, MFS*, and Donald Doller, BS*, Suffolk County Crime Lab, 487 North County Complex, Veterans Highway, Hauppauge, NY 11787*

The goal of this workshop is to teach attendees the necessary information and techniques needed to successfully examine fabric impressions.

This workshop will impact the forensic sciences by making more crime scene investigators and forensic scientists aware of fabric impressions, which are frequently overlooked at the crime scene and in the laboratory.

Fabric impressions are produced when textile materials come in contact with various surfaces. They can be observed in dust or blood at a crime scene or as indentations on various surfaces of a hit and run vehicle. They are often overlooked and sometimes mistaken for footwear or friction ridge impressions. Because they are produced by textile materials, knowledge of weave and knit patterns is essential to understanding and analyzing fabric impressions.

This workshop will cover several important aspects of fabric impressions:

- How fabric impressions are produced and where they are typically encountered
- Fabric construction
- The detection, documentation, enhancement and collection of fabric impressions at the scene and in the laboratory
- Class and individual characteristics; manufacturing considerations
- The production of test impressions
- Comparison techniques

The workshop will consist of lectures, demonstrations, and hands-on exercises.

Impressions, Fabric, Workshop

W18 Truth and Deception: An Overview of the Theoretical Basis for and the Empirical Support of Emerging Technologies and New Approaches in the Research of the Defense Academy for Credibility Assessment

Frank Horvath, PhD, U.S. Department of Defense, Defense Academy for Credibility Assessment, 7540 Pickens Avenue, Fort Jackson, SC 29207; John R. Schwartz, MPA, United States Department of Justice, PO Box 53509, Houston, TX 77052; and Troy Brown, PhD*, Andrew Dollins, PhD*, Dean Pollina, PhD*, and John W. Denver, PhD*, U.S. Department of Defense, Defense Academy for Credibility Assessment, 7540 Pickens Avenue, Fort Jackson, SC 29207*

Upon completion of this workshop attendees, whether forensic scientists or not, will have a better understanding of the potential for forensic application of the range of new and emerging technologies applied to the problem of "lie detection." The technologies and approaches to be considered will include those which have been or are now included in the research program of the Defense Academy for Credibility Assessment (DACA).

"Lie detection" in one form or another is a fundamental feature in criminal investigations, forensic interviews, judicial proceedings and many other human endeavors. Technologies to standardize this process and to make it scientific, objective, and accurate have been widely publicized and over emphasized relative to what can be supported by scientific methods. This workshop will impact the forensic science community by addressing issues that will help attendees to sort fact from fiction in credibility assessment and it will make them aware of scientific, legal and ethical concerns that have been raised in regard to this field.

Early in 2007, the Department of Defense Polygraph Institute (DoDPI) was officially renamed the Defense Academy for Credibility Assessment (DACA). Although the DACA is still responsible for the initial and continuing education of all polygraph examiners in all federal agencies, the name change is a more accurate reflection of the research activities and interests which have for many years been carried out at and through DoDPI, and now DACA. DACA is the principal federal organization in which most research on credibility assessment is being conducted. In this workshop participants will learn about the ongoing research at DACA, especially in regard to emerging credibility assessment techniques and technologies as they apply to the interests of the forensic science community. There have been several recent evaluations of the research in this area. One of most prominent of these reviews, carried out by the National Research Council of the National Academy of Sciences, focused almost exclusively on polygraph testing as it is applied in screening situations involving both employees and applicants. However, examining alternatives to the polygraph was also a key component of that group's charge and for that reason there was commentary on alternative approaches in forensic contexts, particularly when they are used in investigations of specific, known events, such as a criminal offense. There were two conclusions by this group of special relevance: (1) "…in populations of examinees such as those represented in the polygraph research literature, untrained in countermeasures, specific-incident polygraph tests can discriminate lying from truth-telling at rates well above chance, though well below perfection," and (2) "Some potential alternatives to the polygraph show promise, but none has yet been shown to outperform the polygraph. None shows any promise of supplanting the polygraph for screening purposes in the near term." The difficult methodological and other problems facing researchers in this field are evident or implied in these two conclusions. For example, all current approaches are susceptible to countermeasures, deliberate efforts to defeat the testing. Moreover, the psychological state, i.e., emotion or cognition, that underlies the basis for either current or emerging technologies, is unclear. In this workshop, therefore, participants will learn about these problems and how they have been and are being addressed in the research at DACA. In addition, specific attention will be given to these concerns as they relate to the state of the art in emerging technologies. A staff member of the DACA Research Division, will present an overview of the extant research in each of these areas: Event-Related Potentials (ERPs), Brain imaging techniques (fMRI), Thermal imaging, Laser Doppler Vibrometry (LDV), Eye Tracking (Eye Movement Memory Assessment) and Vocal Analysis ("Voice Stress Analysis"). Time permitting, there will an overview of DACA's interests in research on interviewing and interrogation. In all cases, there will be particular attention devoted to the use of these methods and technologies for forensic purposes. In the discussion session following the formal presentations, the research agenda for DACA for the next three to seven years will be offered; participant input and commentary on the agenda will be welcomed.

Lie Detection, Deception, Polygraphy

W19 "The Devil is in the Details," Homicide Investigations, Trial Preparation, and Testimony

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The goal of this workshop is to enhance the skills, observation and thoroughness of personnel associated with a homicide investigation, and improve their ability to effectively testify at trial.

This presentation will impact the forensic community by providing attendees with a better understanding of how to be more thorough in observing the unseen evidence in homicide investigations, and enhancing courtroom skills.

This workshop focuses on working unresolved homicide scenes, preparing for trial, and testifying in court. The authors are going to present numerous murder cases from around the United States and Canada where evidence was evasive and overlooked until further investigation was conducted. The evidence involves DNA, blood patterns, bullet trajectories, pathology, and knowledge of many other disciplines necessary for reconstructing a homicide where minute details can surface and change the course of the investigation. After an arrest, the role of the investigator will be addressed as to trial preparation and proper courtroom testimony. Role playing from previous courtroom trials will be conducted to better illustrate what jurors need to see. Mock trial testimony will be conducted with pre-selected attendees.

The presentation will serve as a training model for first responders, crime scene technicians, detectives, attorneys, pathologists, and any person affiliated with crime scenes and subsequent trial work. The cases presented will provide more insight into thoroughness and observation techniques based upon experience at scenes. Some of the cases will be high profile in nature. Investigative teamwork involving various disciplines will be shown in the cases demonstrating that "more minds working together is smarter than one working alone." The experiences shared in working unresolved homicides will aid in working current or future homicides.

Demonstrative evidence used in some of the trials will be on display and exhibited as interactive participation with the attendees.

Unresolved investigations require a common-sense approach to a most frustrating task. Because high stress often negates the observance and awareness of important details, it is imperative that the investigator condition himself/herself to respond in a precise, thorough, and organized manner. The investigator must be cognizant of all aspects of major crime investigations, and activate all senses simultaneously in order to not overlook any details that might in any way affect the outcome and final disposition of the case. Unresolved homicides can be especially difficult to work and need observation skills for success.

The unresolved investigation workshop is a comprehensive compilation of skills, techniques, and functions that, when applied appropriately, will result in case evidence that has a much better potential of withstanding the rigors of the modern day trial and justice process.

There is a great deal of emphasis on observation and deduction skills that will enable the investigator to conduct a well coordinated and technically accurate investigation. These skills, when coupled with highly tuned intuitive ability, can prove to be invaluable in the criminal justice process and to the profession as well.

Interpretation of bloodstain patterns can also have a tremendous impact on the outcome of a homicide case. Reevaluation of bloodstains in old and unresolved cases can provide enough evidence to reconsider whether or not to prosecute. Cases involving blood spatter analysis will be emphasized, along with exhibits to demonstrate the numerous patterns which can be encountered at crime scenes.

Bloodstain patterns lend themselves to geometric interpretation whereby it is often possible to predict their origin and mechanism of production. This information may well have significant value when patterns are examined by investigators familiar with evidence of this type.

This workshop focuses on overall crime scene interpretation and reconstruction and will acquaint the attendee with observation techniques and skills at violent crime scenes that affect solvability. Once solved and trial is to occur, the attendees will learn from an experienced trial lawyer how to properly prepare for trial. Matters that seem trivial, such as proper attire and demeanor in and outside the courtroom, will be addressed. Communication delivery with effectiveness and clarity will be demonstrated with mock examination of a witness utilizing an actual case. Both direct and cross-examination examples will be demonstrated to round out the day's presentation from investigation to trial.

Homicides, Evidence, Testimony

W20 The Healthcare Serial Killer: Prevention, Investigation, and Prosecution Strategies

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Upon completion of this workshop, attendees will have an increased awareness of the complexity involved in this unique type of investigation. Implications and special challenges for forensic scientists and front line clinicians, healthcare managers and administrators, and local law enforcement will be addressed. Strengths and weaknesses in healthcare delivery systems will be highlighted as they were identified throughout each investigation. Specific challenges faced by forensic investigators and law enforcement will be explored. And lastly, the strategy for successful prosecution in a court of law will be discussed including the particular challenges posed by specific defense arguments for these individuals.

This workshop will impact the forensic community as well as healthcare delivery systems by increasing awareness of the dynamics associated with serial murder committed by patient care providers in these environments. By dissecting two cases that both resulted in convictions but were processed differently, the attendee will have increased knowledge of how to overcome barriers associated with investigations if this type and what multidisciplinary contributions are required for a successful outcome.

The purpose of this workshop is to compare and contrast two high profile cases in which healthcare providers were convicted of serial murder of patients. Serial murder committed by healthcare professionals within the healthcare environment present unique and difficult challenges for investigators. murder investigations of this type are far from traditional and require a multidisciplinary approach. The roles and responsibilities of healthcare administrators, direct patient care providers, licensed professional regulatory boards, law enforcement and forensic scientists overlap in these cases. It is crucial that each discipline recognize specific contributions that can be made both in prevention strategies as well as active investigations to ensure that justice is achieved.

The individuals directly involved in the reporting, investigation and prosecution of Kristen Gilbert and Vicki Dawn Jackson will present

specific challenges and lessons learned from each perspective including: issues involved in initial reporting by co-workers and the difficulties associated with first coming forward to middle management with these serious allegations; issues related to medical/forensic evidence management by patient care providers before the case is opened (when coworkers suspect foul play and begin taking notes, monitoring medication supplies, gathering of data in preparation to report); getting an investigation of this type opened; crucial contributions of forensically trained clinicians in bridging the gap between the healthcare environment and the criminal justice system; complications that arise due to reluctance of administrators and regulatory boards to communicate or cooperate with investigators; identifying and obtaining forensic evidence during the official investigation and the non-traditional methods required to do this; the lack of forensically trained clinicians available to review many volumes of patient medical records and or interpret other healthcare related equipment or systems; determining whether exhumation would be helpful; getting approval for exhumation and related difficulties with follow up lab work and evidence processing; difficulties with processing the degraded physical evidence from exhumed bodies; difficulties of interpreting results from the analysis of exhumed tissue samples; the need for chemicals tests to be developed for the analysis of suspect chemicals in unique matrices (i.e., embalmed or putrefied remains); the prosecution strengths and weaknesses; defense strengths and weakness; the pros and cons of investigating/ prosecuting this type of case in the private healthcare sector vs. the public (federal) sector such as the Veterans Healthcare Administration; reflections and comments from a criminal behavioral analyst about another high profile convicted health care serial killer, Charles Cullen.

Forensic Science, Healthcare Professionals, Serial Murder

W21 The Impact of Confirmational Bias and Context Effect on Report Writing in the Forensic Science Laboratory

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The learning objective of this workshop is twofold: to present the opinions of forensic scientists and attorneys on the effects of Confirmational Bias and Context Effect on decision making processes in the laboratory; and to discuss what effect these factor might have in influencing how the results of forensic science examinations are documented in reports.

This presentation will impact the forensic science community by making forensic scientists aware of ways to maximize the probability that outside influences not enter into decision making processes, and that the scientifically and legally correct verbiage is chosen in preparing reports of analysis.

There are a number of important issues which have been discussed over the past few years that impact the manner in which the results of forensic science examinations are documented and communicated. This workshop will consist of two parts: Part A will deal with the impact (perceived or real) of context effect and confirmational bias on the decision making processes of the forensic examiner. Part B will deal with report writing in the forensic science laboratory. The manner in which the forensic examiner formulates a conclusion will impact how that conclusion is documented in a report and testified to in court.

For the purposes of this discussion, it is important to define terms. "Context Effect" (CE) is the influence of factors outside the scope of the data on a forensic analyst's cognitive thought processes.

"Confirmational Bias" (CB) is the tendency to test a hypothesis by looking for instances that confirm it rather than by searching for potentially falsifying factors.

Are these concepts real, or are CE and CB used as a last resort to explain a conclusion when the options available in the adversarial system of the courtroom fail to impeach an expert witness? Perhaps the answer lies somewhere in between. How should forensic examiners deal with the possibility of both CE and CB entering into their thought processes? How should forensic examiners deal with the accusations that CE and CB have impacted the choice of words in formulating and documenting a conclusion?

Once the analysis is complete and the data has been evaluated, what are the parameters the examiner must consider in documenting the report of analysis? Writing the report and formulating the conclusion are critical. The choice of words both in the laboratory when the report is written, and in the courtroom when the conclusion is stated to the jury, is crucial. Should standards exist related to how conclusions can be verbalized? In the past, and in some laboratories still today, the examiner will document the conclusion somewhere between both ends of the spectrum of absolutes. At one end of the spectrum lies the conclusion that the two samples originated from the same source to the exclusion of all other sources. At the other end of the spectrum lies the conclusion that the samples could not have originated from the same source. In between are hybrids and non-descript terms such as "could have originated" and "scientifically indistinguishable." What are the acceptable terms which should be used in documenting the results of a forensic science examination? In a criminal trial, do the same requirements apply to both sides of the aisle when expert witnesses are called to testify regarding report writing and testifying?

This workshop will include forensic science managers and attorneys who will present their views on context effect and conformational bias, and on the requirements to at least minimize, if not totally negate, their impact on the report writing process.

Context Effect, Confirmational Bias, Report Writing

W22 Don't Bomb in Court: How Arson and Bomb Scene Investigators and Laboratory Personnel Can Survive a *Daubert* or *Frye* Scientific Evidence Hearing in Court

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The goals of this workshop are: (1) to enable arson and bomb scene investigators and arson and bomb laboratory analysts/ technicians/ examiners to understand the importance of preparation for a court proceeding by having a well tailored Curriculum Vitae and a well written scientifically valid expert witness report at a *Daubert* or *Frye* scientific evidence hearing, (2) to demonstrate to arson and bombing investigators and laboratory personnel a proper method for writing expert witness reports and for presenting their testimony and opinions/finding in a court proceeding with the use of demonstrative evidence, (3) to assist arson and bomb scene investigators and laboratory personnel to prepare for and successfully survive a cross examination in a court proceeding, (4) to enable attorneys to understand and conduct both direct and cross examination of arson and bomb scene investigators as well as arson and bomb laboratory personnel, and (5) to demonstrate the sources and types of empirical and expert opinion testimony that an attorney can expert to confront in a *Daubert/Frye* hearing involving arson and bombing.

This workshop will have broad impact on crime scene investigators and laboratory personnel by demonstrating the type of reports to prepare and the organization and presentation of their testimony in their respective disciplines during a *Daubert/Frye* hearing. The attendees will also be exposed to various cross examination styles that they might expect to encounter which testifying. This workshop will also expose attorneys to the type of evidence that they can expert both on direct and cross examination and how to present and attack such evidence.

Upon the completion of this workshop, the forensic experts and attorneys should be able to successfully prepare for and survive a *Daubert* or *Frye* scientific evidence hearing. This workshop will highlight the admissibility issues of arson and bomb scene investigators and laboratory personnel during a trial by utilizing a *Daubert/Frye* scientific evidence hearing with a judge, a prosecutor, and a defense attorney. The workshop will demonstrate the methods of presenting expert testimony and evidence through the use of direct and cross-examination of arson and bomb scene investigators as well as arson and bomb laboratory experts. A fact pattern will outline the information from which the experts will draw the subject matter of their testimony and evidence. Each expert will submit a CV and a written expert witness report to include any demonstrative evidence that will be distributed to the attendees in the handout.

Both the prosecution and the defense will present opposing arson and bomb laboratory experts. The attorneys will examine the credentials of each of the expert witnesses along with the methods and procedures each utilized to arrive at their scientific conclusions and their expert opinions. Each of the experts will illustrate their direct testimony in the presentations with slides or such other appropriate demonstrative evidence. The expert witnesses will be subjected to both direct and cross-examination by the attorneys.

At the conclusion of the testimony the attorneys will make *Daubert/Frye* admissibility arguments to the judge addressing the credentials of the expert witness along with the substance of their testimony and the underlying evidence that each has presented. The judge will then rule on the credentials of the expert and the admissibility or inadmissibility of their testimony and evidence.

While arson and bomb experts will be used as examples in how to prepare for and testify at a *Daubert* or *Frye* scientific or technical hearing, the lessons presented are applicable to any type of forensic expert.

***Daubert/Frye*, Arson, Bomb**

W23 Marijuana Induced Psychosis

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After attending this presentation, attendees will be able to understand the basic function of the endocannabinoid system as it relates to normal and abnormal function; will be able to understand the interaction of cannabis use/abuse with the endocannabinoid system; will understand the experimental and epidemiologic basis for cannabis induced psychosis; and will be able to analyze information in legal cases associated with the development of psychosis and schizophrenia uncovered or co-occurring with cannabis intoxication.

The continuing abuse of marijuana and the use of marijuana for medical purposes mandates the recognition and understanding of the potential production of acute and chronic psychotic effects associated with the use of marijuana. This presentation will impact the forensic community by making forensic scientists more aware of the endocannabinoid system and how it specifically relates to marijuana-induced psychosis.

This workshop will explore the current research and literature on the interaction of cannabis use and psychotic behavior. Cannabis abuse may precipitate the onset of schizophrenia and may induce a dysfunction of the endocannabinoid system involved in the pathology of schizophrenia. The pharmacological basis for direct cannabis-induced paranoia and psychosis as well as the epidemiological findings on cannabis as an environmental risk factor in schizophrenia will be reviewed. Forensic Toxicology and Forensic Psychiatry interpretation and testimony in cannabis-involved causes of psychotic behavior will be presented for audience discussion.

Marijuana, Cannabis, Psychosis

WORKSHORT

WS1 Tool Shed Murders: A Workshop on Injury Characteristics in Blunt Trauma Homicides Involving Common Tools

Wendy M. Gunther, MD, and Leah L.E. Bush, MD*, Office of the Chief Medical Examiner, Tidewater District, 830 Southampton Avenue, #100, Norfolk, VA 23510*

After attending this presentation the attendee will be able to recognize characteristics of injuries on skin, scalp, and bone due to common tools utilized as weapons in fatal blunt trauma; to differentiate homicide from suicide in cases of blunt trauma utilizing common tools, based on scene and autopsy findings; and comprehend use of blood spatter pattern detection in blunt trauma.

This presentation will assist beginners and experts to recognize special characteristics of blunt trauma when common tools are utilized as weapons in homicides and suicides, with attention to both scene and autopsy findings.

Hammers, circular saws and chain saws, screwdrivers, hatchets, shovels, pry bars, threaded pipes, hoes and rakes – every tool in the shed has been used in a homicide. Blunt trauma homicides are often more intrinsically challenging to document and autopsy than are gunshot wound homicides. In this two hour workshop, a number of case studies are used to illustrate the characteristics of blunt trauma injuries from a variety of different tools that have been utilized as the murder weapon in homicides. The differences between blunt trauma to the head and blunt trauma to the chest or abdomen are considered, along with the role of survival time in the appearance of wounds. Skin, scalp, and bone injuries are compared and illustrated.

Characteristics of blunt trauma injury at the scene and at the autopsy table are discussed that help the forensic pathologist to differentiate between homicide and suicide. Scene characteristics in blunt trauma homicides include blood spatter, discussed in comparison to spatter at gunshot wound scenes; a practical demonstration of blood spatter principles is included. Teaching modules within the workshop include a pre-test and post-test composed of a challenge to match selected autopsy photographs with specific tools, ranging from beginner's level to experts-only.

Common Tools, Blunt Trauma, Homicide

B1 Different Effects of PCR Inhibitors on Multiplex STR Assays

Dennis Wang, PhD, Julio J. Mulero, PhD, and Lori Hennessy, PhD, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, attendees will learn the impact of six common forensic PCR inhibitors on the performance of multiplex STR assays.

This presentation will impact the forensic community by showing the forensic community that PCR inhibitors can have different effects on multiplex STR assays. It will also be demonstrate that multiplex STR assays have varying degrees of tolerances to the presence of PCR inhibitors in the PCR reaction.

DNA samples recovered from crime scenes are often commingled with contaminants that present a significant challenge for PCR amplification. Outdoor crimes may leave body fluids such as blood and semen on soil, sand, wood or leaf litter that contain substances which can co-extract with the perpetrator's DNA and prevent PCR amplification. Textile dyes, leather and wood from interior crime scenes can also contain inhibitors that interfere with the DNA polymerase's activity. The impact of these contaminants on the multiplex STR assays can vary from attenuation to complete inhibition of the amplification process, resulting in partial STR profiles or profiles with unusual peak morphology.

In the present study, a systematic approach was utilized to evaluate the effect of six PCR inhibitors commonly found in forensic samples on different multiplex PCR assays. Each multiplex PCR assay has unique primer sequences and buffer formulation. The six PCR inhibitors used in the study were hematin, indigo, melanin, humic acid, collagen, and calcium. For each multiplex PCR reaction, a range of inhibitor concentrations was included during PCR amplification. The amplification results were evaluated based on: 1) the ability of each multiplex PCR assay to generate full STR profiles, and 2) the quality of the STR profiles obtained.

The results revealed that the STR profiles obtained from multiplex PCR assays can be severely compromised by various PCR inhibitors. Within the same multiplex PCR assay, the degree of inhibition varies greatly with different types of PCR inhibitors. Between different multiplex PCR assays, the tolerance to PCR inhibitor also differed considerably. The results clearly indicated that with optimal primer sequences and buffer formulation, PCR inhibition can be kept to a minimal. Furthermore, the results also demonstrated that PCR cycling conditions can influence the peak morphology of the PCR-inhibited samples.

STR Typing, MiniSTR, PCR Inhibition

B2 Evaluation of Bacterial Community Characterization and Terminal Restriction Fragment Length Polymorphism Analysis for the Forensic Identification of Soil

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The goal of this presentation is to acquaint the audience with new methods for identification of soil samples using terminal restriction fragment length polymorphism (TRFLP) analysis of bacteria. In particular, examination of specific bacterial communities and markers, in lieu of the nonspecific use of the 16S ribosomal RNA (rRNA) gene generally assayed, will be used for soil DNA "fingerprinting" purposes.

This presentation will impact the forensic community by demonstrating the efficacy of bacterial DNA profiling in the analysis of soil samples, given the variation in different microbial communities commonly found in soil, while taking spatial and temporal variation into account.

Soil can be of broad evidentiary value as it is commonly found in many locations that may link a victim or suspect to a crime scene. Soil samples can also help ensure that a body or other evidence was not moved from another location, causing confusion as to the identity of an individual or in reconstructing the crime itself. Soil samples from a shoe, tire, clothing, or any other material may be collected by the crime scene investigator and taken to the laboratory for analysis. Older methods of soil analysis include the physical examination of colors or particle sizes, determination of any other materials in the soil, and examination of chemical features such as pH and organic content. Forensic scientists have also employed the used of light microscopy, density gradient testing, high performance liquid chromatography, scanning electron microscopy, and Fourier transform infrared spectroscopy in an effort to differentiate soil samples. However, these methods can very rarely pinpoint the exact location from which a soil sample originated.

A new method for soil identification involves characterization of the microbial communities found in soils, used to distinguish samples from different locations. There are an almost limitless number of microorganisms, particularly bacteria, present in soil. These differ in species and frequency throughout geographical regions and can potentially be used to help establish the site from which a soil sample originated. Past experiments have examined all bacterial species present in a sample through assay of the ubiquitous 16S rRNA gene. Although results showed that TRFLP was sensitive enough to display community changes, 16S may have been so prominent in soil that it generated a tremendous amount of "background noise", meaning the soil samples could not be properly differentiated. The current research is designed to overcome this by examining DNAs that are found in a more limited group(s) of bacteria, but are still polymorphic enough to "fingerprint" soil samples.

Other factors such as temporal and spatial variability may also play a large role in bacterial community profiling. If, for example, two samples come from similar habitats or soil types, the resulting fingerprints may be too similar to definitively differentiate them. In a like manner, if a geographic region contains a large amount of variability among nearby locations, it may reduce the possibility of obtaining informative results even if a good soil fingerprint can be obtained, as a

known soil sample is unlikely to be obtained from the exact same spot as the questioned material. Finally, the makeup of the soil may change temporally, making comparisons difficult or impossible. This research takes these factors into account while examining the usefulness of bacterial community analysis in a forensic setting.

DNA Profiling, Soil, Bacterial TRFLP Analysis

B3 Evaluation of Eight X-Chromosomal STR Loci in Japanese Population

Jian Tie, MD, Department of Legal Medicine, Nihon University School of Medicine, 202 2-30-13, and Toshima-Ku, Senkawa, and Shigemi Oshida, Department of Legal Medicine, Nihon University School of Medicine, 30-1, Oyaguchi Kamimachi, Itabashi-Ku, Tokyo, 173-8610, JAPAN*

The goal of this presentation is to discuss research involving eight X-chromosomal short tandem repeats. The X-chromosomal short tandem repeats (STRs) have recently been recognized to be useful tools in forensic medicine and anthropological studies for human identification as well as the distinctive properties of inheritance of the X-chromosome are responsible for its importance in population genetic studies. Features of X-chromosomal inheritance that are relevant to forensic casework will be discussed on the basis of empirical data, kinship, and paternity testing, mainly in deficiency paternity cases when the disputed child is a female. The goal of this study was to investigate the allelic frequency distribution of eight STRs on the X chromosome using the Mentype® Argus X-8 PCR amplification kit (Biotype AG, Germany), and evaluate the utility of this system in forensic medicine for the Japanese population.

This presentation will impact the forensic community by demonstrating the genetic evolution of eight X-chromosomal short tandem repeats (STR) DXS8378, HPRTB, DXS7423, DXS7132, DXS10134, DXS10074, DXS10101 and DXS10135 were fist reported in the Japanese population.

The X-chromosomal short tandem repeats (STRs) have recently been recognized to be useful tools in forensic medicine and anthropological studies for human identification as well as kinship and paternity testing, mainly in deficiency paternity cases when the disputed child is a female. The distinctive properties of inheritance of the X-chromosome are responsible for its importance in population genetic studies. Features of X-chromosomal inheritance that are relevant to forensic casework will be discussed on the basis of empirical data. In the cells of healthy human females, the X-chromosome is present as a homologous pair and resembles autosomes in this respect. The genetic evolution of eight X-chromosomal short tandem repeats (STR) DXS8378, HPRTB, DXS7423, DXS7132, DXS10134, DXS10074, DXS10101 and DXS10135 were examined in a sample of 353 unrelated males and females from the Japanese population. Multiplex PCR amplification was performed using the Mentype® Argus X-8 PCR amplification kit. The amplified PCR products were resolved and detected by capillary electrophoresis using the ABI PRISM 310 Genetic Analyzer. Allele frequencies of eight X-STR loci were calculated separately for males and females, and exact tests demonstrated no significant deviations from Hardy-Weinberg equilibrium. On the investigated kinship cases (30 family trios), no mutation was detected. Heterozygosity values ranged from 0.4419 (DXS7432) to 0.9269 (DXS10135), PIC ranged from 0.3805 (DXS7432) to 0.9222 (DXS10135). The combined power of discrimination (PD) for eight X-STR loci in males and females were 0.9992634 and 0.9999998, respectively. The eight X-STR loci form a new polymorphic marker system with great discrimination capacity for Japanese population.

X Chromosome, Short Tandem Repeat, Japanese Population

B4 Pilot Study of the Potential for Using Different Biological Specimens as Human Scent Sources

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The goal of this presentation is to provide the forensic community with a comparison between the volatile organic compounds present in different biological samples.

This presentation will impact the forensic community by monitoring the consistency and inconsistency of these volatile organic compounds over time, as well as to investigate the potential of using previously collected forensic evidence samples as human scent samples for investigative and/or a biometric tool.

The purpose of this presentation is to provide the forensic community with a comparison between the volatile organic compounds present in different biological samples. The goal of this research is to monitor the consistency and inconsistency of these volatile organic compounds over time, as well as to investigate the potential of using previously collected forensic evidence samples as human scent samples for investigative and/or a biometric tool.

The human odor is made up of a variety of organic compounds such as aldehydes, alcohols, alkanes, esters, fatty acids, and ketones. Volatile organic compound (VOC) analysis in biological samples such as expired air (breath), sweat, blood, and urine has been used for various applications such as toxicology, medicine, and forensics. Over the recent years interest has increased regarding the identification of VOCs for metabolic profiling or diagnostic potentials for certain diseases that are known for its association with distinct odor.

Identification of target odor compounds can provide valuable information to both the medical and forensic communities. From the medical perspective, analysis of VOCs in biological fluids can reveal interesting diagnostic properties of different biomarkers. In addition to the disease diagnostic potential, analysis of VOCs in biological samples may be useful in differentiating populations (i.e., healthy vs. illness). From the forensic perspective, biological evidence collected may be useful for human identification in terms of matching individuals to odor from a crime scene. Volatile organic components of human scent play important roles in scent association between a person and evidence. Human scent identification line-ups are possible as each person has distinctive odors. Canines have the ability to discriminate human scent because people smell differently.

Curran et al. have demonstrated that human scent is a combination of various compounds differing in ratio from person to person as well as other compounds that vary among individuals. VOCs present in human odor from sweat samples have been detected and identified by solid-phase micro-extraction gas chromatography mass spectrometry (SPME-GC/MS). This study extends the investigation of the different VOCs present in human odor profile to include various biological specimens including blood, breath, oral fluid, sweat, and urine. Hand odor samples were collected on a pre-treated 2 x 2 sterile gauze pad. Expired air was sampled in a Teflon breath sampling apparatus. Whole blood was obtained by finger stick sampling and collected onto FTA cards. Urine and oral fluid specimens were collected under typical forensic evidence collection methods, which were immediately transferred into 10mL headspace vials. Samples were collected from subjects over a 6-month period and the consistencies and inconsistencies of the VOCs were monitored. SPME-GC/MS was utilized to extract, separate, and identify the volatile components from the collected biological samples.

The results demonstrate that significantly different VOCs are observed from the different biological samples studied with the greatest number of compounds observed from urine samples followed by sweat,

oral fluid, blood, and breath. Studies are ongoing in order to try to improve the number of compounds observed by further optimization of the sampling procedures including additional heating. These results show that different biological specimens have significantly different VOCs under the conditions and instrumentation employed but may not preclude the use of canines for matching samples as they could be utilizing different compounds than those detected in this study. Additional work is ongoing to include subjects with specific medical conditions to evaluate the effect this may have on detectable VOCs.

Human Scent, Volatile Organic Compounds, SPME-GC/MS

B5 Development of a Y Alu DNA Screening Assay Using Y Alu Derived Sequence for Detection on the FMBIO III Plus

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After attending this presentation, attendees will learn the use of Y alu derived primers used to detect male DNA.

This presentation will impact the forensic community by discussing the development of an accurate and rapid Y chromosome specific screening test for male DNA. This new assay has the potential to greatly improve time of sexual assault screening and may alleviate the backlog of evidence samples. The forensic science community in the United States has more than 150,000 backlog mixture samples presently. However, present screening methods are tedious and may lead to false positives or false negatives.

Forensic DNA has become an important tool for solving crime. Approximately 169,000 rape case samples await testing. The currently utilized screening tests are tedious and may lead to false positive or false negative results. The goal of this study is to develop an accurate, rapid, Y chromosome specific screening test for male DNA. The chosen target for the male DNA primers are Y Alu derived sequences, STYa and Y 90.[1]

Two different strategies for detection of amplicons have been tested: (1) molecular beacons,[2] and (2) amplifluor primers.[3] Scanning parameters have been determined for the fluorescent dye FAM used in detection of the primers and PCR products. Preliminary results indicate FAM detection is optimal with an excitation by a 488nm laser and a 532/8 nm band pass filter with a 515nm long pass blocking filter at a focal depth 1.5mm, and a photomultiplier tube sensitivity setting of 45% on a fluorescent scanner (FMBIO III plus, MiraiBio Inc. Alemeda, CA).

Parameters for amplification and detection using replicate positive male DNA samples and female DNA were determined. Control male DNA was amplified using Amplifluor primers. When target is present the Amplifluor primer hybridizes and unfolds separating the reporter dye from the quencher. Amplification and detection were performed in a single step in Microamp PCR 8 tube strip Reaction Tubes (PN 801-0580- Applied Biosystems, Foster City, CA). After amplification, the 8 tube strips were placed into a 96 well clear bottom plate (NUNC 96 Microwell Optical Bottom Plate (#164588) to hold them upright and directly scanned on the FMBIO. Using this strategy, detection of male DNA from 5ng down to 125 pg was achieved. Optimization of primer concentration, sensitivity of input DNA down to 25 pg and results using different ratios of male and female mixtures will also be presented.

Collaborators will use the results for further testing on previously screened samples. This new assay has the potential to greatly improve time of sexual assault screening and may alleviate the backlog evidence samples.

This research was supported by an NSF-REU grant # DBI-0647160 to Drs. Julio Soto, Cleber Ouverney, Steven B. Lee.

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3 Khripin Y.High-throughput genotyping with energy transfer-labeled primers. *Methods Mol Biol.* 2006;335:215-40.

Forensic Screening, Y Alu Assay, FMBIO III

B6 Correlation of GSR Persistence in Decomposing Tissue to GSR Persistence in Blowfly Larvae

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After attending this presentation, attendees will be informed of the feasibility and nuances of chemically detecting and identifying gunshot residue (GSR) in decomposing tissue and in blowfly larvae that have been feeding on GSR containing tissue.

This presentation will impact the forensic community by serving as a means to chemically identify gunshot wounds on decomposing victims. The findings presented will aid forensic pathologists in determining the cause of death for a decomposing gunshot victim. This technique will be beneficial, for example, in cases where no bullet was recovered and the body is in a stage of decomposition which makes it difficult to visualize stippling around a wound.

Tissue and larvae samples are analyzed by means of inductively coupled plasma-mass spectrometry (ICP-MS) and scanning electron microscopy with energy dispersive spectroscopy (SEM/EDS) to determine the presence of GSR.

The research covered in this presentation will impact the forensic community by serving as a means to chemically identify gunshot wounds on decomposing victims. The findings presented will aid forensic pathologists in determining the cause of death for a decomposing gunshot victim. This technique will be beneficial, for example, in cases where no bullet was recovered and the body is in a stage of decomposition which makes it difficult to visualize stippling around a wound.

When a firearm is discharged, a plume of GSR consisting primarily of lead (Pb), barium (Ba), and antimony (Sb) is emitted from the weapon and deposits on the hands of the shooter, the surrounding area, and on the victim. Gunshot wounds will often exhibit GSR tattooed onto the epidermis. Postmortem decomposition processes and insect activity can often obscure or alter wounds that would otherwise be easily recognizable by a forensic pathologist as gunshot wounds. Therefore, sensitive and reliable methods for the chemical identification of a gunshot wounds are desirable.

In this work, the persistence of GSR in decomposing porcine tissue will be presented. Swabs of shot porcine tissue will be analyzed by SEM/EDS to observe the morphology of the GSR particles and determine elemental composition. ICP-MS will be performed on microwave digests of GSR wounds from porcine tissue at various stages

of decomposition, in order to detect Pb, Ba, and Sb, which are characteristic elements of GSR. In addition, blowfly larvae collected from the shot porcine wounds will be microwave digested and analyzed for Pb, Ba, and Sb using ICP-MS. By detecting GSR in blowfly larvae, the actual wound would be left intact for further analysis by the pathologists. The correlation between GSR whole body content of the larvae with the GSR content of the porcine tissue will also be presented.

The chemical identification of the metals known to be present in GSR will be shown by means of ICP-MS and SEM/EDS analysis in porcine tissue. SEM/EDS will be performed on swabs of the tissue in order to observe GSR particles and determine their elemental composition. ICP-MS will be performed on microwave digests of shot porcine tissue samples in order to detect lead, barium, and antimony.

The ICP-MS analysis of blowfly larvae feeding on a suspected gunshot wound will also be presented. By detecting GSR in blowfly larvae, the actual wound would be left intact for further analysis by the pathologists. Since a significant amount of lead, barium, and antimony would not normally be present in tissue that had not been shot or in maggots that had not been feeding on tissue with GSR, the detection of these three metals is indicative of exposure to GSR.

Both SEM/EDS and ICP-MS will be utilized throughout the decomposition process in order to determine how long after death GSR can be detected in tissue and in the maggots feeding on the tissue.

The research covered in this presentation will impact the forensic community by serving as a means to chemically identify gunshot wounds on decomposing victims. The findings presented will aid forensic pathologists in determining the cause of death for a decomposing gunshot victim. This technique will be beneficial, for example, in cases where no bullet was recovered and the body is in a stage of decomposition which makes it difficult to visualize stippling around a wound.

Gunshot Residue, Chemical Identification, ICP-MS

B7 Nucleic Acid Based Methods for Assessing the Age of Bloodstains

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After attending this presentation, attendees will learn about the potential for examining the degradation of genetic material in order to estimate the age of bloodstains at a crime scene. A collection of RNA markers were assayed that have differing stabilities and rates of decay, serving as an indicator of a stain's age.

This presentation will impact the forensic community by serving as a tool to aid in the determination of the age of biological evidence. The technique may help to establish the time at which a crime occurred, and therefore could be applied to many aspects of a criminal investigation.

Determining the time at which a crime occurred is often one of the most important aspects of a forensic investigation, as this may impact suspect alibis, potential witnesses, and other relevant information. In order to pinpoint a time period, investigators often utilize evidence that undergoes reliable change, such as insects that develop in a corpse. However, it is possible that other forms of evidence may provide clues to the age of the scene, even in the absence of a victim.

The varying types of RNA molecules, including ribosomal RNA (rRNA), transfer RNA (tRNA), and messenger RNA (mRNA), have different functions in the cell, and thus have differing stabilities. For example, most mRNA molecules have a high turnover rate and decay relatively rapidly, while rRNA molecules exist in the relatively stable ribosome. Because of this, the presence or absence of these molecules in a bloodstain has the potential to serve as an indicator of the time elapsed since deposition.

This presentation will outline a method for quantifying levels of RNA markers and establishing their ratios for use in estimating the age of biological stains. The technique utilized a combination of reverse transcription and quantitative PCR to determine the levels of RNA molecules at varying points in the degradation process. Bloodstain samples of different ages were examined in order to establish useful ratios for fresh and increasingly aged samples, up to an age of three years.

The increasing use of quantitative PCR and the ability to simultaneously extract DNA and RNA from forensic samples may allow this technique to be utilized as a reliable bloodstain age predictor in crime laboratories, alongside standard DNA profiling protocols.

Bloodstain Aging, RNA Degradation, qPCR

B8 Determining Individual Hand Odor Profiles Through Non-Contact Scent Collection Methodologies

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After attending this presentation, attendees will understand some principles of the collection procedures for human scent sampling as well as some preliminary results of the chemical composition of hand odor samples collected via a non-contact methodology.

This presentation will impact the forensic community by serving as a key aspect for the improvement of human scent identification protocols in the United States and the use of this form of trace evidence in courts of law across the nation.

Body odors are of particular importance and provide information about individual identity in scent evidence collection protocols. Of specific interest to the forensic community is the instrumental determination of hand odor composition which may be present in crime scene areas and objects utilized during the execution of criminal acts. The idea that human odor is an individual characteristic which may be used as evidence in a court of law either incriminating or exonerating a suspect brings a number of aspects and challenges in employing this form of evidence which include not only the effective use of canines in scent identification procedures, but more importantly a scientific validation of the underlying principles of the chemical elucidation of individual odor profiles obtained through instrumental analysis methods.

The collection of human scent evidence plays an important role in the effectiveness of scent discriminating canine teams and the law enforcement community which utilize this form of evidence in criminal investigations. As such, collection procedures in the United States have employed a non-contact collection approach through the use of a device called the Scent Transfer Unit (STU-100). The Scent Transfer Unit allows for the ability to perform non-contact scent collection using dynamic airflow from objects or suspects without contaminating or altering the object/target of interest. This device is a portable vacuum designed to draw air through sterile gauze pads and is currently being used by law enforcement agencies as well as the Federal Bureau of Investigation. To date there has been limited scientific validation on the reliability of this device. The only evaluation to date has determined the ability of the STU-100 to trap and release organic compounds at ambient temperatures in controlled laboratory conditions.

An instrumental analysis using headspace solid phase micro-extraction in combination with gas chromatography / mass spectrometry (SPME-GC/MS) has been evaluated for the study of hand odor collected utilizing the Scent Transfer Unit over the palms of the hands of both

female and male subjects for a period of 1 minute samplings with varying collection materials and airflow sampling speeds. The collection process consisted of washing the hands and forearms using a fragrance-free soap, air drying, rubbing the hands over the forearms, and then clasping the palms of the hands together for 10 minutes. Consequently, subjects were asked to open their hands under the Scent Transfer Unit for a period of 1 minute to perform a non-contact sample collection as formulated to mirror the Federal Bureau of Investigation's Standard Operating Procedure for the collection of human scent evidence. These samples were allowed to sit for 24 hours, and then analyzed for a period of 21 hours using a divinylbenzene/carboxen on polydimethylsiloxane SPME fiber prior to GC/MS analysis.

The evaluation of the collected hand odor profiles utilizing the Scent Transfer Unit allows for a scientific approach to analyze and understand the composition of what is being collected in the scent pads which are presented to the canines in practical field work. The understanding of the chemicals present in various fiber chemistry collection mediums as well as varying sampling speeds allows for the interpretation of the individual odor theory and portrays the differences and/or similarities of the volatile organic compound patterns portrayed in each sampling across the individuals tested.

This study demonstrates the usefulness of the Scent Transfer Unit as a scent evidence collection medium which can be used by the forensic community for an optimized collection protocol which may help standardize human scent as a form of trace evidence. Since the actual scent detected by the canine cannot be readily studied, this analysis can provide some indication as to what these biological detectors are finding when brought upon a collected scent sample thus improving the performance and scientific validity of canine teams used across the United States for human scent discrimination purposes.

Human Scent Evidence, Scent Transfer Unit (STU-100), Individual Odor Profile

B9 Forensic Analysis of Black Powder Substitutes by ESI-TOFMS

Megan N. Bottegal, BS, and Bruce R. McCord, PhD, Florida International University, Department of Chemistry, CP 175, 11200 South West 8th Street, Miami, FL 33199*

After attending this research presentation, attendees will have been introduced to a newly developed method for the detection of organic and inorganic components of black powder substitutes using electrospray ionization time-of-flight mass spectrometry.

This presentation will impact the forensic community by demonstrating why it is important to have techniques in place which provide rapid and unequivocal information on the nature and composition of black powder substitute explosive materials both pre- and post-blast. These materials are readily available in significant quantities at many locations in the U.S., and the use of these alternative propellants in Improvised Explosive Devices (IEDs) is on the rise.

Black powder substitutes are readily available in significant quantities at many locations in the U.S., and the use of these alternative propellants in Improvised Explosive Devices (IEDs) is on the rise. It is therefore important to have techniques in place which provide rapid and unequivocal information on the nature and composition of these explosive materials both pre- and post-blast.

Black powder substitutes are alternatives to traditional black powder which have been formulated to have a more controlled burn rate, generate less smoke and residue when fired, and improve the safety of storage. Many of the newer black powder substitutes utilize ascorbic acid (vitamin C) as a replacement fuel for sulfur and charcoal. These propellants typically contain a mixed perchlorate/nitrate oxidizer.

Previous approaches to the analysis of these black powder substitutes have included GC-MS, IC-MS, IC-UV, and CE-UV techniques. Because both the organic and inorganic components of interest in black powder substitutes are charged at neutral to weakly acidic pH, ion chromatography and capillary electrophoresis are the preferred separation techniques for these analytes. By coupling these liquid based separation techniques to a time-of-flight mass spectrometric detector via electrospray ionization techniques, more information is available to the scientist concerning exact mass and isotopic ratios, which, when coupled with migration time, provide an unequivocal identification of the residues of interest. In these studies, samples from intact powders, post-burn and post-blast residues will be analyzed, and the ions of interest including ascorbate, chloride, nitrite, nitrate, chlorate, perchlorate, sulfate, and carbonate will be discussed in this presentation.

Electrospray Ionization, Mass Spectrometry, Black Powder Substitutes

B10 DNA Profiles From Flip-Open Cell Phones

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The goal of this presentation is to demonstrate the best approach to analyzing flip-open cell phones for DNA evidence.

This presentation will impact the forensic community by demonstrating the need for taking swabs from a cell phone at multiple discrete locations, and analyzing them separately if such evidence is encountered in forensic cases.

Flip-open style cell phones were investigated for the potential to produce quality genetic profiles that could be used in forensic casework. Swabs were taken of the outside/back and the inside ear speaker of ten flip-phones on two occasions – prior to and seven days after cleaning with 95% ethanol. Buccal swabs were also taken of the owners to be used as references and each completed a general questionnaire about the regular use, care, and storage of the cell phone. Following a Chelex extraction and filtration through a YM-100 membrane, the samples were amplified with the AmpF*l*STR® ProfilerPlus® PCR Kit, using 28 or 35 cycles. STR profiles were then generated using an ABI Prism® 310 Genetic Analyzer and GeneMapper ID® analysis software v3.2. The phone profiles were compared to the references and to each other, to assess the quality and amount of contamination in the various samples. On average, the swabs taken of the outside location produced more complete profiles, but contained a higher number of drop-in alleles. However, the profiles within a given experimental condition showed wide variation, and were inconsistent and unpredictable. In addition, the cleaning with 95% ethanol was shown to be ineffective, indicating that DNA on a cell phone is extremely resilient. The findings of this study demonstrate the need for taking swabs from a cell phone at multiple discrete locations, and analyzing them separately if such evidence is encountered in forensic cases.

DNA, Cell Phone, Low Copy Number

B11 Discrimination of Glass by Cathodoluminescence, Color Analysis, and Chemometrics

Heidi Barron, BS, and Suzanne C. Bell, PhD, West Virginia University, Department of Chemistry, PO Box 6045, Morgantown, WV 26506-6045*

After attending this presentation, the attendees will be familiar with the application of CIE L*a*b* color coordinates to cathodoluminescence spectra of glass. The presentation will cover cathodoluminescence spectroscopy as well as associated uncertainties with color determination. Chemometric analysis of data will also be discussed.

This presentation will impact the forensic community by demonstrating a new technique, color of glass derived from cathodoluminescence spectra, that may be employed to link suspect glass to known glass.

Forensic scientists are well versed in dealing with colored physical evidence, such as fibers and paints. Glass is a common piece of physical evidence that is generally visually colorless. However, under cathodoluminescence (CL) conditions, glass emits light in the visible range and in effect can be treated as colored. CL is a phenomenon that occurs when visible light is emitted from a material upon electron bombardment. This study utilized CL spectroscopy. Analysis of glass by CL spectroscopy detects luminescence in the visible range. This range of detection can assist in assigning a color to a colorless glass. In this study, a scanning electron microscope (SEM) equipped with a CL detector was used. The electrons generated in the SEM provide sufficient conditions for CL detection. The combination of SEM and CL results in a non-destructive technique for analysis, thus allowing the integrity of the sample to be maintained. Sample preparation for analysis of materials in the SEM is relatively simple. For glass samples, no surface preparation was necessary; the surface did not require carbon coating. Currently employed methods of glass analysis include scanning electron microscopy equipped with energy dispersive spectroscopy (SEM-EDS), laser ablation inductively coupled plasma mass spectrometry (ICP-MS), refractive index measurements, and x-ray fluorescence spectrometry (XRF).

Soda-lime float glass (NIST1830) and multicomponent glass (NIST1412) were analyzed via CL spectroscopy. For each sample, spectra from five different areas were collected as well as five replicate spectra of the same area. Data analysis and chemometrics was conducted using Excel and MatLab. ASTM Standard Methods (D2244, 2616, 6290 and E284, 308, 313, 1164, 1345, and 2022) were used as references and starting points for color determination and calculations. For extraction of tristimulus values, L*a*b coordinates, and color differences, spectra were standardized to a D65 illuminant, 10°observer, 1964 weighting table factors from ASTM. Intra-sample variation was addressed by collection of replicate emission spectra from the same location on a standard glass sample. Although intensity decreased with each collection event (likely due to a surface charging effect), the spectral pattern was consistent. Accordingly, all spectra were normalized to the highest emission for analysis. A similar procedure was used for single samples collected from different locations on the same glass sample. Together, these measurements established the range of instrumental, inter-, and intra-sample variation. The quantitative characterization of this uncertainty was essential in identifying statistically significant color differences between different glass samples.

Results showed that the L*a*b* values for each glass had a %RSD of between 4% and 15% for the five spectra collected in different areas of the sample. Even with these ranges, the two NIST glasses were easily distinguished and the difference was statistically significant. Once uncertainties were determined, it was found that there some intra-sample variation exists within each glass. Although variations do exist, the two types of glass were easily distinguished from one another. This work demonstrates the need for replicates to be collected from each sample. Future work includes CL analysis as well as offline data analysis of non-NIST standard glasses.

The impact of color of glass derived from cathodoluminescence spectra will provide the forensic community with a new technique that may be employed to link suspect glass to known glass.

Cathodoluminescence, Glass, CIE L*a*b* Coordinates

B12 Latent Fingerprint Developing on Thermal Paper and Carbonless Paper

Mi-Jung Choi , Seung-Chan Roh, Man-Ki Kim, Yeo-ool Shin , Ki-Jung Paeng, PhD, and Sung-Woo Park› PhD, Department of Scientific Criminal Investigation, Chungnam National University, 305-764 and Department of Chemistry, Yonsei University, Wonju 220-710, KOREA*

After attending this presentation, attendees will learn a new technique for developing latent fingerprints on thermal and carbonless papers.

This presentation will impact the forensic community by demonstrating a new latent fingerprint method.

This presentation will show the results on the developing latent fingerprint from the thermal papers and carbonless papers. An understanding of the chemical and physical properties of these specialty papers is required to set up what possible method of processing will not damage. The thermal papers which were coated with coreactant, developer dyes, sensitizer and stabilizer would form an image on paper as breaking coreactant capsule by heat and successive reaction with developer dye. Sensitizers are solid phases that melt with heating, forming the reactant that brings the colorless dyes and coreactant together. Stabilizers reduce the reversibility of this reaction and permanently preserve the printed image within this coat. A few kinds of thermal papers of bank automatic teller machine itemize (ATM itemize), express way receipt, and mart receipt were examined. The carbonless papers which were coated with coreactant and developer dyes would form an image on paper as breaking coreactant capsule by pressure and successive reaction with developer dye. Carbonless paper consists of two or three pages coupled to produce a form in which minimum duplicate copies are created. The first page is termed the coated back (CB) and coated with microcapsule, original handwriting or machinery written pressure is directly applied. The next pages are termed the coated front (CF) and only the front of the page is coated (coreactant, CF-F) and the back of this is coated (microcapsule, CF-B). Three different carbonless papers of the contract form of real estate assignment, tax receipt and credit card receipt were examined. Latent fingerprint developing methods were set up by comparing DFO (1,8-diazafluoren-9-one), iodine fuming methods and ninhydrine in various solvents (methanol, acetic acid, chlorofluorocarbon [CFC], hydrofluoroether [HFE]).

The found the damage of thermal paper as blackening the paper itself and handwriting document by applying polar solvent. The damage of bleeding or running was relatively light at the application of CFC or HFE solvent than polar solvent, but it was unreadable. However, the presence of a fingerprint could be confirmed from the fresh and one week old latent evidence using the iodine fuming method. In the case of non-coated surface, ninhydrine in HFE-7100 solvent shows the greatest development even in an one week old fingerprint, and thus successive treatment with iodine fuming for coated surface and ninhydrine in HFE-7100 for non-coated is the most effective method to identifying fingerprint in thermal papers. For CB of carbonless papers, ninhydrine in CFC113, for contract form of real estate assignment, ninhydrine in HFE 7100, for tax receipts iodine fuming followed by ninhydrine in

CFC113 for credit card receipt were the most effective methods. In case of CF-F, iodine fuming method. After verifying the kind of papers by SEM and FT-IR prior to applying specific development methods, the most efficient methods of latent fingerprinting developing on specialty papers, with minimal change on paper have been set up.

Thermal Paper, Carbonless Paper, Latent Fingerprint

B13 Synthesis of Nanosized Ag and Carbon Particle for Latent Fingerprint Developing

Man-Ki Kim, Sung-Woo Park, PhD*, and Mi-Jung Choi*, Chungnam National University,305-764, Daejeon, KOREA*

After attending this presentation, attendees will learn a new technique for developing latent fingerprints on thermal and carbonless papers.

This presentation will impact the forensic community by demonstrating a new latent fingerprint method.

Fingerprints are often considered one of the most valuable types of physical evidence in the field of forensic science. In general three forms of fingerprint evidence that may be found at a crime scene: visible prints, impression prints, and latent prints. Method of latent fingerprint development is powder method, ninhydrin method, iodine fuming, and cyanoarylate fuming were the four most commonly used techniques of latent prints development. Powder method is the simplest and commonly used procedure for developing latent fingerprint. In general there are three classes of fingerprint powders: regular, luminescent, and metallic. Powder adheres to the ridges depends on the size and shape of particles that compose the formulation. That powder should be selected which affords the best color contrast with the surface being dusted. The technique depends on the mechanical adherence of fingerprint powder to the moisture and fingerprint residue components of the skin ridge deposits. In order to obtain latent fingerprint developing from nonporous evidence, the selection of detectant should consider the color contrast and physical properties of the object. Fingerprint powders are commercially available in a variety of compositions and colors. In general, gray color powder of aluminum, black color powder of charcoal and fluorescence powder are mostly used for this purpose. In this research, the nano-sized silver particle was fabricated by the chemical reduction methods using silver nitrate and reducing agent, hydrazine. The efficiency and characteristics of manufactured Ag particles for the developing latent fingerprint are compared as particle shapes of sphere, rod and flake type. Also we compared the data with that of black colored powder of m for rod type mm for sphere type, 0.9 mm carbon. The size of Ag powder are 1 ~ 7 mm of flake type. In mm for flake type, and carbon powder is 5 ~10 mm and 10-20 mm the terms of fingerprint developing efficiency of new Ag materials, the 10% enhancement of confirm friction ridge pattern points are achieved as comparison to commercial gray colored powder and carbon powder. Enhancement of the attachment to fingerprint ridge and reduced scattering was also found in this case. The newly manufactured carbon powder by our team shows significantly less m, formless) in glass and scattering than commercial black powder (10~60 mm we observed about 10% enhancement of developing friction ridge pattern points. New manufactured 9:1 (carbon : Ag) mixture observed about 10% enhancement of latent fingerprint developing than commercial black powder and also color contrast exhibits good. Therefore, it is reported in this presentation, newly formed nano-sized Ag and carbon particles exhibit the very good developing ability toward latent fingerprint from nonporous evidence.

Nanosized Ag, Carbon Particle, Latent Fingerprinting

B14 Sensitivity and Specificity Study of Published Microscopic Examination and Mitochondrial DNA of Forensic Hair Analysis

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The goal of this presentation is to develop a metric that assists in the appreciation of the value of hair microscopy. However, it important to emphasize that the two techniques used in junction provide a much more powerful analytical tool.

This presentation will impact the forensic community by showing the value of microscopic hair examination and providing evidence that when the two techniques of microscopic examination and mitochondrial DNA are combined they provide greater resolution in terms of results than either do individually.

Two methods currently used for forensically evaluating hair are microscopic examination and mitochondrial DNA analysis. These two techniques evaluate different but equally valuable criteria and, therefore, have different resolving power. Mitochondrial DNA analysis assesses genotype, while microscopic examination assesses phenotype. Several clinical studies have been published to assess the efficiency of the two methods. In this study, data was collected from the works of Gaudette,[1] Gaudette and Keeping,[2] Lamb and Tucker,[3] Strauss,[4] Wickenheiser and Hepworth,[5] Houck and Budowle,[6] and Melton[7] and calculated the sensitivity and specificity of the combined data to give an overall assessment of the reliability of microscopic examination and mitochondrial DNA analysis of hair. Sensitivity and specificity are statistical tools used to determine how often the method correctly categorizes the individual as positive or negative, respectively.

Microscopy of hair has often been derided as a weak science[8] but those arguments come from a less-than-enlightened appreciation of the science of forensic hair comparisons.[9] This paper seeks to develop a metric that assists in the appreciation of the value of hair microscopy. However, it important to emphasize that the two techniques used in junction provide a much more powerful analytical tool.

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Forensic Science, Mitochondrial DNA, Microscopic Examination

B15 Comparison of Extraction Procedures for Organic Impurity Profiling of Seized MDMA Tablets

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The goal of this presentation is to optimize and compare two alternative extraction procedures with conventional liquid-liquid extraction (LLE) for organic impurity profiling of seized tablets containing 3,4-methylenedioxy methamphetamine (MDMA).

This presentation will impact the forensic community by potentially identifying an effective method for extracting organic impurities from MDMA. This allows for the production of an MDMA impurity profile, which has potential in aiding law enforcement in monitoring drug trafficking.

Organic impurity profiling of seized synthetic drugs is used to potentially identify common production sources. In the case of MDMA, similarities among impurity profiles can indicate a common synthetic route and similar levels of the same impurities potentially indicate a common production batch. Currently, LLE is typically used to extract organic impurities from tablets with the extract subsequently analyzed by gas chromatography-mass spectrometry (GC-MS) to generate the impurity profile. This study aims to investigate two alternative extraction procedures; headspace-solid phase microextraction (HS-SPME) and microwave-assisted extraction (MAE), both of which offer numerous advantages compared to LLE procedures.

HS-SPME offers more selective extractions than LLE based on choice of fiber type, and requires less sample than LLE. Impurities are pre-concentrated on the SPME fiber, which is advantageous for trace impurity determinations. In addition, the low volatility of the MDMA salt prevents efficient partitioning into the headspace. Hence, profiles obtained with HS-SPME are not dominated by MDMA, as is often the case with LLE procedures. However, HS-SPME has many variables, such as fiber type, extraction time, and extraction temperature that must be optimized to afford efficient extractions.

Microwave-assisted extraction offers highly efficient extractions using small volumes of solvent, and requires fewer steps than LLE. However, the efficiency of the extraction may also prove problematic since other compounds in the sample are extracted and may interfere with subsequent instrumental analysis. Hence, MAE is often followed by HS-SPME for the selective extraction of the target analytes. MAE has not yet been considered as an extraction procedure for organic impurity profiling.

In this study, an HS-SPME procedure was optimized based on extraction time and extraction temperature using a circumscribed central composite experimental design. A similar approach was also used to optimize the MAE procedure in terms of solvent type, solvent volume, extraction time, and extraction temperature. The MAE procedure was then used in combination with the optimized HS-SPME to selectively extract impurities from the MAE extract. Both the HS-SPME and the MAE/HS-SPME procedures were compared with a conventional LLE procedure in terms of the number of impurities extracted from a homogenized batch of seized MDMA, as well as the repeatability and reproducibility of the extraction.

This study is based on work supported by the Department of Justice under Grant No. 2005CKWX0466.

Impurity Profiling, Head Space-Solid Phase Microextraction, Microwave-Assisted Extraction

B16 Use of an Optimized 1,2-Indanedione Process for the Development of Latent Prints

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After attending this presentation, attendees will have a knowledge of the impact of percentage relative humidity upon moisture content of paper substrates and the resultant effect upon 1,2-indaneione performance. Additionally, information will be presented regarding the advantages of use of a combined indanedione-zinc formulation over those of DFO.

This presentation will impact the forensic community by demonstrating an optimized reagent and process to more effectively develop latent prints on paper substrates.

1,2-Indanedione belongs to a class of compounds which have demonstrated great potential in the processing of latent prints, particularly in the area of fluorescence. However, variability in results achieved worldwide has precluded it from being used extensively. For this research, various components of the formulation were analyzed, including purity level of the indanedione, type of carrier solvent, and the use of $ZnCl_2$ both as a secondary application and incorporated into the reagent. Using a resultant optimized formulation, performance comparisons were then made in the areas of visible color development, fluorescence, and degree of substrate staining with those of DFO for both fresh and aged prints. In that incorporation of zinc into a 1,2-indanedione solution (Ind-Zn) can affect shelf life, long term stability of the resultant formulation was assessed. In order to isolate the cause of 1,2-indanedione performance variability, moisture content of the paper substrates on which the prints had been deposited was measured and a correlation found with percentage ambient relative humidity. Determination of visible color and fluorescence as it corresponded to percentage moisture content allowed for defining critical threshold levels necessary for achieving optimal results. Correlating these values with percentage relative humidity then allowed for the development of standard operating procedures for best possible print development.

Through this work, it was determined that a 7.41% v/v formulation of Ind-Zn having PE as a carrier solvent yielded the most optimal results when processing methods optimized for %RH in the laboratory were utilized. Both initial color development and fluorescence were superior to that of DFO; prints developed with Ind-Zn were a minimum of 6.5 units dE* darker and more red than with DFO for all substrates tested. Processing with Ind-Zn on the majority of the substrates tested yielded fluorescence intensity values approximately four times greater than with DFO.

1,2-Indanedione, DFO, Moisture Content

B17 Comparison of Optimized 1,2-Indanedione-Zn and DFO for Latent Print Development

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The goal of this presentation is to introduce a combined formulation of 1,2 indanedione with zinc chloride (Ind-Zn) as an alternative to DFO as a fluorogenic reagent for latent print development.

This presentation will impact the forensic community by demonstrating how Ind-Zn can be used to replace DFO in the latent print examination protocol for dry, porous items, allowing for greater number of superior quality prints to be developed on evidence.

In latent print development, a chemical reagent and process is chosen after consideration of substrate type, background detail, and evidence condition. Fluorescent chemical processes are a newer group of reagents that have broadened the selection of tools available for latent print examiners to use when faced with the many variable states of evidence.

DFO (1,8–diazafluoren-9-one) was one of the first fluorescent chemicals used to visualize latent prints on porous materials when exposed to an alternate light source. 1,2 indanedione is a newer fluorogenic reagent that has been shown to produce latent prints as well, or even better, than DFO, since both chemically react with the amino acids in fingerprint residue. Historically, post treatment with zinc chloride and liquid nitrogen were suggested for increasing the fluorescence. Therefore, for this study, 1,2 indanedione was combined with a zinc chloride solution in order to achieve optimal results, and DFO was prepared according to laboratory's established protocol.

In order for Ind-Zn to be introduced into the latent print protocol for developing porous items, it has to yield superior results when compared to DFO. To compare the effects of Ind-Zn versus DFO, strength of fluorescence, quality, and sensitivity were tested on a variety of substrates. Ten different substrates were evaluated and included: yellow and white lined legal paper, white printer paper (28 lb, 98 brightness), white Xerox paper (20 lb, 92 brightness), white envelope, brown Kraft paper, brown packaging paper, newspaper, green file paper, and manila envelope. Substrate samples were cut into approximately 6" x 2½" inch strips. Fingerprints were collected from 18 different donors, 7 males and 11 females, for each substrate. Five prints were collected on each strip in a depletion series with fingerprint deposition residue decreasing with each print, the most being with the first and the least with the fifth print. Moisture content and relative humidity were recorded to help determine effects on latent print development. The strips were cut in half and then treated with either DFO or Ind-Zn. The strips were allowed to air dry for 10 minutes and then oven dried at 100ºC for 20 minutes. The halves were taped back together to compare the latent prints developed by the reagents side-by-side and then subsequently compared with an alternate light source at 495-515 nm using orange goggles. The prints were evaluated for level of ridge detail using an arbitrary scale, and notes were taken comparing the resultant color, quality, and sensitivity of the two reagents. Photographs of each print were taken using a green excitation wavelength of 500-550 nm and a red-orange filter (549 nm) using a Foster & Freeman DCS-3 imaging system.

Results showed that Ind-Zn has superior ability to develop latent prints when compared to DFO and fluoresces a bright yellow on all substrates. DFO fluoresces a lighter orange color and lacks the contrast that Ind-Zn has against all of the backgrounds. Ind-Zn works especially well on newspaper, green file paper, brown packaging paper, and brown kraft paper. On these surfaces DFO either fails to develop the print or lacks sufficient contrast to effectively visualize the print. Ind-Zn proved to be more sensitive by frequently developing all of the prints on the strip more consistently than DFO. After a cost comparison of chemicals used in both formulations, it was determined that Ind-Zn is also less expensive to prepare than DFO.

Forensic Science, Fingerprints, 1,2-Indanedione

B18 Comparison Between Physical Developer Detergent Solutions

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After attending this presentation, attendees will learn about the similarities and/or differences found among three different physical developer detergent solutions used in the forensic community. Also, it will be described how latent prints from ten different paper substrates were developed in order to determine how the latent prints are affected.

This presentation will impact the forensic community by determining any differences and/or similarities between three different physical developer detergent solutions currently used in the field. In addition, this work will inform latent print specialists of any problems that they may face when analyzing evidence on complicated paper substrates, such as brown kraft paper.

Physical developer has been utilized by fingerprint specialists to analyze the water insoluble components of a latent print since the mid-1970s. Although the process is not completely understood, it has been found that not all physical developer formulations work the same. A physical developer solution is composed of three different solutions: a redox solution, a detergent solution, and a solution of silver nitrate. Although both the redox and the silver nitrate solutions are made from the same chemicals among labs, the origin or the detergent can vary. In this study, three different detergent solutions were evaluated.

Although it is not known what component of a latent print residue reacts with the silver in the physical developer solution, it has been determined that a chemical reaction between the two does occur. Once the sample is removed from the yellowish physical developer solution and rinsed with tap water, a grey to black fingerprint is left behind. Physical developer is often the last process that is used when analyzing a nonporous substrate, such as paper, due to the extent of the substrate background development. There are many cases in which the print is hard to view due to the substrate reacting with the physical developer solution.

In this study, latent prints were collected from eighteen different people, seven males and eleven females. These prints were deposited on ten different paper substrates: white photocopy paper, premium photocopy color photocopy paper, white legal pad paper, yellow legal pad paper, manila envelope paper, white envelope paper, green file folder paper, brown kraft paper, brown packaging paper, and newspaper. It was hypothesized that the prints would not develop to the same extent on each type of paper substrate due to the chemical differences in each paper type.

Three different physical developer solutions were made in order to serve as a representative sampling of the variety used in the field. One solution was made using a detergent containing Tween 20. Another solution utilized Synperonic N, while the last was made using Synperonic NP8. It was hypothesized that the Synperonic NP8 solution would not develop the latent prints as well as the other two solutions due to problems previously reported in the field.

The experiment was carried out dividing each latent print in half and processing each side using a different physical developer solution. Each half-strip was soaked in malic acid for fifteen to twenty minutes in order to remove as much calcium bicarbonate from the paper as possible. Next, the paper was processed using the designated physical developer solution for about fifteen minutes, followed by rinsing with tap water four times. The paper was dried by running the half-strips through an Arkay Stat-Dri dryer one time. The half-strips where then taped back together in order for comparison and photographing to be performed. Before the strips were divided, the moisture content was recorded in order to determine a difference, if any, on the results of the developed prints.

Results to date show that the Tween 20, Synperonic N, and Synperonic NP8 chemicals that are used in the differing detergent solutions of physical developer do not greatly affect the print, but differences were seen. It was determined that the Synperonic NP8 detergent developed the least amount of prints having good ridge detail among the three; however, it cannot be determined if it was the n-dodecylamine acetate or the syperonic NP8 that caused the variation. The greatest difference between the developed prints was seen in the substrate, proving our hypothesis to be correct. Moisture content was shown to have no effect on the development of the latent print.

Forensic Science, Fingerprints, Physical Developer

B19 Storage of DNA Samples at Ambient Temperature Using DNA-SampleMatrix®

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After attending this presentation, participants will learn about optimizing DNA storage of Forensic samples in a new matrix that may result in an increased ability to re-test crime scene samples.

This presentation will impact the forensic science community by demonstrating how the ability to re-test samples is an important part of forensic work and may lead to exoneration of the innocent or the identification of a suspect. Good storage of samples containing small amounts of DNA is important for maintaining the quality of the samples over time. The current work focuses on forensic DNA samples; however this technology is applicable to all DNA laboratories.

Biological samples collected and stored for diagnostic and research purposes include cells, viruses, and DNA/RNA. Advances in PCR technology have enabled successful analysis of minute quantities of these samples, including low quality and quantity DNA, which is commonly encountered in forensics. For example, DNA samples from bone and teeth recovered following large scale mass disasters and terrorist acts, as well as crime scene samples from sexual assault and touch evidence, such as fingerprints, can yield less than 100 pg of DNA.

The ability to re-test samples is a critical component of forensic work, where trace evidence can lead to exoneration of the innocent or the identification of a suspect. Thus, proper storage of samples containing small amounts of DNA is important for maintaining sample integrity over time. The objective of this study is to develop an efficient, long-term storage strategy for DNA samples. The current work focuses on forensic samples; however this technology is applicable to all DNA laboratories.

The ability to consistently recover and re-test forensic DNA samples may be affected by variables such as storage temperatures and repeated freeze-thaw cycles. Biomatrica, Inc. has developed a technology that allows for the stable, dry storage of biological materials at ambient temperatures. DNA-SampleMatrix® works by forming a protective shield around the sample that prevents further damage and degradation over time.

An international consortium of leading forensic, academic, and government laboratories has been formed to evaluate DNA-SampleMatrix® as an alternative to conventional freezer storage. In one study, the quality of control DNA (K562) recovered from room temperature dry storage in DNA-SampleMatrix® at various time intervals is being assessed. A comparison of samples stored in standard microfuge tubes at room temperature also is being conducted. Experiments comparing storage at -20◦C of samples maintained either in DNA-SampleMatrix® in a 96-well plate format (SampleGard®) or microfuge tubes is on going. Recovered samples will be quantified using qPCR and agarose gel electrophoresis. Preliminary results indicate that the integrity is maintained of DNA samples stored dry in DNA-SampleMatrix® over three months as compared to samples stored in standard microfuge tubes.

Samples stored in DNA-SampleMatrix® e were amplified using a variety of STR multiplexes including Powerplex16®, Identifiler™, and Profiler Plus®. No detectable inhibition to PCR amplification of the STR multiplexes was observed even in the presence of high concentrations of the DNA-SampleMatrix®.

Preliminary results also will be presented from additional consortium studies evaluating the ability of DNA-SampleMatrix® to store and protect samples previously extracted and typed from proficiency tests, degraded DNA samples, DNA extracted from bones and teeth, low copy number samples, samples that have been sent through the U.S. mail, and sample stability following multiple freeze-thaw cycles.

DNA Stability and Storage, Matrix, Degraded DNA

B20 Canine Detection Using a Calibration Standard and an Optimized Explosive Training Aid System

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The goal of this presentation is to educate on the use of contraband mimics for biological and instrumental detector training and calibration.

This presentation will impact the forensic community by fostering an understanding of how contraband mimics can aid in the training and testing of biological and instrumental detectors.

Odor detection has become a focused area of research over the past number years because of its importance to the forensic, law enforcement, and legal communities. Despite the increasing number of instrumental methods for detection of these characteristic chemical odors, the use of trained canines as biological detectors remains one of the most widely accepted methods to reliably detect explosives, drugs, arson, cadavers, mold, and human scent. Therefore, detector-dog response is one of the major applications involved with odor detection studies; both for the determination of the chemical signature of individual odors to which these canines are actually alerting, and to whether or not there is a common element within different items to support the use of contraband mimics. A comprehensive review of commercially available explosives has revealed and large redundancy between many different trade names and manufactures and a table of recommended explosives based maximum coverage and highest purity has been constructed.

It has been previously shown that law enforcement detection canines that are trained on real, representative samples containing actual parent compounds of drugs and explosives can and will alert to mimics based upon the dominant volatile odor compounds (VOC) found in the headspace of the parent compounds. Laboratory and field studies of explosive canines have shown that the dogs do not alert directly to TNT based explosives (such as military dynamite), smokeless powders (SP), or plasticized explosives (such as C-4) but rather to 2,4-dinitrotoluene (TNT and SP) and 2-ethyl-1-hexanol, respectively. This shows the potential for alternative training methods/aids to be used in place of dangerous and restricted high and low explosives. This study explores the potential for the use of a selection of high and low explosive training aid mimics incorporated into Controlled Odor Mimic Permeation Systems (COMPS) as training aid substitutes for explosives detection. COMPS devices were created with each compound using the optimum odor permeation rate found through careful dissipation rate studies. Evaluation of the dissipation rate of the compounds from the COMPS devices is used as a determining factor for the longevity of the COMPS method. Canine training was performed using a kit of six training aids found to be optimal for a wide variety of explosive compounds (TNT based, plasticized, smokeless powders, etc.).

Double blind field trials were performed with local K-9 trainers and their canines to determine if the canines were able to find the aid to which they had been trained upon as well as the corresponding actual explosive. The canines used in this study were previously unexposed to any form of explosive, explosive pseudo, or explosive mimic. The analysis of field results obtained using these canine teams will be presented to demonstrate the reliability and efficacy of the alternate compounds as training aids. In addition, this study explores the use of non-target volatile chemicals as possible calibration standards for canines that can be used to determine the ability and reliability for detection as well as for field calibration of instruments. The benefit of these non-target chemicals is that they are unlikely to be found in the field during training scenarios as well as in working conditions and can be used to provide a universal comparison of biological and instrumental detectors. Overall, the results demonstrate that canine detection of high and low explosives can be accomplished using non hazardous training aids by the optimal selection of odor compounds combined with selected COMPS. In addition, COMPS for drugs including MDMA have been successfully developed and will be discussed.

Canine Detection, Explosives, Mimic

B21 The Development of the Human Scent Collection for the Minimization of Environmental Contamination During Non-Contact Human Scent Sampling

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The goal of this presentation is to educate people on possible methods to alleviating conditions leading to environmental contamination during non-contact human scent sampling.

This presentation will impact the forensic community by increasing knowledge on alleviating conditions leading to environmental contamination during non-contact human scent sampling.

The study of human scent has been of interest to the forensic science community due to its application to human scent canines for the use of scent trailing and scent identification line-ups. Human scent is defined as volatile compounds originating from the body and is constant over time and environmental conditions. These compounds make up the "primary odor" of a human, and are of interest to this study. Any volatiles emitted from the body that are not consistent over time and are due to diet or environmental factors make up "secondary odor," also "tertiary odor" is due to compounds applied to the body such as soaps, lotions or perfumes. Improving the scientific understanding of human scent components, as well as, improving the collection and delivery of such components will enhance the admissibility of such evidence in the courts.

Human scent can be collected by direct contact sampling, or by non-contact sampling with devices such as the STU-100. With direct contact sampling the subject holds a piece of material or object in the hands or against the body for a period of time. Odor is collected directly onto such object. The Scent Transfer Unit™ or STU-100 is currently used by law enforcement for the non-contact sampling of human scent volatiles. With this device a scent pad, usually a piece of gauze is placed at the head of the device. The device is placed near the object of interest. Air is pulled through the device, extracting volatiles from the object onto the scent pad to be collected. For the purposes of this study, following collection, the scent pads are placed into vials and allowed to equilibrate. The headspace is analyzed using SPME/GC/MS.

A significant obstacle in the collection of human scent is environmental contamination from people or other sources distinct from the subject. Environmental contaminators hinder the reproducibility of the delivery of human scent compounds. These are particularly substantial problems with non-contact sampling. Studies have shown when blank scent pads devoid of a human scent profile are sampled with the STU-100 and analyzed with SPME/GC/MS, there is high contamination of compounds found in human scent on the pads.

In order to lessen these problems, a human scent collection chamber has been designed, which uses a positive air flow filtration system, filtering particles and reducing odorant compounds. An enclosure large enough to sample a single human was built. A metal cover attached and sealed securely to the top of the chamber, while the other walls of the chamber allow small amounts of air to pass. A section of the metal cover was removed and replaced with a grating. A filter was placed over the grating and a fan over this. When the fan is turned on, air from the surroundings passes through the filter and into the chamber, removing particles greater than one micron in size. As the clean air enters the chamber, the contaminated air is forced out, thus minimizing environmental contaminants and creating an environment for the reproducible delivery of human scent components.

Another obstacle in human scent research studies is the lack of available calibration standards. Experiments were conducted using liquid mixtures of the various human scent chemicals as a calibration sample but using STU-100 and SPME-GC/MS headspace sampling revealed that this approach is not reliable with large variations in the amounts and ratios of components. By optimization of polymer type and thickness we have been able to develop an array of controlled odor mimic permeation systems (COMPs) capable of providing reliable amounts of the calibration compounds.

Human Scent, Scent Transfer Unit, Environmental Contamination

B22 Laboratory and Field Experiments Used for the Determination of Odor Signature Chemicals in Marijuana

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The goal of this presentation is to provide information to the forensic and law enforcement community regarding odor detection of marijuana by detector canines using SPME GC/MS analysis.

This presentation will impact the forensic community by confirming and identifying the chemical odorants of marijuana used in odor detection by canines

Marijuana products constitute the most widely used group of illicit drugs. Research on marijuana and its psychoactive properties began over a century ago, however there has been limited research into the chemical odorants that contribute to its unique odor. Odor detection of controlled substances including marijuana and cocaine has recently become a significant area of research because of their importance to the forensic, law enforcement and legal communities. Narcotic odor is a result of odorant(s), which is/are characteristic of a drug and detected by the olfactory receptors. Research has determined that certified law enforcement detector canines often do not alert to the parent drug itself, rather they alert to by-products or decomposition products. These products have been shown to be volatile organic compounds (VOCs) used by detection canines to locate controlled substances. Despite other methods for the detection of narcotic odor, the use of canines remains widely accepted as the most reliable and cost effective method of detection. Research into the odorants of cocaine and MDMA has shown methyl benzoate and piperanol respectively to be responsible for detected odors by the majority of law enforcement canines tested. This study presents the VOCs emanating from marijuana products under variable conditions in addition to the differences in odor perception of canines based on sample size, and length of exposure.

Solid phase micro extraction (SPME) combined with gas chromatography/mass spectrometry (GC/MS) was utilized to extract the VOCs from the headspace of marijuana and cocaine. Headspace SPME sampling makes it possible to obtain consistent samples of VOCs above very small quantities of drugs as well as very large samples. The odor chemicals present in the headspace of marijuana were compared with those extracted from other plant materials in addition to paper currencies. Sampling was done employing variable sample sizes, exposure and equilibrium times in addition to containment scenarios ranging from completely closed to completely open. The SPME GC/MS method utilized a 70µm Stable Flex™ Carbowax Divinylbenzene (CW/DVB) SPME fiber (Supelco). Carbowax Divinylbenzene has been proven effective in removing volatiles from the headspace of illicit drugs. Quantification of the volatiles extracted from the headspace of the marijuana products were evaluated and are presented.

The purpose of this research is to identify and quantify the significance of drug odorants which could potentially generate an alert by a detection canine. The illicit drugs involved in this study included marijuana and cocaine. The active odor signature chemical of cocaine has been confirmed to be methyl benzoate with threshold levels of 1-10µg spiked methyl benzoate or 0.1-1ng/sec-odor diffusion. The level of odor signature chemicals needed to initiate consistent alerts from law enforcement detector canines further enhances the significance of dog alerts to possible controlled substances, because these levels are only found if substantial quantities are present. The threshold levels of the potential odor chemicals will be investigated to further justify this statement.

Research has determined the highest composition of VOCs present in the headspace of marijuana to include α-Pinene, Limonene, β-Pinene, Carene, α-caryophyllene, β-myrcene and Caryophyllene. There is significant interest in determining the exact composition of the dominant chemical odorants in addition to their relative abundances based on sample size. Quantification of parent drug residues and drug odorants has also been evaluated for different paper currencies (U.S. and Jamaican). α-Pinene and limonene have been observed above the headspace of non-controlled plant materials as well as paper currency.

Results from these experimentations demonstrate that sampling time, size and degree of containment can have an influence on the ratio of VOCs observed. Field experiments, to determine canine interest in the observed chemical odorants were conducted. This research has not detected significant drug odorants above paper currency in general circulation verifying that there is insufficient drug contamination on paper currency in circulation to initiate an alert by a properly trained law enforcement detector dog. Field testing is under way to determine the dominant odorants which may include β-Pinene, α-caryophyllene, β-myrcene and Caryophyllene.

Marijuana, Canine, Odor Detection

B23 Repair of Damaged DNA Using Commercially Available Enzymes

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After attending this presentation, attendees will learn about various commercial DNA polymerases and their use in repairing damaged DNA to restore the ability to type the sample for genetic profile.

This presentation will impact the forensic community by providing knowledge regarding damaged DNA repair.

Biological stains like blood and semen are frequently exposed to environmental conditions in crime scenes. The DNA in these biological stains is subject to damage in the presence of environmental factors like UV, moisture, heat, chemicals, and nucleases from microorganisms (Chung et al., 2004). The most common types of DNA damage are DNA breaks—double and single strand breaks due to UV exposure and damage by nucleases. It is often difficult to obtain a complete genetic profile for human identification purposes from highly damaged forensic samples.

The purpose of this research is to evaluate different DNA repair treatments and other strategies for damaged DNA using commercially available polymerases. The first step was to obtain damaged DNA exposed to ambient condition, UV light and sunlight. Blood and semen samples were exposed to these three conditions over a period of two weeks, one month, two months, three months, six months, and nine months and then collected and stored at -20ºC. Quantification of the samples was performed using the qPCR Quantifiler kit (Applied Biosystems). The extent of damage and subsequent repair was assessed by multiplex PCR amplification and analysis of the qualitative and quantitative results of 16 different genetic loci that display a range of sizes in base pairs as separated by capillary electrophoresis (ABI 310 Prism). DNA that displayed damage (as determined by allelic dropout of high molecular weight loci) were treated using different polymerases. Several different treatments were utilized including, Restorase DNA Polymerase (SIGMA-ALDRICH), single and double doses of AmpliTaqGold DNA Polymerase (Applied Biosystems) and Y family polymerases. Y family polymerases have the capability to carryout translesion synthesis. During the process, a polymerase incorporates nucleotides opposite a damaged DNA template, thus bypassing lesions that would otherwise impede synthesis (Ballantyne, 2006). DPo4 is a thermal stable member of the Y family polymerases and has been chosen as the candidate for this evaluation work. DPo4 can bypass several lesions like thymine-thymine dimers, cisplatin adducts and N-acetyl-2-aminofluorne adducts (Boudsocq et al. 2001, Ballantyne, 2006).

Preliminary data indicate that alleles that were not detected in the 6 month UV exposed and sunlight exposed samples were recovered using a process of pre-incubation with Restorase DNA Polymerase before amplification with Taq Polymerase. The results for the different time points of blood and semen using different variables and enzymes will be presented.

This research was supported by NSF-REU grant # DBI-0647160.

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Damaged DNA, DNA Repair, Allelic Dropout

B24 Investigation Into DNA Transfer Through Forceful Contact

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After attending this presentation attendees will find out whether offender DNA can be detected in sites of forceful contact and how the profiles observed vary between different types of force. This may be an important tool in those investigating physical abuse in men, women, and children.

This presentation will impact the forensic science community by providing an important tool in those investigating physical abuse in men, women, and children. DNA will be deposited after a punch or slap, although the quantity/quality will vary depending on the force applied.

DNA will be deposited after a punch or slap, although the quantity/quality will vary depending on the force applied.

The British Crime Survey of 2001 found that approximately 45% of women and 26% of men aged 16 to 59 had experienced at least one incident of inter-personal violence in their lifetimes. In Britain every year three million children are victims of abuse. Many victims are too terrified to tell the authorities what has happened, and without their testimony or the evidence of witnesses it may be impossible to identify the perpetrator and prosecute them.

A number of studies including those by van Oorschot *et al*. (1997), Lowe *et al*. (2002) and Ladd *et al*. (1999) have shown that it is possible to obtain a DNA profile from objects, touched even for only a few seconds. As yet, the only investigation into the transfer of DNA through forceful contact is that by Rutty (2002). This study showed that during simulated manual strangulation 7 out of 19 test swabs showed victim and offender DNA profiles, with the offender profile being observed up to 6 hours after contact. 12 out of the 19 showed victim only DNA profiles. No other study, as yet, has investigated different forms of forceful contact. It is hypothesized, therefore, that when an individual hits another some of the offenders DNA will be transferred onto that person's skin and vice versa.

This investigation follows on from the preliminary study performed by our group last year. Fifteen individuals were recruited and requested to wash their hands 15 minutes prior to sampling. They were then asked to slap and punch an acetate sheet attached to a focus pad. The sheets were swabbed with moistened, sterile, cotton swabs before and after contact. Later the experiment was repeated with a one hour gap between hand washing and sampling. A third experiment consisted of each individual punching and slapping the sheets three times in succession one hour after hand washing.

DNA was extracted from the swabs using the Qiagen QIAamp DNA mini kit and was quantified using the Quantifiler human DNA quantification kit. DNA was amplified and analysed using AmpF*l*STR® SGM Plus® PCR Amplification kit, ABI 3130 genetic analyzer and Genemapper ID®. Amplification was carried out using 28 and 34 (Low Copy Number) cycles of PCR, with the LCN PCR being performed in duplicate.

After amplification at 28 cycles few individuals exhibited transfer of DNA to the acetate sheets, mostly seen as single alleles at different loci. The increase in cycles to 34 (consensus results analysed) did result in an increase in the number of alleles observed. No full profiles were generated from any samples taken post punch, with only two full profiles seen after application of slap, one 15 minutes post wash and one 1 hour post wash (both single slaps and from different individuals). Fifteen minutes post wash 8 out of 15 volunteers transferred partial profiles after a single punch. One hour post wash 11 out of 15 (single punch) and 13 out of 15 (3 punches) exhibited partial profiles. After slapping the acetate sheet, under all 3 situations, all samples from all volunteers resulted in partial profiles – the only exceptions being the two full profiles already mentioned.

Overall little difference was seen between the samples taken 15 minutes post hand wash and those taken one hour post wash. Equally, little difference was observed between single and multiple punches. However there may be an increased difference if more punches/slaps are applied although it is unlikely that larger numbers of punches or slaps will be applied to the same area of the body. More identifiable profiles were observed from slaps than punches but the profiles observed do show some difference between the volunteers.

DNA, Force, Physical Abuse

B25 Identification of Improvised Explosive Device Assemblers Using MiniSTRs

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After attending this presentation, attendees will understand how miniSTRs and mtDNA can be used to identify individuals that handled an improvised explosive device (IED) prior to its detonation.

This presentation will impact the forensic community by providing a greater understanding of the nature of DNA obtained from detonated pipe bombs as well as the best approach to take when using genetic material to identify the handlers of IEDs.

The detonation of an IED produces very high temperatures, which, in combination with the general nature of DNA from shed skin cells, means that only degraded DNA is likely to remain on the resultant bomb fragments. Further, because the bomb surface has only touch DNA, low copy number (LCN) techniques must be utilized during analysis. Previous research has employed STR[1] and mtDNA[2] analysis to identify the handlers of pipe bombs. The rate of obtaining an STR profile was very low, while increased success was garnered using mtDNA. Unfortunately, although obtaining a mtDNA profile is valuable, it is not individualizing evidence, hence nuclear DNA testing is preferred in many instances. The development of miniSTR primers has provided a novel tool with which to amplify degraded DNA.

In the research to be presented, 17 volunteers were asked to handle two sets of pipe bomb components; one was made of PVC pipe and the other of steel. Prior to handling, the bomb components were soaked in bleach and subjected to UV irradiation to ensure that any DNA previously deposited on the pipes would not be detected during downstream analyses. Pipe bombs were filled with smokeless powder and a fuse was used as the initiator for the device. The bombs were

detonated in a safe facility and all remaining fragments were collected. DNA was isolated using the double swab technique. Following an organic extraction, DNA was amplified using two sets of miniplex primers: miniSGM[3] and miniNC01.[4] Because the DNA was LCN, reactions were performed in triplicate, and only alleles that appeared in at least two of the three tests were considered for the purposes of identification. Reference samples from the volunteers were processed using the same primer sets and assignments were made based on blind analysis of matching alleles. In tandem, mtDNA analysis was performed by sequencing the hypervariable regions. The success rate of identifying the assemblers of the IEDs using miniSTR analysis was compared to the success rate using mtDNA. Finally, the overall success rate using the techniques in combination was computed. In addition, success rates from the PVC pipe bombs were compared to those from the steel pipe bombs to determine if a difference in bomb making materials can result in varying rates of identification success.

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MiniSTR, Improvised Explosive Device, Low Copy Number DNA

B26 Investigative Studies Into the Recovery of DNA From Improvised Explosive Device Containers

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After attending this presentation, attendees will become familiar with obtaining DNA profiles from recovered IED containers (e.g., backpacks) and how this information can aid in identifying the person(s) responsible. Attendees will also learn how this approach can be more beneficial than trying to recover DNA profiles from the detonated IED itself.

This presentation will impact the forensic community by introducing a new approach to investigate cases involving IEDs, while at the same time contributing to many evolving topics in forensic science including low copy number/touch DNA, degraded DNA, PCR inhibition, and miniSTRs.

Improvised explosive devices (IEDs) have become the weapon of choice for military and terrorist attacks nationally and world-wide. Events such as the Centennial Olympic Park bombing in 1996, the London bombings of 2005, and the ongoing conflict in Iraq demonstrate the destructive and psychological capabilities of IEDs. Their ease of assembly and delivery, as well as the ability to readily conceal them, are important factors in their increased use.

IEDs are often transported and delivered in a container (e.g., a bag, backpack, or briefcase), which serves as a method of concealment. It is likely that any such container has undergone extensive, direct contact with the person responsible for the device, making DNA analysis plausible. Past research has shown that mtDNA profiles,[1] as well as a limited number of STR results,[2] can be obtained from a detonated IED. Although such data are valuable, they do not lead to absolute identification however. Analysis of DNA from IED containers has the potential to produce more discriminatory results (increased number of STR loci) for two reasons. First, the DNA on the container may not be as degraded as the DNA on the actual IED. Second, around 90% of the nonexplosive components of an IED survive the explosion,[3] thus pieces of the container are more likely to be collected, providing more sample to work with.

For the research presented, study participants were asked to carry a backpack for 1 – 2 weeks in a manner resembling everyday use. An IED was then placed in the backpack and detonated under the control of the Michigan State Police Bomb Squad. Pieces of the container were collected, and areas of likely contact (zippers, handles, straps) were individually swabbed to recover shed cells. Organic extractions were performed, followed by STR analysis. Results of these experiments will be presented.

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DNA, Improvised Explosive Device, Short Tandem Repeat

B27 Post Blast DNA Persistence: A Comparative Analysis of Three Extraction and Amplification Methods

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After attending this presentation, attendees will understand the capabilities and limitations of three singular methods for the extraction and amplification of nuclear DNA from an array of evidentiary materials recovered during controlled detonations of parcel bombs. Attendees will further appreciate the persistence of viable DNA on typical evidentiary items that have been subjected to the harsh environment of an explosion.

This presentation will impact the forensic community by introducing successful methods for obtaining full or partial DNA profiles from post-blast evidentiary materials.

A practical and reliable method for extracting and amplifying small quantities of DNA from evidence in criminal investigations is sought. Extracting and amplifying trace amounts of DNA for the purpose of obtaining a DNA profile may be essential to the association of suspects to evidentiary items. Recovery of very small quantities of DNA may be improved through the preferential use of optimized methods that can render suitable full or partial DNA profiles.

The sensitivity and reproducibility of varied methods for extraction of DNA was tested and validated through the use of known serial dilutions of whole blood using seven protocol variations for extraction. From these initial experiments three optimized extraction methods and two amplification methods were selected. The extraction methods included Orchid Cellmark's Optimized Organic Extraction procedure, Orchid Cellmark's EZ1 Biorobot extraction with a 100µl elution volume and Orchid Cellmark's EZ1 Biorobot extraction with a 50µl elution volume. Amplification was accomplished using either a PCR based method (Ampf*l*STR™ Identifiler Kit or Minifiler STR™ Kit by Applied Biosystems) or a whole genome amplification method (REPLI-g UltraFast™ Mini Kit by Qiagen). The extraction and amplification

methods were applied to a set of evidentiary materials including blood, saliva, tape, hair and fingerprints (applied to a solvent-based adhesive) that had been prepared in triplicate. Each set of evidentiary materials was packaged within a parcel containing a pipe bomb and subjected to the controlled detonation of the improvised explosive device (IED) with the package.

All samples collected were extracted following an overnight lysis. After extraction, each sample was concentrated using a Microcon column and eluted using 20 µl of water. Each sample was quantitated using a Quantifiler™ Kit by Applied Biosystems. Samples were either diluted or concentrated to obtain a target amount of 250-500 pg of DNA in a 5 µl volume for the PCR amplifications or a target amount of 1 ng for the whole genome amplifications (WGA). The samples were amplified in a 12 µl amplification reaction volume. For the samples not yielding complete profiles, a re-amplification was performed if sufficient DNA was available, otherwise, the samples were exposed to a variety of post-PCR clean-up methods to improve the genetic profiles generated.

Successful typing of the evidentiary samples was demonstrated with all three of the extraction methods tested; however, the amplification method selected post-extraction resulted in significantly different success. The Optimized Organic Extraction coupled with amplification via the Ampf*IS*TR™ Identifiler kit resulted in full DNA profiles obtained from the blood, saliva, full fingerprint and the partial fingerprint samples. When the samples were amplified using Ampf*IS*TR™ Minifiler™, full profiles were obtained from the blood, duct tape, packaging tape, full fingerprint and partial fingerprint samples. The EZ-1 100 µl elution coupled with amplification via the Ampf*IS*TR™ Identifiler kit resulted in full profiles from the blood, hair and partial fingerprint and full profiles with the Ampf*IS*TR™ Minifiler™ kit amplification of the blood, saliva, and the partial fingerprint. Finally, the EZ-1 50 µl elution coupled with WGA did not result in any full profiles and demonstrated failures at most alleles for the samples that did produce partial results. Additionally, the electropherograms produced from the WGA samples exhibit a significant difference in inter-locus balance and a large number of shoulder peaks and extraneous peaks. Of interest, when some of these same samples were amplified using the AmpfISTR™ Identifiler kit prior to WGA, they produced full profiles.

DNA, Post-Blast, Persistence

B28 Effects of Cyanoacrylate Fuming, Time, and Location of Biological Material on the Recovery and Analysis of DNA From Post-Blast Pipe Bomb Fragments

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The educational objectives of this presentation are to demonstrate that DNA analysis can be performed on post-blast pipe bomb fragments; to show how biological material located on pipe bombs is subjected to a unique set of environmental challenges; to convey the effects of cyanoacrylate fuming, if any, on DNA analysis of post-blast pipe bomb fragments; to convey the effects of time between pipe bomb deflagration and collection on the success of the DNA analysis; and to convey the effect of where the biological material is originally located has on the success of the DNA analysis.

This presentation will impact the forensic science community by making the attendees more aware of the factors that affect the success of DNA analysis of post-blast bomb fragments and the practitioners will use this knowledge to the benefit of their laboratories.

As knowledge and technology have improved in the collection, extraction, amplification, and analysis of biological material, the range of evidence potentially suitable for DNA analysis has expanded to include touch evidence. Specifically, with respect to the jurisdiction of the Bureau of Alcohol, Tobacco, Firearms and Explosives Laboratory, it may now be possible to identify the individual who assembled a pipe bomb by analyzing the fragments collected after the device has been deflagrated.

Forensic evidence commonly encountered in the laboratory has been exposed to environmental insults including degradation due to bacterial action, environmental contaminants from the scene, and laboratory introduced chemical contaminants during the course of routine examination. Added to these challenges, biological material recovered from post-blast bomb fragments has been exposed to unique extreme conditions. As the device deflagrates, the biological material is exposed to both extreme temperatures and the products of combustion. These highly oxidative combustion products coat the fragments and can further degrade the DNA over time.

This study investigates the effects of several of these factors. Collection and analysis of the biological material was performed both within days of deflagration and three months later to determine the effect of time. While previous examinations of the effects of cyanoacrylate fuming have been conducted to determine if it has detrimental effects, it was hypothesized that the cyanoacrylate fuming may actually protect the biological material remaining on the fragments over time if the fragments are fumed soon after collection. The study also compared the success rate of DNA analysis on biological material placed on the end cap and that of biological material placed on the pipe nipple.

To perform this study, six pipe bombs were assembled using 1” x 8” steel pipe nipples and associated end caps. The components were cleaned, decontaminated with 10% bleach, and rinsed with 70% ethanol prior to deposition of the biological material. Six aliquots of a washed buccal cell suspension were spotted at marked areas on each of the end caps and each of the pipe nipples and allowed to dry overnight. A buccal cell suspension was used instead of individuals handling the components to ensure a consistent initial quantity of biological material. The devices were placed in the center of a roll of chicken wire and placed in individual trenches to increase the chances of recovering the post-blast fragments. After deflagration, the fragments were recovered and taken to the laboratory. The following day the fragments from three of the devices were cyanoacrylate fumed. The double swab method was used to collect the biological material from two spots on each pipe and two spots from each pair of end caps resulting in four samples from each device and a total of twenty-four samples from all the devices. The remaining fragments were kept at room temperature in the laboratory until the collection and analysis was repeated three months later.

DNA analysis was performed on the swabs at the time of each collection. The tips of each pair of swabs were extracted together using the Qiagen QIAamp® Micro Kit. The concentrations of DNA in the extracts were determined using the ABI Quantifiler™ Human DNA Quantification Kit and the ABI 7500 Real-Time PCR System. STR amplification and analysis was performed using the ABI AmpFLSTR® Identifiler® Amplification Kit and the ABI 3130 Genetic Analyzer with GeneMapper™ ID software.

Four main conclusions were drawn from data collected during the course of this study. First, as has been shown previously, DNA can be recovered and successfully analyzed from post-blast bomb fragments. Second, cyanoacrylate fuming demonstrated no beneficial or detrimental effects on the DNA analysis of the biological material recovered from the fragments either immediately after deflagration or when analyzed three months later. Third, significantly more DNA was recovered from the cell spots on the pipe fragments than from the end cap fragments at both time points. Finally, time between deflagration and sample collection/DNA analysis had a significant effect on the amount of DNA recovered from the post-blast fragments and therefore the chances of successful DNA typing.

DNA Analysis, Pipe Bomb, Post-Blast

B29 Physical Separation and STR Analysis of Male / Female Epithelial Cell Mixtures and Male / Female White Blood Cell Mixtures Using Interphase Fluorescent in Situ Hybridization Techniques and Laser Capture Microdissection

Robert Driscoll, MFS, Dane Plaza, BS, and Robert A. Bever, PhD, Bode Technology, 10430 Furnace Road, Lorton, VA 22079*

Upon completion of this presentation participants will learn a four step procedure to produce a single STR profile from evidence consisting of male and female mixtures of epithelial cells and blood cells. The procedure incorporates the use of X and Y chromosome fluorescent in situ hybridization probes, laser capture microdissection techniques, and STR amplification methods using ABI AMPFLSTR Identifiler and Minifiler system kits.

The research presented will impact the forensic science community by providing the forensic community with a method to analyze mixtures. The method will result in single STR profiles and identify individuals from evidence containing male and female epithelial cell mixtures and male and female white blood cell mixtures.

Mixtures from two different individuals cannot be easily resolved when the mixtures consist of similar cell types. Laser capture microdissection (LCM) has been successful in physically separating sperm cells from epithelial cells in order to resolve DNA mixtures associated with sexual assault evidence. Often sexual assault evidence involves cells not associated with spermatocytes. Therefore we have developed a four step procedure to resolve mixtures of male and female epithelial cells or male and female blood cells. The four step protocol consists of the following methods:

1. Identification of male and female cells using fluorescent in situ hybridization (FISH) techniques with the Vysis CEP X® alpha satellite and CEP Y® satellite III probes.
2. The physical separation and collection of male and female cells using the Arcturus® PixCell IIe ® LCM System.
3. DNA extraction using Qiagen QIAamp® DNA Micro collection kits.
4. The amplification of the LCM collected cells using Applied Biosystem Inc. (ABI) AMF/STR Identifiler® and ABI AMPF/STR MiniFiler® systems.

Using the above protocol, STR profiles have been resolved from male / female mixtures of epithelial cells, white blood cells, and combinations of both. Additionally we have used this procedure to develop single STR profiles from blood and saliva stains placed on paper substrates, cotton fabric, and stainless steel surfaces. Using ABI Identifiler and Minifiler amplification systems, full and partial STR profiles have been obtained from DNA extracted from 500 to 5 FISH processed cells collected by laser capture micro-dissection.

DNA Mixtures, Laser Capture Microdissection, Fluorescent In Situ Hybridization

B30 Forensic Casework Challenges Using the AmpF/STR® MiniFiler™ PCR Amplification Kit

Gina M. Pineda, MS, Sudhir K. Sinha, PhD, and Huma Nasir, MS, ReliaGene Technologies, Inc., 5525 Mounes St., Suite 101, New Orleans, LA 70123*

The goal of this presentation is to show forensic casework result interpretation challenges using the ABI AmpFlSTR® MiniFiler™ PCR Amplification Kit.

This presentation will impact the forensic community by demonstrating examples of forensic casework situations where a revised result interpretation guideline was required to properly report the results of the highly sensitive MiniFiler™ kit.

Amplifying STR's from old, degraded or trace-level DNA samples is the biggest concern for forensic DNA labs. A genetic system must be sensitive, robust and accurate. A major obstacle to overcome is the acquisition of genetic information given the integrity and amount of the DNA template. PCR amplicon sizes can restrict the ascertainment of a reasonable genetic profile. The design methodology adopted by AB for the development of the AmpFℓSTR® MiniFiler™ kit involves shifting primer sequences in closer to the area of locus variability. In doing so, the target region becomes reduced resulting in smaller PCR fragments. This adjustment increases the chances of PCR amplification and minimizes competition between loci in the multiplex. ReliaGene's in-house validation studies of the MiniFiler system included sensitivity, stutter generation, accuracy/reproducibility, precision, sample degradation, various tissue amplification, low copy techniques, and DNA mixtures. The data generated in these validation experiments gives some suggestion to the advantages and limitations seen in the MiniFiler™ PCR Amplification Kit when applied to forensic samples and was used in the establishment of result interpretation guidelines for MiniSTR's.

ReliaGene has performed the MiniFiler test on several forensic cases to date and has encountered situations where a revised result interpretation guideline was required to properly report the results of this highly sensitive kit. This presentation will highlight the implementation of these result interpretation guidelines in various forensic casework scenarios of degraded and low level template DNA. Sample types tested include fingerprint lift, 43-year-old bone, and various degraded tissue samples. Several case examples will be presented and discussed.

MiniFiler Result Interpretation, Degraded Samples, Forensic Casework

B31 Development of an Improved Cell Elution and Preferential Lysis Method for Sexual Assault Cotton Swab Evidence Analysis

Jessica Voorhees Norris, MSc, Helina Cunniffe, Kate Manning, BSc, Sarah J. Linke, MS, Jerome P. Ferrance, PhD, and James P. Landers, PhD, University of Virginia, Department of Chemistry, McCormick Road, Charlottesville, VA 22904*

The focus of this project is the development of an improved method for the elution and preferential lysis of cells from cotton swab evidence samples collected from sexual assault victims.

This presentation will impact the forensic community by demonstrating an alternative to conventional differential extraction (DE) for increased recovery of biological materials in an effort to increase the amount of male DNA available for genetic identification.

Genetic analysis of mixed profile DNA samples obtained from vaginal swabs is a well-established technique in the investigation of sexual assault and rape cases. Unfortunately, the procedures involved in a typical forensic DNA analysis require that significant laboratory time be dedicated to a single case, particularly regarding sample preparation. Because of time and funding constraints involved in the investigation of such cases, a significant backlog exists in many DNA analysis laboratories.

The current protocol for recovery of genetic material from cotton swabs involves DE, a method that utilizes anionic detergent and proteinase K to selectively lyse vaginal epithelial cells while retaining intact sperm cells. The female DNA released into solution from the lysed vaginal epithelial cells is separated from intact sperm cells via centrifugation. The DE method does not always provide for efficient independent genetic analysis of the separated male fraction. Although

this treatment decreases the number of vaginal cells present in the sperm cell suspension, sperm cell lysis and subsequent loss of valuable evidential material often occurs during the proteolytic digestion step of the traditional DE process.[1] In addition, the method is time-consuming, often requiring overnight incubation of a swab sample.

Microchip technology offers a rapid, cost-effective alternative to conventional DNA analysis methods, and separation of sperm and epithelial cells on a microchip as the first step in forensic analysis of sexual assault evidence has been demonstrated.[2] This method required intact sperm and epithelial cells; therefore, a method for release of intact cells from cotton swabs was developed.[1, 3] This work showed increased recovery of sperm cells over traditional DE methods (two-fold), increasing the likelihood of obtaining a perpetrator genetic profile, particularly with low copy number (LCN) samples. Use of this cell recovery method with the traditional analysis requires selective lysis of the epithelial cells without loss of sperm cells. Whether associated with conventional processing or an anticipated lab-on-a-chip platform, increased sperm cell recovery and comprehensive epithelial cell lysis would be beneficial to the forensic community.

The presented work will detail the improved method for cellular recovery from swab samples along with a method for preferential lysis of epithelial cells. Elution of cells from cotton swabs utilizes an anionic detergent solution and allows recovery of intact sperm and epithelial cells, which can be separated to provide male and female fractions. Preferential lysis of the collected epithelial cells is performed using proteolytic digestion of cell solution, providing a starting point for traditional processing, but with a greater recovery of sperm cells. Various cell elution and preferential lysis conditions were evaluated by counting the eluted sperm and epithelial cells using a hemacytometer. Results indicate that an optimized two-step elution/preferential lysis method required less time than conventional DE, provided comprehensive lysis of epithelial cells to decrease contamination of the male fraction, and improved the recovery of sperm cells.

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Differential Extraction, Preferential Lysis, Cell Elution

B32 Improved Methods for the Elution and Extraction of Spermatozoa From Sexual Assault Samples

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After attending this presentation, attendees will be able to understand the importance of physically eluting spermatozoa from sexual assault samples prior to differential extraction and DNA profiling; and to learn how to perform differential extraction of spermatozoa/epithelial cells in less than one hour and still produce high quality, full STR profiles.

Implementation of these new methods for elution and differential extraction of spermatozoa will impact the forensic science community by leading to improvements in the ability and speed of forensic scientists to generate a larger number of successful STR profiles.

Attendees will receive technical information specifically on optimization of sperm elution from cotton swabs. Furthermore, attendees will learn how to perform differential extraction of sexual assault samples in less than one hour and produce high quality, full STR profiles from minimal numbers of spermatozoa.

Methods currently used by forensic laboratories for eluting spermatozoa from cotton applicator swabs collected following sexual assaults typically recover between 5 - 10% of the total spermatozoa present. This report describes a novel elution method developed by selecting and optimizing a combination of physical and chemical conditions designed to release the spermatozoa from the cotton fibers of the swab. The result is a drastic improvement in the number of spermatozoa recovered (85-95%). The use of this procedure produces significantly cleaner slide preparations aiding in the visualization and enumeration of sperm present in the sample.

Once spermatozoa have been eluted from the cotton swab, the sample is then subjected to differential extraction (DE). DE is a procedure commonly used on sexual assault samples for the purpose of separating the male and female DNA fractions. The classic differential extraction method often takes up to two days of processing time and is not very effective on samples with a high epithelial to sperm cell mixture ratio. These samples present a challenge to forensic analysts as they do not produce clean, full profiles when STR typing is performed. To this end, Orchid Cellmark Inc. has developed a new method that shortens the overall DE processing time to less than one hour. Following the use of Orchid Cellmark's new sperm elution procedure, the resulting sperm pellet is treated with an optimized extraction buffer cocktail that enhances the specific lysis of epithelial cells in less than 15 minutes. This treatment allows for a cleaner, more effective isolation of sperm cells which subsequently produce cleaner, full profiles that are easy to analyze. A detailed description of this new method and data obtained from the extraction of samples containing various epithelial to sperm cell mixture ratios will be presented.

Implementation of these methods in forensic laboratories will lead to improvements in the ability and speed of forensic scientists to recover significantly more spermatozoa from sexual assault samples and generate a larger number of successful STR profiles. These methods should lead to the successful resolution of a larger number of forensic cases.

Spermatozoa, Elution, Extraction

B33 Extraction of High Quality Genomic DNA From Forensic Evidence Samples

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After attending this presentation, attendees will learn about a new and unique method for extraction of genomic DNA from forensic evidence samples. The extraction method enables recovery of DNA from difficult forensic samples such as highly inhibited, degraded and those samples containing low quantities of DNA.

The presentation will impact the forensic science community by demonstrating a novel method developed specifically for extraction of genomic DNA from forensic evidence samples.

Isolation of DNA from forensic evidence samples is a challenging process which creates bottlenecks in the sample processing workflow. This is due to the large variation in sample types, possible exposure of the samples to environmental insults, presence of PCR inhibitors and limited starting material. A genomic DNA extraction method has been developed for lysis of various sample types, high recovery of DNA from

samples that contain low quantities of DNA and effective removal of PCR inhibitors. The method employs a proprietary chemistry for cell lysis, and a proprietary process designed for purification of DNA. The process for extraction of DNA was optimized using multifactor variant analysis and guard band studies. Performance of the developed method for extraction of DNA was compared to traditional phenol/chloroform method and several commercially available kits. Sample types investigated include liquid blood, blood stains on denim, cotton fabric and FTA paper, buccal swabs, liquid saliva, semen stains on cotton fabric, and cigarette butts. Purified DNA was free of PCR inhibitors. DNA yields for all sample types tested were equal to or better than both phenol/chloroform extraction method and commercial kits tested, especially for lower input amounts. STR profiles generated with the AmpFℓSTR® Identifiler® genotyping system produced balanced profiles devoid of PCR artifacts. The extraction method is suitable for manual and automated processing.

DNA Extraction, DNA Isolation, DNA Purification

B34 Quantitative and Qualitative Assessment of Total Human and Human Male DNA in Forensic Type Biological Samples Using a Multiplexed Real-Time PCR System

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After attending this presentation, attendees will learn about a methodology for simultaneous quantitation of human DNA and human male DNA in forensic biological samples in single PCR reaction using real-time PCR technology and its utility in the assessment of the quality of extracted DNA.

This presentation will impact the forensic science community by demonstrating a real time assay for simultaneous quantitation of human male and total human DNA in biological samples.

In order to select the appropriate STR analysis methodology and obtain optimal STR analysis results for forensic type samples, it is desirable to determine the relative quantities of male and female DNA and detect the presence of PCR inhibitors at an early stage in the analysis. This assessment is necessary because the forensic samples often contain mixtures of DNA from male and female contributors and are exposed to environmental insults. A multiplex TaqMan® assay has been developed to:

1. Quantitate total human DNA and human male DNA simultaneously
2. Determine the ratio of human male and female DNA
3. Detect PCR inhibitors
4. Allow selection of appropriate STR amplification kit
5. Predict success with downstream STR amplification

The multiplex assay is designed for the 7500 Real Time PCR System using the ribonuclease P RNA component H1 (RPPH1, VIC® labeled probe) human target and the sex determining region Y (SRY, FAM™ labeled probe) male-specific target. A synthetic oligonucleotide sequence was co-amplified as an internal PCR control (IPC, NED™ labeled probe). A validation study of the multiplex assay was performed according to the Revised Validation Guidelines by Scientific Working Group on DNA Analysis Methods (SWGDAM;http://www.fbi.gov/hq/lab/fsc/backissu/july2004/standards/2004_03_standards02.htm#perfcheck). Briefly, standard curves for both human (RPPH1) and human male (SRY) specific targets were generated using human male genomic DNA. The RPPH1 and SRY assays demonstrated human specificity with minimal cross-reactivity to DNA from other species. Reproducible DNA concentrations were obtained within a dynamic range of 0.023 to 50 ng/µl. In addition, the multiplex assay was highly sensitive to human male DNA in the presence of high amounts of female DNA, detecting as little as 25 pg/µl of human male DNA in the presence of a thousand-fold excess of human female DNA (25 ng/µl). The ability of the assay to predict inhibition of PCR was demonstrated by a shift of the Internal Positive Control (IPC) Ct values in the presence of increasing quantities of hematin and humic acid, common inhibitors of PCR. Experiments that were performed to demonstrate the correlation between the quantification results using the multiplex assay and the strength of STR profiles generated using the AmpFℓSTR® Identifiler®, Yfiler® and MiniFiler™ PCR Amplification Kits will also be discussed. The multiplex assay provides guidance for the selection of the appropriate STR amplification kit to obtain interpretable STR profiles. This approach will reduce the number of samples that need re-processing thereby decreasing the turn around time in a forensic laboratory.

DNA Quantitation, Real Time PCR, DNA Analysis

B35 United States Transferable Fiber Census

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The goal of this presentation is to inform trace analysts of rapid method for estimating the transferable fiber population in a given area and to provide an estimate of the current transferable fiber population taken from different geographical areas in the U.S.

This presentation will impact the forensic community by providing a basis for estimating the statistical significance of fiber trace evidence.

The results of the survey are intended to assist the analyst in identifying evidentiary values for fibers from different color and type classifications. Similar studies were compiled but, currently there is no definitive reference for fiber evidence in the United States; the aim of this project is to construct an internet accessible database containing the results from fiber surveys taken at different locations throughout the United States at differing times of the year.

The initial analysis of fiber distribution is based on data sampled from four locations; Florida, Virginia, Texas, and Illinois. Samples were collected with one of two methods; an electrostatic collection by physical wiping and an adhesive tape lift. The sampling method developed for the tape lift set of fibers is unique in that it is not biased toward dyed fibers as in the electrostatic method. The common method of sample retrieval using a tape lift has been modified in this project to allow for direct microscopic analysis of the lift. In the modified tape lift method, the cellophane tape used to lift the fibers is place on top of at second piece of the same tape oriented at a 90° rotation. The advantage of this method of sample collection is that the tape will retrieve all fibers in the background, and the lift can be directly analyzed therefore removing potential subsampling bias from the method.

Fibers were categorized into one of eleven generic fiber classes and one of six color classes. The current results indicate a distribution of cotton (65%), acetate (10%), and nylon (4%) as the most commonly found fiber types in the combined population with variations in the subsets of time of year and location. The least common fiber types were linen (1.1%) and silk (0.4%). The most common color types were un-dyed (35%), blue (28%), and black (19%). The most common fiber type/fiber color combinations were un-dyed cotton (26%), blue cotton

(23%), and black cotton (7%). Uncommon fiber type/fiber color combinations were acrylic/green, silk/red, rayon/green and wool/green at less than 0.2%. The distribution of color type within each fiber class was not uniform, although a majority of the fibers in most classes were un-dyed. The fiber census is intended to be an ongoing sample collection and analysis process updated to remain consistent with varying trends in the textile industry.

This research was supported by the National Institute of Justice, Office of Justice Programs. The research was undertaken as collaboration between the WVU Forensic Science Initiative and the National Center for Forensic Science, members of the Forensic Resource Network. Views presented do not reflect the position of the government or infer endorsement.

Fiber Evidence, Fiber Population, Microscopic Analysis of Fibers

B36 Forensic Examination of Counterfeit One New Turkish Lira Bimetallic Coins

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After attending this presentation, attendees will learn a general guideline of examination involving the physical parameters and surface features in examination of bimetallic coins.

The presentation will impact the forensic community by providing an examination guide on bimetallic coins including the core-extrusion method which is an effective and reliable supplementary method of examination.

The New Turkish Lira (Yeni Türk Lirasi, YTL) was introduced on January 1, 2005. The New Turkish Lira is equivalent to one million (old) Turkish Liras (Türk Lirasi, TL). In other words, six zeros were dropped from the old TL to make the YTL. Old Turkish liras were withdrawn from circulation during 2005. However within just one year after launching, counterfeit 1 YTL coins started to be found in Turkey. Counterfeit coins are usually produced by casting and show morphological details with less precision than those on genuine coins.

Since the advent of the new coin with a face value of One New Turkish Lira (1 YTL), a compound coin composed of a brass-colored inner disc and silver-colored outer ring, crime cases involving counterfeiting and use of false coins have increased in Turkey. In recent months, Turkish Police have seized many counterfeit 1 YTL coins that look like the genuine coins because of their pictures and letters, and because the feeling to the touch and weight were very similar to those genuine coins. The color and shape of counterfeit 1 YTL coins so closely resembled those of genuine coins that they could not be distinguished from genuine coins by the naked eye. The small details of stamped markings were blurred or absent on counterfeit 1 YTL coins but were clear and definite on genuine coins.

In this study counterfeit coins (1 YTL) were quantitatively analyzed by Scanning Electron Microscope with Energy Dispersive X-Ray Spectrometer after determinations of their diameter, thickness, weight, and appearance. The weight of each One New Turkish Lira (both genuine and counterfeit coins) was measured to sub-milligram using an electronic balance. The diameter and rim thickness of each One New Turkish Lira (both genuine and counterfeit coins) was measured twice employing a vernier caliper.

Scanning Electron Microscopy with Energy Dispersive X-Ray Spectrometry is a widely used nondestructive elemental analysis method. The coins were brushed and sequentially rinsed with distilled water and acetone. Each cleaned coin was mounted on a scanning electron microscope sample stub using double-sided carbon adhesive tape. The samples were then subjected to morphological observation and elemental analysis via scanning electron microscope with energy dispersive x-ray spectrometry without any coating. The working distance and magnification powers were varied while secondary image observation. A fixed working distance of 15mm and 200 times magnification were employed during energy dispersive x-ray analysis.

The major elements detected in the outer ring of both genuine and counterfeit coins were Cu, Ni, and Zn. Elements detected in the inner disc of genuine and counterfeit coins were also Cu, Ni, and Zn. The major elements percentage detected in the genuine coins were Cu, Ni, and Zn which were significantly different from the counterfeit coin samples.

Counterfeit Coins, Elemental Analysis, SEM/EDS

B37 Analytical Data for Ortho-, Meta-, and Para-Chlorophenyl-Piperazines (CPP)

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After attending this presentation, attendees will be briefed of the problems associated with identifying the ortho, meta and para-chlorophenyl-piperazine (CPP) isomers.

This presentation will impact the forensic community by demonstrating that a conclusive identification of the meta- and para-CPP isomers is not possible using gas chromatography and/or mass spectrometry. The purpose of this study was to look for alternative ways to make conclusive identifications of CPP isomers using HPLC, GC, GC/MS, GC/IRD, and FTIR.

Background: A new drug has arrived on the drug scene, 1-(3-chlorophenyl)-piperazine, commonly known as meta-CPP or mCPP. In the United States, mCPP tablets have been identified in several mid-western states, including Texas, Iowa, and Illinois. In 2006, three suspected ecstasy tablets were seized in Stillwater, Oklahoma and submitted for identification. A preliminary identification of mCPP was made. After referring to article in Microgram, which stated that a forensic lab had originally misidentified mCPP as pCPP, it was decided further analysis of the Oklahoma tablet was necessary.

Methods: Initially, an Agilent 6890 GC was used for screening. The compounds were analyzed on two different column types, DB-1 and HP-50, with the same instrument conditions. The DB-1 column retention times for the different compounds were: ortho-CPP – 4.08, meta-CPP – 4.49, para-CPP – 4.52, mixture – 4.08, 4.50 and 4.52. The 4.50 and 4.52 peaks were not baseline separated. The HP-50 column retention times were: ortho-CPP – 4.30, meta-CPP – 4.80, and para-CPP – 4.80. The mixture had only two peaks at 4.31 and 4.80.

Subsequently, an Agilent 5973 GC/MS equipped with a DB-1 GC column illustrated that the mass spectra of meta-CPP and para-CPP are identical. The ortho-CPP mass spectrum has additional ion peaks at 132 and 161. The combination of ion peaks and earlier retention time allowed for differentiation of ortho-CPP from meta- and para-CPP.

Upon completion of these experiments, it was determined that the GC retention times and mass spectra of the meta and para isomers were almost identical. A conclusive identification of either compound was not possible using gas chromatography and/or mass spectrometry.

The third type of analysis performed was GC/IRD utilizing an Agilent 6890 GC attached to a Digilab IRD II. A Rtx-1 GC column was used for the analysis. When comparing the three individual isomers, there are small, but distinguishable, differences in first peak grouping located between 3200 cm^{-1} and 2600 cm^{-1}. The principle peaks with the most differences are in the lower wavenumbers (1600 to 600 cm^{-1}). The three individual compounds are easily identified using GC/IRD. Modification of the GC method allowed sufficient separation of the isomer mixture to allow for identification.

The fourth type of analysis was FTIR spectrometry using ATR. The FTIR instrument used for analysis was a Magna-IR 550 Spectrometer Series II manufactured by Thermo Nicolet. The individual spectra for the different isomers were unambiguously different, with distinct characteristics throughout the spectrum (400 to 4000 cm^{-1}).

Lastly, HPLC analysis was performed on an Agilent 1100 LC equipped with a ZORBAX Eclipse-XDB C18 column. The mobile phase consisted of 5% acetonitrile and 95% of an aqueous mixture composed of 500 ml DI water, 0.35 gram decanesulfonic acid, 1 ml hexylamine and 2 ml phosphoric acid. The isomers were well resolved, allowing differentiation of the isomers. The retention times for ortho, meta and para isomers were 4.286, 7.901 and 9.210 minutes, respectively.

Conclusions: Conclusive identification can easily be made of the ortho-CPP isomer. It elutes at an earlier time on three different types of GC columns, and has different mass, IR and FTIR spectra when compared to the meta and para-CPP isomers.

The individual meta and para isomers cannot be distinguished using mass spectrometry, but are readily differentiated using IR and FTIR spectral data. If a mixture of these isomers is suspected, a technique such as GC-IRD could be used to separate and identify the components of that mixture. Alternatively, HPLC in combination with GC-MS can be utilized to determine which isomer(s) is present in such a mixture.

Drug Chemistry, mCPP, Chlorophenyl-Piperazine

B38 Probing Single Strand DNA Using Bioconjugated Quantum Dots

Shannon Gross, BS, and Jorn Chi Chung Yu, PhD, Sam Houston State University, Department of Chemistry 1003 Bowers Boulevard, Box 2117, Huntsville, TX 77341*

After attending this presentation, attendees will have the opportunity to discuss a method for detecting small amounts of DNA with a novel nano-material which has unique advantages over current dyes. The ease of adaptation of this technique to forensic labs from other chemistry-focused areas will be shown. Discussion of similar efforts towards advances in science being applied to forensics will be encouraged.

This presentation will impact the forensic community by demonstrating a new method that will impact the determination of profiles of those DNA samples that couldn't be determined by conventional DNA analysis procedures. Controlling high variations of small quantity, and degraded DNA samples have been a challenging problem in forensic DNA profiling. The investigation of novel nano-materials and single strand DNA is potentially applicable to single cell DNA analysis.

DNA analysis of small quantity, and degraded samples has been a challenging problem in forensic DNA profiling. Our investigation of novel nano-materials in single strand DNA is potentially applicable to single cell DNA analysis. The new development will have a great impact on the determination of profiles of those DNA samples which are too degraded or small to be determined by conventional DNA analysis procedures. Attendees will have the opportunity to discuss our method for detecting small amounts of DNA with quantum dots and the differences between quantum dots and typical fluorophores which have influenced the method development.

Quantum Dots (QDs) are semiconductive nanocrystals with fluorescent properties dependent on the particle size which can be synthesized but are also commercially available from a number of sources. They are more ideal for trace analysis than current fluorophores because they are more strongly fluorescent and typically have a slower decay rate. The nanocrystals are soluble in organic solvents unless they are coated with a polar group. It is this group which typically determines the chemistry to be employed to conjugate it to a molecule in aqueous solution. After the adaptation of QDs to aqueous solution, attempts to supplement or replace current fluorophores and dyes in biological and chemical fields have gained great attention in the scientific community. Some successful replacements of fluorescent cellular dyes, even in vivo, have demonstrated the versatility of this novel material.

Generally, strategies on bio-conjugation of QDs have been mainly based on the covalent linkage, electrostatic attraction and biotin–avidin interactions of QD surface ligands with target molecules. Determination of functionalities of QD bioconjugates are usually characterized by microscopic, spectroscopic techniques, immunoassay, and gel electrophoresis. In our previous work, we have adapted the established carbodiimide-mediated coupling reaction (such as N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide (EDC) - N-hydroxysuccinimide (NHS) chemistry) to allow conjugation of antibodies to water soluble QDs. Biological activity of antibody conjugated QDs was investigated by capillary electrophoresis immunoassay (CEIA). Separation of un-reacted QD bio-conjugates and immunocomplex was visualized in the electropherogram.

To improve the limit of detection of forensically valuable DNA while limiting additional costs in adopting new techniques is desirable within the forensic community. In this work, single strand DNA analysis was investigated by using a commercially available biotin conjugated QDs (biotin-QD). Strapavidin was selected as a bridging molecule between biotin-QD and a biotinylated DNA strand. Detection of different sizes of DNA was achieved by a genetic analyzer (Applied Biosystems, ABI 310). Optimization of the method, including injection time, buffer selection, buffer additives, detection wavelengths, will be reported and discussed. The goal is to use this novel nano-material combined with the separation power of CE to develop a rapid detection assay for single strand DNAs. This new technique offers the potential to analyze smaller sample sizes, thus minimizing evidence destruction and allowing analysis of samples expected to be too small to detect by current methods. It is also expected that the technique is highly transformative, because, other than the bio-conjugation chemistry, the technique utilizes equipments and materials currently available in a forensic DNA lab.

Single Strand DNA Profile, Quantum Dot, Capillary Electrophoresis

B39 Functionalization of Nanocrystals for Latent Fingerprint Development

Shamah Lloyd, Jorn Chi Chung Yu, PhD, and Shannon Gross, BS, Sam Houston State University, Department of Chemistry, 1003 Bowers Boulevard, Box 2117, Huntsville, TX 77340*

After attending this presentation, attendees will have the opportunity to discuss a new method for visualizing latent fingerprint with new nanomaterials which have unique advantages over current dyes. Attendees will be able to understand the chemistry of functionalization of nanomaterials for the purpose of latent fingerprint development

This presentation will impact the forensic community by discussing a sensitive method for latent fingerprint development. The new technique will impact the forensic science community by offering a new way in visualizing trace amount of fingerprint residues or aged fingerprints on porous objects.

The use of ninhydrin reacting with amines (including α-amino acids) in fingerprint residues to give a colored product has long been a method of choice for latent fingerprint development on porous surfaces. However, background interferences and discontinued-ridges of ninhydrin-developed fingerprints often caused problems in the later comparison of fingerprints. Fluorescent ninhydrin derivatives and post-ninhydrin treatment are common alternatives for the improvement of the

quality of latent fingerprints. A new development of visualization of latent fingerprints using functional nanocrystals will be proposed. Attendees will be able to understand the functionalization of nanomaterials and their chemistry in latent fingerprint development.

Semiconductive nanocrystals, also known as quantum dots (QDs), are nanocrystals with fluorescent properties dependent on the particle size. QDs have been considered as promising replacement over organic fluorophores in order to enhance the limits of detection. Many merits of using QDs, such as incredibly high photostability, wide absorption spectra, high fluorescence signal-to-noise ratio, and wide variety of emission colors make them very attractive in signal enhancement, sensor design and biological applications. With these unique properties of QDs, single bacterial pathogen detection has recently been made possible. The limits of detection can be improved at least 100 times with QDs as compared to the conventional fluorescein isothiocyanate (FITC)-based method. Menzel et al. first utilized QDs for latent fingerprint development. They investigated CdS/dendrimer nanocomposite to target fingerprint lipids or triglycerides. The dendrimer has been used as a bridge to incorporate CdS nanoparticles and to bond the fingerprint residues. Unfortunately, to mediate nanocrystallite/dendrimer composites, diimide pre-treatment of object surface was needed, thus created unwanted cross reactions. Moreover, nanocryallite/dendrimer composites tended to adhere onto every where, not just fingerprint residues. Serious background interference was inevitable. A better strategy is to functionalized QD surface to allow direct attachment onto fingerprint residues with minimum background interference, and promote high contract of fingerprint images.

Generally, strategies of functionalization of QDs have been based on the covalent linkage, electrostatic attraction and biotin–avidin interactions of QD surface ligands with target molecules. The established zero space carbodiimide-mediated coupling reaction (such as N-(3-dimethylaminopropyl)-N'-ethylcarbodiimide (EDC) - N-hydroxysuccinimide (NHS) chemistry) has been proved effective to allow conjugation of amines to water soluble carboxylate QDs. In this work, our strategy was focused on the synthesis of reactive ester on QD surface as the functional QDs to react amines in fingerprint residues. Both water soluble and insoluble species of functional QDs were tested in order to determine the best quality of fingerprint image. Excitation of fluorescence of QDs was achieved by using an alternative forensic light source (CrimeScope, CS-16-500). Comparison of conventional methods with the new technique will be reported and discussed.

Nanocrystals, Latent Fingerprint Development, Fluorescence

B40 Species Identification of Degraded Bone Fragments Using the 12S rRNA Gene

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After viewing this presentation, attendees will be presented with an assay that allows for the reliable species identification of degraded bone fragments using the 12S rRNA gene located in the mitochondrial genome.

This presentation will impact the forensic community by demonstrating a protocol for the species identification of small skeletal fragments to aid in missing person investigations.

In many missing persons cases, such as those regularly undertaken at the Armed Forces DNA Identification Laboratory (AFDIL), small skeletal fragments of unknown and potentially non-human origin are sometimes encountered. When initial DNA testing of these fragments is unsuccessful, it is important to determine if the amplification failed because the fragment is simply too degraded or the fragment is from a non-human source. In order to address the question, a set of universal PCR primers targeting a 307-base pair region of the mitochondrial cytochrome *b* gene[1,2] was recently tested and validated at AFDIL. However, when the assay was implemented in routine practice, it showed limited success due to the large amplicon size. As a result, an assay targeting a smaller fragment was necessary.

Published[3] vertebrate primers targeting a short (140 bp) yet variable portion of the mitochondrial 12S rRNA gene were further investigated for species identification. The amplification was optimized for aged, degraded skeletal remains and then tested under these conditions for sensitivity, mixture detection and effectiveness on degraded animal bones. The optimized assay yielded visible amplification products from as little as 10pg of input DNA on agarose gels, and produced sequencing results from approximately 1pg of input DNA. Experiments evaluating various mixture ratios proved the optimized protocol to be sensitive to minor components present at approximately 10% of the total input DNA quantity. Finally, DNAs results from a variety of known vertebrate species were successfully tested to confirm that the small amplicon provided sufficient information to classify the samples.

To complete the developmental validation of the assay, the 12S protocol was used to evaluate 20 bone samples submitted blindly by the Central Identification Laboratory (CIL). Initial testing correctly identified 13 samples (65%) at the species level and classified an additional 3 samples were correctly classified as non-human. Only 20% of the samples either failed to amplify or produced molecular data that differed significantly from the anthropological classifications. New bone fragments were submitted by CIL in order to re-evaluate for any the failed or and non-concordant samples for additional testing samples. Results from the subsequent testing produced informative data for these remaining 20%. In total, proved the 12S assay proved to be informative for all of the 20 samples. Successful identifications were obtained for 95% of the samples. The sequence data from the remaining unidentified skeletal element was a mixture between the authentic dog DNA and contaminant human DNA and a single inconclusive classification. In comparison, the validated cyt *b* protocol was less successful, with the majority (60%) of the same samples either failing to amplify or providing inconclusive results.

Through a variety of tests, the 140-base pair 12S mtDNA protocol optimized at AFDIL has been shown to be a robust and reliable assay that will be helpful in verifying human versus non-human origin of aged, degraded skeletal fragments.

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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Mitochondrial DNA, Species Identification, Degraded

B41 Validation of the AB 3730xl DNA Analyzer for Paternity and Forensic Use

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The goal of this presentation is to discuss the validation study of the AB 3730xl DNA Analyzer with a 48-capillary array with the AmpFlSTR® Identifiler® PCR amplification kit for paternity and forensic testing applications.

This presentation will impact the forensic community by providing public forensic laboratories with a validated means for high throughput DNA testing with robust results.

The Applied Biosystems (AB) 3130 Genetic Analyzers and 3730 DNA Analyzers are capillary electrophoresis-based instruments that generate genotypic information by separating amplified DNA fragments based upon their sizes and detecting fluorophores covalently-bound to incorporated primers. The 3130 Genetic Analyzers are increasing in popularity in labs performing forensic STR fragment analysis. The 3730 DNA Analyzers are considered medium-to-high throughput instruments that are not currently used in forensic laboratories. Sorenson Forensics primarily uses a 3130xl Genetic Analyzer for fragment analysis. The purpose of this study was to validate the AB 3730xl DNA Analyzer with a 48-capillary array with the AmpFℓSTR® Identifiler® PCR amplification kit for paternity and forensic testing applications.

This validation was performed for both Sorenson Forensics and Sorenson Genomics (paternity) laboratories. The following studies were performed in accordance with SWGDAM (Scientific Working Group on DNA Analysis Methods) guidelines and DAB (DNA Advisory Board) standards: Crosstalk, Concordance, Reproducibility and Precision, Sensitivity, Mixture, Match Criteria, Contamination, Stutter, and Peak Height Ratio Analysis. DNA samples used for this study included various sample types of simulated casework samples, such as buccal swabs, hairs, cigarette butts, blood on fabrics, and touched items, as well as NIST SRM 2391b samples. Sample quantities were determined either by the Quantifiler™ Human DNA Quantification Kit or a PicoGreen®-based assay. All samples were amplified using the AmpFℓSTR® Identifiler® PCR amplification kit and analyzed on a 3730xl DNA Analyzer. The default GeneMapper36_POP7 run module for the 3730xl and reduced cross talk (G5-RCT) dye set were used. The data were analyzed using either GeneMapper® ID software v3.2 or GeneMapper® software v4.0.

The AB 3730xl DNA Analyzer has proven to reliably and robustly analyze DNA fragments from the AmpFℓSTR® Identifiler® PCR amplification kit. Experimental results obtained from a 3730xl DNA Analyzer were concordant with results obtained from a 3130xl and/or an ABI Prism® 3700 Analyzer. Observed crosstalk was below 75RFU which did not interfere with interpretation. Concordant and reproducible results were obtained from the known samples, NIST SRM 2391b samples, 9947A positive amplification controls, and allelic ladders. Precision of the instrument was demonstrated by analyzing multiple Identifiler® ladders, simulated casework samples, and GeneScan™ 500 or 600 LIZ® size standard. The results of the sensitivity study indicated that the optimal range of input DNA for amplification is between 1.5ng - 3ng. Mixture analyses studies provided insight as to what mixture ratios could be confidently interpreted from casework samples. Stutter percentages fell within manufacturer's published guidelines. These results demonstrate the usefulness and applicability of the 3730xl for high throughput commercial DNA testing.

The results of these studies provide support for the use of the AmpFℓSTR® Identifiler® PCR amplification kit in conjunction with a 3730xl DNA Analyzer with a 48-capillary array for forensic and paternity testing in our laboratory. This instrument allows for a higher throughput and may decrease cost per sample through labor savings. Further studies could be performed to optimize the 3730xl for forensic applications. An injection time study would benefit forensic casework samples so that multiple injection times could be used. Further investigation into the merits of GeneScan™ 600 LIZ® size standard could also be assessed. Other commercially available multiplexes should also be validated on this instrument. This study comprises an initial validation of the Identifiler® multiplex on the AB 3730xl DNA Analyzer with a 48-capillary array for forensic and relationship testing applications.

Validation, 3730xl, Identifiler®

B42 Optimization of Degenerate Oligonucleotide Primed-Polymerase Chain Reaction for Forensic DNA Analysis Using Taq/Proofreading Enzyme Combinations

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The goal of this presentation is to discuss the research project to complete the optimization of a whole genome amplification (WGA) technique, Degenerate Oligonucleotide Primed – PCR (DOP-PCR). The optimized DOP-PCR should be able to overcome stochastic effects such as allelic drop out, stutter and peak imbalance that often arise when analyzing low copy number DNA evidence that is either degraded or of low quantity.

This presentation will impact the forensic community by providing a technique that may more efficiently analyze low copy number DNA evidence by increasing allelic success and profile acquisition. This technique is advantageous because it can be utilized with little additional cost to the forensic laboratories because it is designed to use equipment, kits, and techniques that are currently available.

Trace or latent DNA evidence including fingerprints, hairs, saliva, minute drops of blood and sweat are sometimes the only evidence available from crime scenes. This type of evidence usually contains less than 100 pg of DNA (~15 diploid cells or less) and is referred to as low copy number DNA evidence. Because of the limited quantity of DNA available, these types of samples can become difficult to analyze and interpret with traditional STR (short tandem repeats) analysis, preventing profile acquisition. Most analysis problems are due to stochastic effects that become prevalent with low copy number DNA samples. This includes allelic drop out, peak imbalance and high stutter. To overcome these limitations, techniques such as whole genome amplification (WGA) have been explored for forensic utility. Degenerate Oligonucleotide Primed-PCR (DOP-PCR) is a WGA technique that pre-amplifies large sections of the genome to produce enough DNA for downstream STR analysis. During non-specific cycling, a partially degenerate primer is utilized that binds at a low annealing temperature (30 ºC) at many random sites throughout the genome. The fragments produced are large, with good coverage and an overall higher yield. During the specific cycling, the temperature is increased to 62 ºC, increasing the stringency of the degenerate primers 5'end annealing to the previously amplified fragments. The final product size after DOP-PCR can be as much as 7 kb in length. It is believed that combining proofreading enzymes such as Pyrococcus furiosus (Pfu), Thermococcus gorgonarius (Tgo), or Pyrococcus species GB-D (Deep Vent) with Taq (*Thermus aquaticus*), may result in an increase in fidelity and final product size as well as a decrease in error rate. This is important because if longer products can be obtained, then a larger representative portion of the genome can be amplified, decreasing allelic drop out and increasing the probability of obtaining a complete STR profiles.

Five different DOP-PCR enzyme combinations were tested with DNA input values ranging from 0.25 nanograms to 7.8 picograms. The enzyme combinations included Taq:Pfu, Taq:Deep Vent, Taq:Tgo, Platinum Pfx, and ABI GeneAmp High Fidelity which consists of TaqGold and an unknown proprietary enzyme. All samples were amplified using optimized DOP-PCR technique (dcDOP-PCR). Samples were visualized on a 1% agarose gel to determine the DNA sample fragment size. All DNA sample fragments were then quantified

to obtain the total yield using the ABI QuantiBlot® Human DNA Quantitation kit. dcDOP-PCR product DNA was then concentrated and amplified using AmpF® Profiler Plus® PCR Amplification Kit. The products from this STR multiplex amplification were separated and analyzed via capillary electrophoresis using the ABI 3100*Avant* Genetic Analyzer. The success was measured by percentage of alleles present, heterozygous peak balance and occurrence of other stochastic effects. Fragment length, yield and STR analysis data will be presented and discussed.

These research findings will impact the forensic community by providing a technique that may more efficiently analyze low copy number DNA evidence by increasing allelic success and profile acquisition. This technique is advantageous because it can be utilized with little additional cost to the forensic laboratories because it is designed to use equipment, kits and techniques that are currently available.

DOP-PCR, Low Copy Number DNA, Proofreading Enzymes

B43 Differentiation of Glitter Lip Glosses Using Pyrolysis-Gas Chromatography/ Mass Spectroscopy

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The goal of this presentation is to teach methodologies using pyrolysis-gas chromatography/mass spectroscopy that can be used in conjunction with infrared spectroscopy to differentiate cosmetic glitter lip glosses.

This presentation will impact the forensic community by showing the potential of pyrolysis-gas chromatography as a method for the differentiation of glitter lip glosses from the same manufacturer.

Glitter lip gloss is a growing trend in the makeup industry increasing the potential to find this material as trace evidence in criminal investigations and as an aid in establishing a link between individuals at crime scenes. Previous research[1] examined twenty-three different lip glosses from nine common manufacturers using IlluminatIR with QuaIID software. This research showed that SensIR analysis was successful in distinguishing between lip glosses from the nine different manufacturers. However, it was not able to distinguish between lip glosses within the same manufacturer. A continuation study was performed to determine if further characterization of the original lip glosses within a manufacturer would be attainable using Pyrolysis-Gas Chromatography/Mass Spectrometry (Py-GC/MS). Lip glosses from seven of the nine manufacturers utilized in the previous study were analyzed: Bonne Bell, Caboodles, L'Oreal, Maybelline, NYC, Revlon, and Smackers. Three separate runs were performed on each of the lip glosses on different days to account for reproducibility within a particular type of gloss. Samples were placed on a ribbon probe and pyrolyzed at 800ºC for 20 seconds using a CDS Pyroprobe 5000. Ion chromatograms were produced with an Agilent 6890N Gas Chromatograph using an Agilent 5973 mass spectrometer as a detector. Chromatographic runs were performed at a maximum temperature of 325ºC for 50 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 and variation in pyrolysis temperature was performed to differentiate samples.

In this study, samples of ten of the lip glosses were purchased two years apart and tested to determine whether manufacturer's formulations of lip glosses varied during this time period. Lip glosses of the same color were tested. Results showed identical total ion chromatograms in all ten products from samples purchased two years apart. Therefore, it was determined that manufacturer's formulations did not vary during this time frame and showed no interlot variation. One new color for five different brands of lip glosses was purchased to determine whether the color of the lip gloss has an affect on the total ion chromatograms obtained. Again, results showed identical total ion chromatograms to the original spectra obtained indicating that color has no affect on the results obtained.

All lip glosses tested were differentiated using this method. Thus, Py-GC/MS shows potential to be a valid, reproducible method for the differentiation of lip glosses from the same manufacturer.

Reference:

1 Gilstrap, L., and Quarino, L., "SensIR Characterization of Glitter in Lip Glosses From Nine Manufacturers", Thirty-first Annual Meeting of Northeastern Association of Forensic Scientists, Newport, Rhode Island, 2005.

Glitter Lip Glosses, Pyrolysis, Ion Chromatograms

B44 A Practical Guide to Drug Identification Using Fast GC/MS

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After attending this presentation, attendees will understand some principles of drug identification using Fast GC/MS with hydrogen carrier gas, the necessary equipment for the application, and examples of various common drugs of abuse.

This presentation will impact the forensic community by demonstrating how this technique can improve sample throughput in dramatically reduced analysis time.

The use of helium has long been the preferred carrier gas for GC/MS applications, mainly in the United States. With the recent developments that suggest that the helium supply may become reduced, hydrogen gas is an excellent, viable, and economic alternative.

Safety precautions are very manageable. Utilization of proper precautions along with innovative engineering of today's GC/MS instruments makes the use of hydrogen easily accomplished.

The availability of new and free software downloads have taken much of the "trial and error" out of developing methods for GC/MS. Current method parameters are simply entered into a table format and the corresponding parameters are calculated and displayed.

A study comparison of two different capillary columns used for analysis as well as several examples of methods developed for practical applications will be presented.

Hydrogen, Helium, Fast GC/MS

B45 Validation of the AmpFℓSTR® MiniFiler™ PCR Amplification Kit and its Application to Identify Human Remains From a 1992 Helicopter Crash at the San Diego Police Department Crime Laboratory

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After attending this presentation, attendees will become more informed about the MiniFiler kit in order to better evaluate its success in recovering complete DNA profiles from challenged samples often

encountered in forensic casework. In addition, DNA typing of human remains exposed to the elements of the high desert will highlight MiniFiler's ability to obtain robust and reliable DNA profiles from highly degraded and inhibited samples.

This presentation will impact the forensic community by providing the basis of the eight validation studies conducted according to SWGDAM and ISO 17005 guidelines, five of which will be discussed: sensitivity, stochastic, peak height ratio, concordance, mock casework, and challenged samples that include the DNA typing of bone samples discovered at the site of a 1992 helicopter crash in the high desert of Baja California.

The study established that complete, reliable, and artifact-free DNA profiles can be obtained using between 0.2-0.6 ng of DNA, with the optimum template amount being approximately 0.3 ng. Homozygote genotypes can be reliably interpreted using a homozygote threshold of 450rfu, for both of the Applied Biosystems 310 and 3130 genetic analyzers, as the majority of instances of allelic dropout were observed to occur below this level. The peak height ratio between the two heterozygous peaks averaged approximately 78%. However, imbalance of as much as 36% was observed at all peak height pairs between 500 and 4000rfu. Caution should be exercised in relying on peak height ratios when attempting to elucidate component genotypes in a mixture.

Of the 20 known samples used in this study, concordance was found between the DNA typing results obtained from the MiniFiler and Identifiler kits for all except one sample in which a microvariant allele at the D21S11 locus was observed. This microvariant allele is detected by Identifiler, but fails to be detected by MiniFiler. The insertion/deletion causing this microvariant allele is suspected to occur within the MiniFiler primer binding site for this locus.

The Mock Casework and Challenged Samples demonstrated that for many of the loci in which no alleles were detected using Identifiler, results were obtained using MiniFiler. Therefore, the chance of obtaining complete profile information is greater when MiniFiler is used in conjunction with Identifiler, as opposed to the use of Identifiler alone on degraded or inhibited DNA samples.

For the victim of the 1992 helicopter crash, an incomplete genetic profile was achieved with the use of Identifiler, obtaining complete results at only 6 loci, and partial results at 3 loci. The ski slope effect seen in the original electropherogram was indicative of degradation, and PCR inhibition was observed from the qPCR quantitation results. When the DNA from the victim's bone sample was typed using MiniFiler, a complete profile that complemented the Identifiler results was obtained. Combining the results obtained from both MiniFiler and Identifiler allowed for a more powerful statistical analysis in comparison of the DNA profile of the bone to that of the DNA profile from the putative son of the crash victim, ultimately identifying the remains.

Data obtained from the eight validation experiments evaluating the performance of the AmpF*l*STR® MiniFiler™ PCR Amplification Kit demonstrates the MiniFiler kit, when used in conjunction with the Identifiler kit, provides an increased power to obtain genetic profiles from challenged samples. This validation study supports the use of the MiniFiler kit on forensic casework samples that are degraded and/or contain PCR inhibitors, and also demonstrates that these recent advances in DNA technology can provide answers for cases that have remained unsolved for years.

MiniFiler™, Validation, Identification of Human Remains

B46 Conclusion of Validation Study of Commercially Available Field Test Kits for Common Drugs of Abuse

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The goals of this presentation are to discuss sensitivity, specificity, and reproducibility data for commercially available drug field test kits; to describe the effects of environmental conditions on the performance of field drug test kits; and to integrate information presented to decide upon test kit type most suitable for own agency.

This presentation will impact the forensic community by providing law enforcement agencies with data to enable them to select the test kits best suited to their needs. Information is provided with respect to the measured criteria as well as corollary observations regarding test kit quality control, handling safety, and color. Results of this study will be included in the Best Practices Guide provided by NFSTC to all interested parties.

The National Forensic Science Technology Center (NFSTC), as part of its Field Investigation Drug Officer (FIDO) program, has developed a comprehensive training program and quality assurance system that provides law enforcement with the resources necessary to perform preliminary identification of controlled substances utilizing field test kits. In order to provide information concerning test kit performance, NFSTC expanded the FIDO project to include a validation study of the test kits most frequently employed by law enforcement agencies. The NFSTC previously presented to the Academy preliminary results of this validation study in 2006. This presentation presents the results of some additional testing on the NarcoPouch ®, NIK®, and NARK® II field test kits as well as the results of the entire validation study performed on the QuickCheck® test kits.

Kits included in this study are those manufactured by ODV Inc., Public Safety Inc., Sirchie Group, and the Lynn Peavey Company. In particular, the kits designed for presumptive identification of cocaine, methamphetamine, and heroin were assessed.

The results presented here include a narrower limit of detection (LOD) range than what was previously reported as well as the effects of environmental stress conditions on the test kits. Each kit type was subjected to dry heat, moist heat, refrigeration, or freezing temperatures for a period of two weeks.

Each sample was tested in duplicate with color assignment occurring after a one minute time interval. Colors were assigned as a numeric designation of hue, value, and chroma within the Munsell Color Chart System.

The results of this validation study will provide law enforcement agencies with data to enable them to select the test kits best suited to their needs. Information is provided with respect to the measured criteria as well as corollary observations regarding test kit quality control, handling safety, and color. Results of this study will be included in the Best Practices Guide provided by NFSTC to all interested parties.

Field Test Kits, Drugs of Abuse, Validation Study

B47 The Use of Liquid Latex for Soot Removal From Fire Scenes and Attempted Fingerprint Development With Ninhydrin

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The goal of this presentation is to illustrate the application of liquid latex for soot removal from fire scenes, and fingerprint recovery with subsequent chemical applications.

This presentation will impact the forensic community by enabling investigators to perform additional chemical processes to recover fingerprints. Fire investigators and crime scene specialists have a better chance of finding fingerprints at a fire scene if they can successfully remove soot from the exterior surfaces.

Fires accounted for 3,675 deaths and approximately 10.7 billion dollars worth of property loss in the United States in 2005. Of the 1.6 million fires that were reported, 52,500 of these were classified by law enforcement agencies as arson. Unfortunately, the clearance rate for arson cases remains low, largely due to the destructive nature of the fire itself, subsequent fire-fighting measures taken, and the misconception by fire investigators that there is no forensic evidence left at the scene. Recent research supports the theory that amino acids found in fingerprint deposits survive high temperatures, suggesting that prints could be yielded from fire scenes if the soot layers were properly removed prior to chemical printing processes. However, several previously published methods of soot removal have potentially detrimental effects to fingerprint and DNA evidence that might be present. Scotland Yard has developed a method of applying liquid latex upon a surface, that, when peeled, removes soot, but no such research has been attempted in the United States. An experiment was conducted to assess the application of liquid latex to drywall and glass panes, and its potential to yield fingerprints after the soot was removed. Results of this study supported previous research on the success of soot removal, and also yielded usable fingerprints within the soot itself prior to soot removal techniques. While the Ninhydrin application did not provide additional print detail, more research in this area is suggested to improve the likelihood of finding fingerprint evidence at fire scenes.

Arson, Soot Removal, Fingerprints

B48 Masking of Blue Color of Positive Seminal Acid Phosphatase by Red Color of Red Blood Cells

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After attending this presentation, attendees will gain a better understanding of the Seminal Acid Phosphatase test and how red blood cells can mask the blue color of the Seminal Acid Phosphatase test.

This presentation will impact the forensic community by bringing better understanding on how the color of red blood cells can affect the ability of the criminalist to observe the Seminal Acid Phosphatase test.

Sexual assault evidence is submitted to forensic laboratories for biological screening and DNA analysis. A screening method for detection of seminal fluid utilizes a chemical test for seminal acid phosphatase (SAP). This is a two-step test that uses 1 drop of thymolphthalein monophosphate (SAP #1) and after one minute, 2-3 drops of Na_2CO_3/NaOH solution (SAP #2). The SAP test rapidly produces a blue color in the presence of seminal fluid and remains colorless when seminal fluid is not present. When an SAP test is performed on a mixture of semen and red blood cells (RBC), the red color of the cells can often mask the characteristic blue color of a positive SAP test, leading to an inconclusive result. This experiment examines the use of deionized water as a means of diluting the red color of the blood to better observe the characteristic blue color of a positive reaction.

In this experiment, five samples were used (neat blood, neat semen, and 1:10, 1:50, and 1:100 semen/blood ratios). Neat semen, neat blood, and samples of each of the three ratios were spotted onto swabs (a total of five swabs), and allowed to dry in a fume hood over night. Cuttings (2-3mm by 1mm) were taken from each swab, placed into Fresh Plate® spot wells in row #1, and re-hydrated using one drop of deionized water (~ 20 micro liters). After waiting one minute, 20 micro liters of the solution were transferred down into a well in row #2 and 1 drop of deionized water was added. After another minute elapsed, 20 micro liters of the solution from the well in row #2 of the Fresh Plate® was then placed in a well in row #3 of the Fresh Plate®. This dilution procedure was performed on all samples. The 20 micro liters of water taken from wells in rows #1 and #2 had an observable red color. The SAP test was performed on all wells in rows #1-3 for all the samples following the SAP procedure using 1 drop of SAP #1 and 2 drops of SAP #2. The SAP test produced the expected blue color on the samples containing seminal fluid and the blue color was observable.

When water was used as a diluent, the characteristic blue color could be observed in each of the semen/blood dilutions and the neat semen sample on the cutting in the wells of row #1. The neat semen and the 1:10 semen/blood dilution produced a positive SAP result on the cutting and the water dilutions in all rows. The SAP test did not produce positive results in the 1:50 and 1:100 semen/blood dilutions in the lower wells in rows 2 and 3. This could have occurred because of a lowering in concentration of seminal acid phosphatase.

When testing for the presence of seminal fluid in samples with blood present, adding one drop of water to the Fresh Plate® well containing the dry cutting appeared to reduce the concentration of red blood cells in the well enough so that the analyst could observe the blue color, a positive SAP test.

Seminal Acid Phosphatase, Blood and Semen Mixture, Rape Evidence

B49 Simultaneous High Performance Thin Layer Chromatographic Determination of Heroine, Morphine, Cocaine, and MDMA

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The goal of this presentation is to propose a HPTLC (High Performance Thin Layer Chromatohraphy) technique for identifying major psychoactive drugs (morphine, heroine, cocaine, MDMA) on the same plate with a well separated mobile phase.

This presentation will impact the forensic community by discussing a proposed HPTLC method shown to be useful to detect related drugs simultaneously from samples and could be easily quantified densitometrically. Furthermore this method will impact the forensic science community by assisting police investigations in classifying street drugs according to their ingredients to find the manufacturer.

The capability of the technique was tested with authentic biological samples. This method provides an advantage for routine forensic analysis.

Background: These psychoactive drugs are frequently abused as all over the world and in our country. Decreasing prices for drugs may indicate increased availability. Recently, parents have admitted suspicious substances found in their children's possessions to our institute for identication. These situations may confirm our opinion as told above. Immunoassay and Thin Layer Chromatography (TLC) are most common screening methods. Each method has advantages and disadvantages. The traditional thin-layer chromatography (TLC) is an indispensable technique for forensic narcotic and systematic toxicology laboratory analysis for qualitative determinations. HPTLC is a new modern analytic instrument for semi-quantitative analysis based upon TLC. It assures quantitative determinations with direct densitometric measurements of chromatographic spots *in situ* on the plate. Here, a method for the drug determination in street samples with a HPTLC Scanner Photodensitometer and a sample applicator is presented. The HPTLC method has proven to be rapid, sensitive and accurate for quantitative determinations of these drugs in street and biological samples.

Experimental Method: Chromatographic separation was developed with Toluene:Acetone:Ethanol:NH_3(25%) (67:25:5:3) mobile phase using an automated HPTLC system. F254 10 cm×20 cm on glass, layer thickness 0.1 mm was used. All the standards were commercially pure products. All the solvents were purchased as analytical grade. Samples were applied with an automated HPTLC sampler. All standard solutions were prepared by dissolving 2 mg of reference substances with 1mL methanol. Standard solutions of related drugs were applied to the same plate in incremental amounts (5–2000 ng), checked visually, to obtain the limit of detection (LOD) of the technique.

Conclusions: Under optimized HPTLC conditions, morphine, heroine, cocaine, MDMA were baseline separated with the Rf of 0.14, 0.45, 0.80 and 0.35, limit of detection values are 25, 25, 5, 10 ng/µL, respectively. In conclusion, the proposed HPTLC method showed to be useful to detect related drugs simultaneously from the samples and could be easily quantified densitometrically. Furthermore this method may be useful for police investigation by classify the street drugs according to their ingredients to find the manufacturer.

HPTLC, Simultaneous Determination, Major Drugs

B50 Presumptive and Confirmatory Identification of 1,2-Triazolo-Benzodiazepines

Thomas A. Brettell, PhD, and Erika L. Asselin, BS, Cedar Crest College, Department of Chemical and Physical Sciences, 100 College Drive, Allentown, PA 18104*

After attending this presentation, attendees will understand the methods used for presumptive and confirmatory identification of the subclass of benzodiazepines called the 1,2-triazolo-benzodiazepines. Experimental data as well as literature data from commonly used sources will be presented.

This study will impact the forensic community by allowing for a summary of many common analytical techniques and their results to identify these drugs by a number of methods.

Forensic science drug laboratories are reporting a significant increase in the prevalence of benzodiazepines in submissions from drug-facilitated sexual assaults. The pharmacological properties of these drugs, and their availability by prescription, make their potential for abuse high. Their physiological effects on the central nervous system such as drowsiness, confusion, impaired coordination, and amnesia are ideal effects for use in the commission of these crimes. Most of the time, benzodiazepines are presented as bulk evidence in the tablet form or as a powder from a crushed tablet. When tablets are crushed into powder, isolation and conformation of the active ingredient becomes much more difficult since there is no logo to compare as in whole tablets. A series of presumptive and confirmatory tests are then needed for identification.

Benzodiazepines are generally divided into four sub-classes based on their structure. The basis of all the structures is a seven-member diazepine ring with most of the benzodiazepines having a phenyl substituent at the -5 position. The four basic structural groups are: (I) 5-aryl-1,4-benzodiazepines, (II) 4,5-oxazolo-benzodiaepines, (III) 1,2-triazolo- or 1,2-imidazo-benzodiazepines, and (IV) 1,4-thienodizepines. There are a number of other benzodiazepines that do fall into any of the four basic groups and are usually grouped as "odd" benzodiazepines. This study focused on the sub-group of the benzodiazepine class of drugs, 1,2-triazolo-benzodiazepines, which are being often detected in samples from the drug-facilitated sexual assault cases and other crimes.

This study is a comprehensive analysis of this class of drugs using data collected from the literature as well as new data generated in our laboratory. Prior analytical studies of 1,2-triazolo-benzodiazepines deal mainly with their metabolites and toxicology testing. This study will compile the physical properties, chemical properties, and analytical methods for analyzing and identifying these drugs. The drugs of interest were adinazolam, alprazolam, estazolam, midazolam, and triazolam. Adinazolam is used to treat anxiety disorders and is not available in the Unitied States. Alprazolam, commonly known as Xanax®, and estazolam, commonly known as Prosam®, are used to treat anxiety and panic disorders. Midazolam, commonly known as Versed®, is used as a sedative or hypnotic prior to surgical anesthesic. Triazolam, commonly known as Halcion®, is used as a hypnotic to treat insomnia. All of the 1,2-triazolo-benzodiazepines are Schedule IV controlled substances in the United States. Previously unreported data from color reagents commonly used in forensic science drug laboratories will be presented as well as new information from analysis by gas chromatography (GC) and thin-layer chromatography (TLC). Data included in this study has also been collected using ultraviolet (UV) spectrophotometry, high-pressure liquid chromatography (HPLC), infrared spectroscopy, Raman spectroscopy, mass spectrometry (MS), and proton nuclear magnetic resonance spectroscopy (H^1-NMR).

Benzodiazepine, 1,2-Triazolo-Benzodiazepines, Drug Chemistry

B51 Results of the SWGDAM Inter-Laboratory Exchange Study on Bone Extraction for Mitochondrial DNA Analysis

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The goal of this presentation is to present the results of the round-robin DNA typing study of skeletal remains conducted by the forensic mitochondrial DNA community including commercial, academic, and government forensic mitochondrial DNA laboratories in the United States and abroad.

This presentation will impact the forensic community by lending assurance to the forensic community that subtle differences in extraction, amplification, and sequencing protocols will still yield reproducible results.

With the implementation of the National Missing Persons DNA Database, the forensic DNA analysis of remains consisting of bone evidence continues to increase. Since the DNA found in forensic samples is frequently limiting and/or degraded, mitochondrial DNA (mtDNA) analysis is often the analysis method of choice. Obtaining mtDNA sequence from calcified tissue is particularly challenging. Laboratories employ several different approaches to obtain mtDNA of

sufficient quantity and quality from skeletal remains. In addition, no proficiency test is currently commercially available with bones as the evidentiary material.

The Mitochondrial DNA Subcommittee of the Scientific Working Group on DNA Analysis Methods (SWGDAM) has conducted an inter-laboratory study comparing the extraction methodologies and sequencing results obtained from a single source of bone sample. For the purposes of this study, a tibia was obtained from an anthropological research facility. This tibia had been buried for a period of approximately three years prior to dry storage at room temperature at the facility for an unknown period of time. Prior to distribution, the tibia was assessed for suitability and verification of mtDNA sequence. The tibia was sectioned by the organizing laboratory and distributed to the twenty-one participating laboratories. Extraction, amplification, and sequencing of the bone sections were performed according to each laboratory's standard protocols. Results were submitted from nineteen of the participants with concordant results for mtDNA sequencing. For laboratories submitting results for autosomal and Y STRs, concordant results were also obtained.

In addition to submitting typing results, participating laboratories submitted their standard operating procedures which contained details of their extraction methodologies as well as amplification and sequencing strategies. These details are presented. Despite variation in the cleaning methods of these bone portions, as well as variations in extraction methods (including decalcification, if applicable), quantity of sample used, amplification parameters, post-amplification quantification, sequencing chemistries and instrumentation, all methods proved reliable and the results obtained were concordant. Comparison of these results highlights the robust nature of forensic typing methodologies.

Although the results obtained from the current study demonstrated the reliability of forensic testing, the next generation of this inter-laboratory bone exchange study will include a more environmentally challenged sample to more closely mimic the type of samples encountered in a forensic context.

This study also displays the willingness of the forensic community to advance the knowledge of the field through collaborative studies.

Mitochondrial DNA, Skeletal Remains, Inter-Laboratory Study

B52 Dieletrophoretic (DEP) Separation of Sperm and Epithelial Cells

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After attending this presentation, attendees will be introduced to a new method based on the principle of dielectrophoresis (DEP) for separating sperm cells from epithelial cells (e-cells). This introduction will include a presentation of the general principles of DEP for cell separation, a description of a specific chip-based DEP system for separating sperm and e-cells, and results to evaluate the efficacy of the DEP separation system relative to the differential chemical lysis method that is currently used in most forensic DNA labs for sexual assault cases.

This presentation will impact the forensic community by providing information about a new approach for handling biological evidence in sexual assault cases.

A critical step in the successful DNA analysis of most sexual assault cases is the effective separation of male sperm and female epithelial cells, which are typically collected on a vaginal swab at the hospital soon after the event. In the differential extraction procedure currently used by most forensic DNA analysts, the swab containing both cell types is re-hydrated, cells are collected and a two-step differential lysis is performed. In the first step, the epithelial cell fraction is removed by a mild chemical lysis (detergent and proteinase), leaving the majority of the sperm heads intact. Cell separation relies on the more robust nature of the sperm head membranes, in particular, on the use of a chemical agent (e.g., DTT) in the second step to reduce disulfide bonds to assist in digesting the sperm membranes. Although the preferential lysis extraction is, by and large, effective, it suffers from several drawbacks. For example, some sperm DNA is lost to the epithelial fraction in the first lysis step, as well as in subsequent wash steps, and the procedure is labor intensive and not particularly amenable either to automation or to the microfluidic devices that are being examined for forensic applications.

To address these issues, we have been investigating the use of dielectrophoresis (DEP) for separating sperm and epithelial cells. DEP, a phenomenon first described by Pohl in 1978, is the movement of cells in the presence of a non-uniform electric field. Such an electric field can induce an electric dipole on a cell. The resulting interaction of this dipole with the non-uniform electric field can lead to a net force on the cell, inducing cell movement. DEP is particularly useful for selectively separating and sorting cell types because the strength and direction of the induced forces are very sensitive to cellular structure and composition. Experimental conditions (e.g., applied field strengths, applied field frequencies) can be chosen to fine-tune the DEP forces. Consequently, DEP can be used to separate cell types based on differences in size or in membrane or cytoplasm composition. In this presentation, we describe the use of a DEP system (the Silicon Biosystems™ SlideRunner™ DEP system) to separate sperm and epithelial cells in a chip-based format. Results (e.g., purity of the separated fractions, yield, sensitivity, and reproducibility) will be presented to describe the efficacy of the DEP separation for mixtures of sperm and female (buccal) epithelial cells.

Dielectrophoresis, Differential, Extraction

B53 Comparison of Commercial Blood Test Kits for Use in Crime Scenes

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After attending this presentation, attendees will learn the about the similarities and differences between the two commercial test kits "HEXAGON OBTI" and "ABAcard HemaTrace" in terns of design, sensitivity, response time, and cost for forensic identification of human (higher primate) blood.

This presentation will impact the forensic community by demonstrating how the identification of human blood at the crime scene using a fast and reliable technique is important for investigative purposes, for collection of useful stains for subsequent DNA profiling, and bloodstain pattern analysis. Two commercially available test kits based on the immunochromatographic technique were compared and reported.

To date, validation and implementation studies have been conducted for each of the two test kits but they have not been compared with each other. The objective of this study is to evaluate and compare the "HEXAGON OBTI" and "ABAcard HemaTrace" test kits in terms of their specificity, sensitivity, cost and more importantly, their ease of use at crime scenes. Human bloodstains, human body fluids (saliva, urine, semen) and animal bloodstains (sheep, cow, fish, pig, chicken, dog, goose, goat, cat, macaw, buffalo and eight kinds of higher primates) were tested according to the manufacturer's instructions.

These findings indicated that the sensitivities, specificity and cost of the two commercial test kits were comparable. Both kits were specific to human and higher primate blood and could detect up to two nanoliters of blood. The key differences between them were in their response time and the design of their component parts. The

"HEXAGON OBTI" test card exhibited a much faster response time (almost immediately), compared to the one to two minutes lag time required for the "ABAcard HemaTrace" test card, for the different concentrations of blood. In terms of design, the "HEXAGON OBTI" kit design was more user-friendly than the "ABAcard HemaTrace" kit. In the former, the cotton swab for collection was designed as an integral part of the cap of the extraction buffer solution bottle. This design facilitates the ease of sampling at the crime scene and the transfer of the swab back into the extraction buffer solution for incubation. After the incubation period, the tip of the bottle cap is broken easily and two drops of the extract can be squeezed onto the test card, i.e., transferring extract directly from the bottle onto the test card. For the "ABAcard HemaTrace" kit, the cotton swab is not provided as part of the kit. A small plastic dropper is supplied to transfer the extract onto the test card. This design increases the possibility of contamination as there is a need to open the cap of the buffer solution twice: once for putting the swab into the buffer solution for incubation and a second time to transfer the extract to the test card using the dropper.

From the comparison and evaluation study of the two kits, "HEXAGON OBTI" is the preferred kit for use at crime scenes, given its faster response time and better design which facilitates the collection and testing of stains.

Immunochromatographic Technique, Human Blood Identification, Test Kit

B54 Advances in Automation - Incorporation of the Biomek NXP Liquid Handler Into a Small Forensic Biology Laboratory

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The goal of this presentation is to discuss the advantages of the integration of the Biomek NXP into a small forensic biology laboratory, as well as to address the trials of being the first forensic laboratory to validate the instrument.

This presentation will impact the forensic community by demonstrating that the validation and implementation of the Biomek NXP increases the efficiency and throughput of a small forensic laboratory by decreasing the amount of time a forensic analyst spends processing a single sample.

The Palm Beach County Sheriff's Office (PBSO) Forensic Biology Unit has been using the Beckman Coulter BioMek® 2000 liquid handling robot on casework evidence for over four years. As a result, there has been nearly a 50% increase in the number of samples processed in the laboratory. In order to further enhance the sample handling capabilities of the laboratory to include automated extraction, qPCR preparation, normalization of sample DNA concentrations and amplification preparation, the PBSO has acquired the Biomek® NX^P. Similar to the BioMek®2000, the NX^P also uses the Promega Corporation's DNA IQ™ Extraction Kit for the extraction process. However, since this instrument has not been implemented into a forensic laboratory, the PBSO has been responsible for writing all of the software methods necessary to operate the robot. Training on the Biomek® NX^P was initiated at Beckman Coulter where beginning and intermediate courses were attended in order to acclimate to the system's software package. This knowledge was transferred to the PBSO's Biomek® NX^P but not without many challenges, especially as it related to the custom parts and protocols used within the laboratory. After extensive manipulation of the software, two all encompassing methods were written. The first method incorporated DNA extraction, using Promega's DNA IQ™ Kit, integrated with quantification using the Applied Biosystems' Quantifiler™ Human DNA Quantification Kit. This method allows the user to indicate how many samples will be extracted, as well as which extraction protocol will be used. An adjunct method combines the normalization of DNA extracts followed by PCR set-up for the Eppendorf Mastercycler. A user simply indicates which samples are concentrated and, using the data from the ABI Prism® 7000, the method will normalize all samples on the plate to the desired concentration, 1.21 ng/µL. Once the samples are extracted, quantified, normalized, and amplified using Promega's PowerPlex® 16 Bio, amplified products are electrophoresed on a 6% polyacrylamide gel followed by allele detection using the Hitachi FMBIO II Scanner. To test the reliability and reproducibility of these methods, the following validation studies have been conducted: first, a checkerboard test using 10mm blood punches was conducted on the Slicprep™ 96 Device plate and the Beckman Deep Well Plate to ensure there was no contamination. Data showed there was no cross contamination of samples from one well to another. Experiments were also run to look at sensitivity, mixture, and non-probative sample analysis, as well as to assess the improvement in efficiency and workflow in a small forensic biology laboratory. It is anticipated that the incorporation of the versatile Biomek® NX^P into a forensic caseworking laboratory will dramatically decrease the amount of time a forensic analyst spends with a single sample, thereby increasing the number of samples that can be handled which will reduce the backlog of cases.

This research was funded in part through an NIJ grant (2005-DN-BX-K099).

Biomek NX, Automation, Validation

B55 The DNA Mixture Conundrum: Sample Variation and Its Effects on Mixture Deconvolution Tools

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After attending this presentation, attendees will come to understand the need for stringent evaluation of mixture deconvolution tools and their applicability in solving DNA mixtures.

This presentation will impact the forensic community by illustrating that aid in DNA mixture interpretation may be found in DNA mixture deconvolution programs.

Learning Objectives: DNA mixture interpretation is often a dreaded and confounding task to many in the forensic community; however, it is important that reliable results are obtained when contributing mixture evidence to the criminal justice system. Without national guidelines on how to perform DNA mixture interpretation and statistical analysis, the possibility exists for inconsistency in mixture interpretation between laboratories across the United States. This study focuses on evaluating the DNA mixture deconvolution tools FSS-i^3 i-STReam, Least-Square Deconvolution (LSD) and DNA_DataAnalysis and assesses if these programs may be used to aid forensic DNA analysts in solving two-person mixtures.

Materials and Methods: Several DNA mixture samples were created at different major and minor contributor ratios and amplified with various commercial STR kits. The samples were amplified in replicate in order to test the variation that exists within PCR and to observe how this variation affects the mixture deconvolution tool's ability to reliably solve DNA mixtures. The data was collected on a 3130xl and analyzed with GeneMapper ID v3.2 and i-STRess v4.1.3, LSD, or DNA_DataAnalysis v2.01.

Summary of Results: The deconvolution tools were evaluated based on if they made calls, if the calls were correct, and why incorrect calls were obtained. The variability between the replicates was also analyzed and this PCR variability was used to explain some of the different and/or incorrect calls that the mixture deconvolution tools obtained. Also, by performing this study at varying ratios, it can be illustrated that the reliability of the deconvolution tools is dependent on the ratios of the major and minor contributors. These ratios play directly into the mathematical formulas that the programs are using to solve the DNA mixtures. Furthermore, not only does the analyst need to be proficient in DNA mixture analysis, but optimization of various parameters within the programs is important to obtain the correct contributor profiles.

Conclusions: There are several DNA mixture deconvolution tools available to help analysts in deciphering these mixtures; not only do they bring more consistency to DNA mixture interpretation, but they also shorten analysis time and with appropriate tuning can prove to be fairly reliable. However, further analysis of these deconvolution tools is still needed before their applicability in the forensic community is established.

DNA Mixture Deconvolution, PCR Replicates, FSS-i3 i-STReam

B56 Assessment of the Forensic Utility of the Carbon, Nitrogen, and Oxygen Isotope Variability in a Suite of RDX-Based Explosives

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The goal of this presentation is to summarize the methodologies used in stable isotope analyses of nitrated high explosive, demonstrates substantial variations in the carbon, nitrogen, and oxygen isotope composition of high explosives, and discusses how these data can be used in forensic analysis of explosive devices.

This presentation will impact the forensic community by providing an initial suggestion on appropriate methodology for oxygen isotope analysis of explosives and does a preliminary assessment of isotopic variability. There are not yet any accepted methods for this problem for use by those doing forensic analyses of explosives. The accepted methods for oxygen isotope analysis of solids work poorly on high explosives, due to their high nitrogen content. This presentation explains these difficulties and recommends ways to overcome these complications.

Introduction: The natural relative abundances of isotope of light elements, like carbon, nitrogen and oxygen, vary by small, but measurable, amounts due chemical processes which fractionate the isotopes based on their mass. The forensic applications of stable isotopes are rapidly increasing, but this is still an uncommon analytical technique, and has not yet been used as evidence in any U.S. criminal case, but has been used in civil cases and cases overseas. Stable isotope abundances are measured as the ratio of the heavy, rare isotope to the light, common isotope ($^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$). However, the precision of the measurements is so low (~1 part in 10^6 variation in the raw ratio) that typically these isotope ratios are reported as a per mil deviation from of the isotope ratio of a standard material, or delta notation.

Methods: Explosive components were purified from plastic explosive samples using hexane (2x) extraction to remove plasticizers followed by acetone extraction (2x) and filtering to purify the explosive, in this case RDX. No further purification was needed on these samples as RDX was the only explosive component. Carbon and nitrogen isotope ratios were measured by a standard EA-IRMS method, with no need for dilution of the CO_2 peak due to the high N content. Instrumentation used was a Eurovector EA interfaced with a GVI Isoprime magnetic sector mass spectrometer. Oxygen isotope ratio measurements done by standard methods presented some problems. Using a Thermo TC/EA-IRMS (high temperature reduction coupled to a Delta V+ isotope ratio mass spectrometer), the conversion of the explosive-oxygen to CO appeared reasonable as quantitative yields were produced, there was good chromatographic separation of N_2 from CO on masses 28 and 29, and isotope ratio measurements were reproducible. However, the mass 30 background following the N_2 peak never returned to their nominal values, making the $\delta^{18}O$ measurements offset from their true values. The cause of this problem is the creation of NO (with a mass 30 interference) in the ion source following the N_2 peak (discussed for $\delta^{18}O$ measurements of nitrates in: Gehre and Strauch, 2003; Révész and Böhlke, 2002). Use of the Conflo III dilutor during the N_2 peak improved measured isotope ratio measurements by almost 8‰. Replacement of the standard 0.6m 5Å molecular sieve column in the TC/EA with a 1.5m column permits extension of the delay time between the N_2 and CO elution, further reducing the NO background affecting the CO oxygen isotope ratio measurements.

Preliminary Study: A suite of RDX-based plastic explosives, thought to be derived from a common production operation, was assessed for its range in C,N and O isotopic composition. Other forensic analyses found no differences in these explosive materials including FTIR, GC-ECD, and LC-MS, yet an unexpectedly wide range of isotopic compositions was observed. The $\delta^{13}C$, $\delta^{15}N$ and $\delta^{18}O$ of RDX had ranges of 19.8, 17 and 10.3 ‰ respectively. The large majority of these samples showed a negative correlation between the $\delta^{15}N$ and $\delta^{18}O$ values suggesting that they had been manufactured in batches and the manufacturing process caused this anti-correlation. A few samples fell off of this curve, but had isotope ratios within the ranges of the other samples suggesting that these multivariate statistical approaches are needed for interpretation of data of this nature. Moreover other RDX-based explosives with different binder chemistry, and thus of clearly distinct origin, also fell off of the main O-N isotope trend demonstrating that stable isotope analysis of explosives is a useful approach.

Conclusions: The forensic value of stable isotope measurements of high explosives is only useful in the context of other more established forensic analyses. However, in cases where a direct comparison of material from a crime scene with that from a suspect or direct comparison of explosives from two devices, the carbon nitrogen and oxygen isotope ratios of the explosive can be useful for demonstrating that the devices were constructed with the same batches of explosives. Substantial C, N and O isotope variations of RDX provide a means to categorize explosives which are otherwise chemically identical. Special precautions must be used in oxygen isotope analysis of high nitrogen explosives due to the creation of NO in the ion source. Inaccurate results may be obtained despite excellent yield and reproducible oxygen isotope measurements, but for inter-laboratory comparisons accurate results are crucial.

Stable Isotopes, RDX, Explosives

B57 Development of Two Mini-X Chromosomal Short Tandem Repeat Multiplexes

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The goal of this presentation is to describe the development of two multiplex polymerase chain reaction (PCR) assays for the detection of fifteen different X chromosome short tandem repeat (STR) markers and

the sex-determining region of the Y chromosome. How these assays might be utilized at the Armed Forces DNA Identification Laboratory (AFDIL) to aid in identity testing will be demonstrated. The attendee will also learn about developmental considerations necessary when working with reduced-size STR assays.

This presentation will impact the forensic community by introducing X-STR markers for identity testing, as well as providing a suitable context for their use.

The multiplex detection and analysis of STR markers is a common tool used for genetic identity testing in the forensic setting. Numerous published assays describe a number of potential markers located throughout the autosomes and male-specific Y chromosome. Commercial kits are available, allowing routine use in crime laboratories. Markers located on the X chromosome, however, have thus far been relatively rarely used in forensic identity testing within the United States. At AFDIL, kinship testing is routinely used to identify skeletal remains. In cases where maternal reference individuals are unavailable or where the unidentified individual has one of the most common mitochondrial DNA (mtDNA) haplotypes, mtDNA testing is insufficient for establishing human identity. Sufficient statistical power must then result from fewer, smaller STR loci or low copy number analyses. In such cases, markers on the X chromosome may provide additional information. This is especially true for situations where a daughter is utilized as the reference individual for her father.[1] Consequently, the selection of candidate X chromosomal markers and the development of these markers into mini-STR multiplexes offers the potential to supplement both traditional STR testing and mtDNA sequencing.

STR loci are chosen for forensic use based upon their discriminatory power, repeat size, and observed heterozygosity. Additionally, because DNA templates encountered in the forensic setting, and at AFDIL specifically, are often degraded, amplicon size should be considered in selecting potential markers. In such cases, shorter amplicon sizes are favored with the goal of recovering the maximum number of alleles. Each of these factors were taken into consideration in the design of the two multiplexes presented here; markers were selected to maintain high heterozygosity (>0.630) while limiting the largest amplicon size to under 180 base pairs. Another criterion for selecting candidate STR loci is pairwise linkage; in order to take advantage of the product rule in the calculation of random match statistics, markers should not be linked to one another. Marker selection restricted to a single chromosome, then, introduces an additional challenge because some loci will necessarily be linked. Based on a review of published X chromosome mapping studies[1], four linkage groups have been identified. The markers present in the two nine-plexes represent all four linkage groups, affording maximum discriminatory power.

In this presentation, data illustrating both marker selection and multiplex development for two nine-plex X chromosomal STR assays will be presented. So-called "X-plex 1" consists of markers DXS7424, DXS6789, DXS7130, DXS9902, DXS7423, DXS9895, GATA165B12, DXS101, and SRY; "X-plex 2" consists of markers DXS7133, GATA172D05, DXS8378, DXS7132, DXS6803, HPRTB, GATA31E08, DXS9902, and SRY. SRY and DXS9902 were included in both multiplexes for concordance and gender confirmation (SRY).

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:

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X Chromosome, Mini-STRs, Identity Testing

B58 Developmental Validation of a Real Time PCR Assay for the Quantitation of Total Human and Male DNA

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After attending this presentation, attendees will understand the utility, performance and limitations of the Plexor™ HY System in forensic sample quantitation.

This presentation will impact the forensic science community by presenting a full developmental validation data set from a new qPCR system for the quantitation of forensic samples.

Multiplexed Short Tandem Repeat (STR) analysis has become the dominant technology in DNA-based human identification. Although highly informative, these assays require a defined range of template quantity to produce optimal results. In addition to accurate sample quantitation, simultaneous assessment of sample quality and highly sensitive detection are necessary to fully answer the question of how best to proceed with sample analysis.

Quantitative PCR has displaced hybridization-based methods for human-specific quantitation. This change has reduced the rate of false negative results (due to lack of sensitivity) and increased the objectivity of data interpretation (numerical output rather than visual comparison of band intensities). However, some current qPCR methods do not allow simultaneous quantitation of total human and human male DNA as well as sensitivity that consistently exceeds that of the subsequent STR assays.

The Plexor™ System, a quantitative PCR method, has been developed using the specific interaction of two modified nucleotides. One of the PCR primers includes a modified nucleotide, iso-dC, adjacent to a fluorescent label on the 5′ end. The second PCR primer is unlabeled. The reaction buffer includes the complementary iso-dGTP, which has been modified to include dabcyl quencher. Incorporation of the dabcyl iso-dGTP adjacent to the fluorescent dye reduces signal that allows quantitative data to be obtained. Multiple targets can be simultaneously detected through use of a different flurophore for each target. The non-destructive nature of this approach permits melt/dissociation analysis of amplified products. This post-PCR analysis can compare similarity of the amplified sequence between the standards and unknowns, providing a useful quality confirmation.

The Plexor™ HY System is a multiplex assay that has been developed for the simultaneous quantitation of total human DNA and human male DNA. An internal PCR control (IPC) has been included to monitor inhibition in the quantitation process. This assay uses three dyes to detect amplification and a fourth dye to provide a passive reference signal. The autosomal target is a multicopy 99bp target on chromosome 17. The Y-chromosomal target is a multicopy 133bp target on the short arm of the Y-chromosome. The IPC target is a synthetic sequence added to all wells. The amplified IPC is 150bp, the longest amplicon in the assay.

Associated Plexor™ Analysis Software has been developed to visualize amplification data from multiple instrument platforms, plot standard curves, and calculate DNA concentrations of unknowns. An STR normalization module has been built in to the software that, with simple user inputs, allows the software to: (a) compute sample input volumes required for amplification in autosomal and Y-STR reactions, (b) calculate necessary dilutions for concentrated samples, and (c) flag low quality and inhibited data. Protocols for use with the Applied Biosystems 7500 and 7500 FAST Real-Time PCR Systems and the Stratagene Mx3000P® and Mx3005P® QPCR Systems have been developed. A discussion on use with other instrumentation will also be presented. In addition to analysis software, development of automated

methods for qPCR set-up, DNA normalization and STR amplification set-up will be described.

Data will be presented demonstrating the performance of this assay and the interface of the analysis software. Developmental validation studies include: (a) within run and between run reproducibility, (b) Y-assay male specificity, (c) human specificity (non-human DNA analysis), (d) post-quantitation normalization and STR amplification, (e) inhibitor impact and purification method studies, (f) concordance with existing quantitation systems including non-probative samples, (g) quantitation of degraded DNA, (h) male/female mixture studies, and (i) interlaboratory comparisons.

DNA Quantitation, Real Time PCR, Forensic Science

B59 Genomic Approaches to the Identification of Individuals Through Familial Database Searches

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After attending this presentation, attendees will learn how to use familial searching to generate investigative leads that would otherwise go undetected by the current database searching methods. Additionally, attendees will learn how adding Y-STRs and mitochondrial DNA sequencing to the CODIS autosomal STRs improves the discrimination power of familial searching.

This presentation will impact the forensic community by providing an objective assessment of the utility and limitations of familial searching as an investigative tool to aid in the identification of perpetrators of no-suspect and cold cases and also to identify victims of mass disasters and human rights abuses.

Forensic DNA databases (e.g., CODIS) are routinely used to identify the perpetrator of a crime by comparing the unknown biological evidence profile to the known convicted offender profiles in the database. The most common type of database search is referred to as a high stringency match search, where the evidence and offender profiles must match at all loci to produce a hit. However, instances occur when two compared profiles share at least one allele at each locus; this type of hit results from a moderate stringency match, which requires at least one allele at all loci in common between the two profiles. Due to the highly similar yet non-identical profiles generated from these moderate stringency searches, the law enforcement and forensic science communities have recognized that these partial matches may indicate a potential close familial relationship, such as parent and offspring, and these matches could be valuable investigative leads to find the true perpetrator. Until recently, the FBI did not allow the release of the identity of an offender that partially matches a crime sample from another state's search. Furthermore, most states do not have policies regarding the reporting of partial profile matches resulting from database searches. Consequently, these moderate stringency matches—some of which may be true relatives—are not routinely evaluated in most states.

Although the CODIS search algorithm can identify individuals with shared alleles, CODIS was not purposely designed to identify relatives. An alternative approach that specifically aims to identify family members, called familial searching, has been used to identify victims of mass disasters, human rights violations, and missing persons cases. Before familial searching methods are employed in criminal cases, it is imperative to evaluate the discriminatory power of the CODIS STRs to identify potential relatives. It has been previously demonstrated the high proportion of false positive leads (i.e., unrelated individuals who appear related by chance) that result from familial searches of profiles with 13 STRs. A majority of these false positives will likely be dismissed upon law enforcement investigation. However, with the national database rapidly approaching 5 million profiles, investigation of the thousands of putative relatives generated from a familial search would be inefficient and ineffective.

In order to decrease the proportion of false positive matches and subsequent unnecessary investigation, Y-STR and mitochondrial DNA (mtDNA) analysis can be added to the CODIS STRs. Although these lineage markers are not fully informative for positive individual identification, Y-STRs, and mtDNA can be highly informative for identifying unique, family-specific haplotypes and sequences. We can exploit the lineage-specific nature of these markers and the high incidence of unique haplotypes to reduce the number of false positive matches that result from familial searches using only autosomal loci. The addition of Y-STR and mtDNA analysis to the CODIS loci enables more accurate identification of potential close relatives by excluding individuals who cannot be related to the true perpetrator either through a paternal or maternal lineage. Upon Y-STR and mtDNA analysis of individuals after a familial search of their autosomal STR profiles, we observe a dramatic decrease in the proportion of database individuals that require further investigation. The addition of lineage-specific markers to the CODIS autosomal STRs will allow greater discriminatory power than familial searching with CODIS markers alone. The acceptable level of discrimination has yet to be determined by the forensic and law enforcement communities.

Familial Searching, Offender Database, DNA Identification

B60 Development of a New Autosomal STR Multiplex With Additional Loci to Benefit Human Identity Testing

Becky Hill, MS, Peter M. Vallone, PhD, Margaret C. Kline, MS, and John M. Butler, PhD, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8311, Gaithersburg, MD 20899-8311*

After attending this presentation, attendees will gain knowledge of a new autosomal STR multiplex assay with non-CODIS loci.

This presentation will impact the forensic community by introducing a new DNA test for human identification purposes.

Learning Objective and Outcome: The importance of the development of this new autosomal STR multiplex for its use within the forensic community and its value for rapid reference sample typing will be discussed, as well as the approach used in its development.

A total of 26 additional STR markers spanning unused chromosomal locations across the 22 autosomes have been characterized[1, 2] so that they may be combined without conflicting with the current 13 CODIS core loci that are widely used in U.S. DNA databases. These 26 STRs were originally developed as reduced size 3plex miniSTRs with product sizes below 140 bp for recovery of information from degraded DNA that can come from missing persons or mass disaster samples.[3] A single amplification, five-dye multiplex has been designed and developed to combine all of these new loci in one reaction to enable rapid analysis of reference samples. These new STR loci have been examined in U.S. population samples and sequenced for calibration of allele nomenclature in standard samples.[1, 2] In addition, a concordance evaluation was performed with the multiplex to compare genotypes obtained with the previously characterized miniSTR loci to determine if there are any null alleles present with the newly designed primer sets. The multiplex was also run across father/son plates to determine the individual mutation rates of each STR locus characterized.

Methods and Materials: The development of the new autosomal STR multiplex will be discussed along with the accompanying concordance evaluation and mutation rate study performed with its use. The 26 miniSTR loci were previously characterized[1, 2] and redesigned to be combined in a single amplification five-dye reaction. The primers

for these loci were all designed using Primer3 software. These primers were then screened using the AutoDimer software[4] and BLAST searches were performed to determine the compatibility of the primers used in multiplex. Four separate dyes were then assigned to the forward primers (6-FAM, VIC, NED, and PET) according to the multiplex design. The fifth dye channel (LIZ) was reserved for the appropriate size standard. The primers were quantified and mixed together to be run with previously characterized samples. Problematic loci causing artifacts were identified and redesigned. Once all of the adjustments were made optimization of the multiplex ensued, such as empirically determining primer concentrations for balanced dye signals and dye-blob removal with post-amplification filters. SRM 2391b was genotyped using the multiplex and from this information, bins and panels were created for each locus in the GeneMapper ID, version 3.2.1 software. The multiplex was then evaluated across more than 600 samples representing the three major populations in the U.S.: Caucasian, African Americans, and Hispanic. The population data were genotyped and a concordance study was performed comparing these types to those previously determined from the miniSTR loci[1, 2] to identify any null alleles from either dataset. The multiplex was also examined across approximately 400 father/son paired samples and mutation rates from father to son were calculated.

Summary of Results: The new STR multiplex with 26 different loci and Amelogenin has been designed and evaluated for concordance with non-overlapping PCR primers using >600 U.S. population samples. Mutation rates were also determined using father/son samples.

Conclusions: A new STR multiplex has been developed in a single amplification reaction for rapid reference sample typing.

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Short Tandem Repeat DNA Typing, Autosomal STR Multiplex, Mutation Rates

B61 Primer Modifications for the Improvement of Degenerate Oligonucleotide Primed-PCR-Based Whole Genome Amplification From Limited Quantities of DNA

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After attending this presentation, attendees will learn an alternative form of WGA analysis for low-copy number forensic samples will be introduced to the attendees. In addition, results from optimization techniques will be discussed.

This presentation will impact the forensic science community by expanding on what has previously been reported on WGA methods for forensic analysis. These results may impact a laboratories decision to include low-copy analysis as a testing option.

Genetic analysis of compromised biological evidence is a frequent problem faced by forensic DNA analysts. Unfortunately, a complete and reliable STR (short tandem repeat) profile is difficult to obtain when using limited input quantities of DNA, whether a sample is limited in total quantity or limited in quality due to degradation. Currently there are several commercial STR multiplex kits available that allow simultaneous amplification of the core loci used in the Combined DNA Index System, or CODIS. However, the recommended input range is 0.5-2.5ng template DNA, a quantity that is not always available for testing from forensic casework samples. Therefore, researchers are attempting to formulate methodologies that can accommodate low-copy number samples (≤100pg – equivalent to ~15 diploid cells or less) for accurate STR profiling. Whole genome amplification (WGA) is one technique that has been developed to pre-amplify the complete genome with minimal amplification bias prior to downstream applications such as locus specific STR multiplex amplification. This study sought to modify the Degenerate Oligonucleotide Primed (DOP)-PCR Whole Genome Amplification (WGA) method for improvement of downstream STR analysis of low copy number forensic DNA samples. Experiments involved increasing the degeneracy of the standard DOP primer which contains a six nucleotide degenerate region in its interior sequence, flanked by specific sequences on the 3' and 5' ends of the primer. These specific sequences in the standard DOP primer may prevent ample annealing across the genome limiting the ability to attain true whole genome coverage. By decreasing the specificity of the primer, or increasing its degeneracy, these modifications will likely increase the number of potential binding sites during the low annealing temperature cycles of the DOP-PCR reaction. These new primers may therefore aid in a more thorough amplification of the regions of the human genome containing STR loci and thus reduce allele drop out. Input DNA quantities of 0.125ng and 0.062ng were examined for each of three degenerate primers (6, 10, and 16 degenerate nucleotides) using standard DOP-PCR thermalcycling parameters. The total DNA recovered was quantified and electrophoresed to determine the yield and size of the resulting DNA fragments. All DOP-PCR products were then amplified using the AmpF*l*STR® Profiler Plus® STR kit followed by separation and detection by capillary electrophoresis (ABI 3100*Avant)*. While DOP-PCR products using the 10N and 16N primer were not able to be visualized or quantified using the standard conditions, use of the 10N primer significantly increased STR amplification success, producing as high as 78% of the expected alleles from as little as 0.062ng input DNA with a lower rate of drop-in or stochastic allele occurrence when compared to the 6N primer results. Further, both 10N and 16N primers averaged >50% heterozygote peak balance ratio for most input quantities examined. These results show that modifications of the traditional DOP-PCR reaction to include the use of a more degenerate primer (10N) allows for the generation of longer DNA fragments and more complete, balanced chromosome representation from limited and/or compromised clinical and forensic biological samples. Additionally, the DOP-PCR technique described herein utilizes equipment and technical skills already in place in most existing forensic and clinical DNA laboratories. Thus, if successful, the knowledge gained from this study may help to provide the forensic community with a procedure that would be highly beneficial and easy to implement.

Forensic DNA Analysis, Low Copy Number PCR, WGA

B62 A 2-D Microchip-Based Process for Volume Reduction and Purification of Total Nucleic Acids

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Upon completion of this workshop, participants will gain an understanding of a microdevice that can be used to reduce the volume of a dilute biological sample for downstream solid phase-based extraction and purification of nucleic acids on a single microdevice.

This presentation will impact the forensic community by introducing a microdevice for nucleic acid purification from the types of dilute biological evidence collected in forensic investigations, providing the potential to increase the speed of processing forensic casework samples. This work is a step toward the use of a micro-total analysis system for forensic genetic analysis.

The purpose of this research is to demonstrate the ability to reduce the volume and then purify the nucleic acids from dilute crude biological samples on a single microfluidic device.

There are numerous advantages in utilizing microfluidic devices for forensic analyses including reductions in analysis time, cost of instrumentation, and reagent consumption, as well as the ability to be combined with downstream analytical processes on a single microfabricated device.[1] In addition, there is an inherent reduction in sample consumption, important when sample is limited in forensic casework. Microchip solid phase extractions (SPE) have proven to be highly efficient and reproducible for the purification of DNA using silica-based solid phases, as demonstrated by Bienvenue, et al.[2] More recent studies demonstrate the effectiveness of the same silica-based microchip extraction method in the isolation and purification of RNA.[3] The self-contained microdevice provides an environment for RNA extraction with less opportunity for the introduction of RNases, allowing for more efficient purification of RNA by reducing sources of contamination and degradation.

Working with small amounts of sample is realized in microfluidic extractions, however, larger samples, on the order of milliliters, are often generated in casework in the collection of samples from fabrics and surfaces; these still require standard processing as they are not compatible with current microchip devices. The presented research describes a two-dimensional microchip-based method that brings together two orthogonal processes that sequentially carry out sample volume reduction and purification of nucleic acids from dilute biological samples. Volume reduction solid phase extraction (vrSPE) will be performed using a silica phase to remove impurities and concentrate the sample down to a suitable volume for a subsequent SPE on a single microdevice. A newly-developed method for DNA and RNA extraction will be used in the SPE performed after the volume reduction. The method involves the use of chitosan-coated silica beads as a solid phase, which binds and releases nucleic acids based on a pH-induced charge switch.[4] The advantage of this phase over silica is that it completely avoids the use of PCR inhibitors such as guanidine hydrochloride and 2-propanol used in typical silica-based SPE. Nucleic acids are eluted at a pH compatible with PCR buffer, allowing for future integration into a micro-total analysis system. This work will demonstrate the effectiveness of the vrSPE method coupled with chitosan-based SPE as a method for isolation and purification of nucleic acids. An integrated device design will be presented, along with preliminary studies describing the capacity and extraction efficiency of the device. Data from downstream PCR and RT-PCR analysis will be reported, and results from this work will demonstrate the first integrated microfluidic device for volume reduction and total nucleic acid purification utilizing an aqueous chitosan SPE method.

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Nucleic Acids, Microchip, Extraction

B63 Solving Burglary Cases in New York City Through the Biotracks® DNA Testing Project

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This presentation is designed to demonstrate the success of using current DNA technology and State and National databases to solve lesser offense crimes and will discuss the logistical challenges of outsourcing a large number of cases.

In 2000, the Office of the Chief Medical Examiner's Department of Forensic Biology did a pilot study in which members of the FARU (Forensic Analysis Reconstruction Unit) team assisted the New York City Police Department in collecting evidence in thirty burglary cases. The DNA results for these cases generated two database matches. Based on this and other State's data, the New York City Police Department decided to create the grant funded "Biotracks" program. This program focused on testing DNA evidence collected from non suspect burglary cases since burglars have a >70% re-arrest rate. In New York City the "Biotracks" program was a collaborative effort between the New York City Police Department (NYPD) and the Office of Chief Medical Examiner's Department of Forensic Biology (OCME), utilizing private contract laboratories for the DNA testing. The NYPD was responsible for collection and submission of the evidence to the private laboratories; the OCME as the local CODIS laboratory received the data and was responsible for the technical review of all samples and controls, as well as, for the CODIS uploads and subsequent hit resolutions.

From September 2003 to December 2006, 2200 cases with over 4400 evidence items had been tested. Approximately 970 CODIS eligible profiles were uploaded generating 130 Local, 10 State, and 3 National forensic case to case hits, and 250 State and 10 National offender hits. An additional batch of approximately 1000 cases is still in progress. Of the items submitted the best success rates (>85%) was obtained for blood samples and smoked items, while touched objects such as samples from tools only had a 11-12% success rate. Challenges encountered during the outsourcing process included irregular batch sizes, testing techniques, result reporting and prioritization requests. The in house review process included the technical review of all controls associated with each batch, two levels of technical review for all samples and mixture interpretation for all mixtures. OCME staff would represent

DNA data for grand jury proceedings but several judges have required testimony from employees of the contracting laboratories.

Overall the program succeeded in identifying the perpetrators in many burglary crimes and also confirmed the presence of serial offenders by connecting cases to each other. Several burglary cases were linked to violent crimes such as sexual assault or homicide which again reinforces the importance of applying DNA testing to lesser crimes such as burglaries.

Biotracks, CODIS, OCME

B64 Validation and Implementation of Applied Biosystems AmpF*l*STR® MiniFiler for Challenging Samples Caveats and Impacts

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The goal of this presentation is to provide an introduction to the first commercially available miniSTR kit from Applied Biosystems. Upon completion of this presentation attendees will have been provided an overview of BCIT's validation studies of this new kit as it was integrated into our laboratory system and an overview of MiniFiler's strengths and weaknesses through casework examples

This presentation will impact the forensic science community by introducing BCIT's latest validation data and case examples related to the newly released MiniSTR kit. This new system will push the boundaries of usable forensic DNA evidence for human identification.

Custom mini-short tandem repeats (miniSTR's) have been reported over the last several years and have shown great promise for forensic DNA applications on highly degraded and/or inhibited DNA. A commercially available miniSTR multiplex (AmpFlSTR Minifiler) was released in the winter of 2007 by Applied Biosystems that will facilitate a standardized approach and wide spread adoption by the forensic community. The Minifiler™ system amplifies eight autosomal STR loci (D7S820, D13S317, D21S11, D2S1338, D18S51, D16S539, FGA, CSF1PO) and amelogenin using 5-dye technology and spanning an amplicon size of 70 to 283 basepairs. This multiplex is designed to augment and add genetic information to standard STR systems by redesigning primer sets to produce smaller amplicons.

This paper will outline BCIT's validation results for this new system as it was integrated into our standard operating procedure for forensic DNA analysis on "challenging" samples. In our laboratory, samples are processed as follows: extraction with one of two techniques (organic extraction followed by Amicon filtration or Promega's DNA-IQ paramagnetic resin system), quantification with Applied Biosystems Quantifiler™, amplification with Applied Biosystems AmpFlSTR Profiler Plus (and/or now MiniFiler™), genetic analysis using an ABI-310 interfaced to Genemapper ID and statistical analysis using EasyDNA_In_A_Minute. In our validation studies very reliable results can be obtained routinely with 200pg of input DNA (at 1/2 reaction volume) although the adoption of Minifiler™ has extended the range of usable samples down to the 62pg range. At this low end of input DNA, however, one must interpret the results cautiously due to an increased rate of allelic dropout and higher peak imbalance and, therefore, we recommend running samples in duplicate to address these stochastic effects. These results along with additional validation results will be presented to highlight the utility of this new kit within a system designed to analyze low copy number or degraded samples. BCIT's laboratory has also done extensive validation of the two DNA extraction methodologies on a wide range of sample types in order to assess the effectiveness of the DNA-IQ system and these results will also be presented.

Ultimately the goal of any validation study is to prepare a new system for use in forensic casework. In this presentation some case examples will also be presented to highlight the integration of MiniFiler™ into this laboratory. For example, in the mid-1970's a man disappeared while piloting his single engine aircraft in southern BC. The wreckage and associated remains were recently discovered by hikers in a heavily wooded area to the northeast of Vancouver, BC. Even after decades in this moist environment sufficient nuclear DNA was recovered to proceed with STR analysis, however, in this case the standard Profiler Plus procedure showed signs of significant degradation and allelic dropout. Minifiler™ augmented the usable data which resulted in a full panel of 12 STR loci plus amelogenin. By comparison to a daughter, the deceased's sole living relative, the combined likelihood ratio was extended from an estimated 118 (Profiler Plus® data only) to approximately 5000 (Profiler Plus® and MiniFiler™ data combined).

AmpFlSTR Minifiler™, MiniSTR, Degraded DNA

B65 Application of the MiniFiler™ Kit to the Analysis of Notoriously Problematic Evidence: Degraded Casework Samples, Fired Cartridge Casings, and Telogen Hairs

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After attending this presentation, the attendee can expect to learn how the MiniFiler™ kit has been used to successfully develop STR profiles from notoriously degraded, low-level, and inhibited samples. In addition, the attendees will learn how the results obtained with the MiniFiler™ kit compare to those obtained using conventional STR typing kits.

Telogen hairs and fired cartridge cases frequently go unanalyzed in forensic laboratories for DNA evidence due to the high incidence of failure with conventional STR typing kits. The methods and results presented here may impact the evidentiary material accepted and successfully processed by forensic laboratories by demonstrating improved DNA recovery and typing from these notoriously difficult samples.

Degraded samples often result in the inability to produce STR profiles due to the DNA fragment length attenuation. The reduced amplicon size of the recently developed commercially-available MiniFiler™ kit (Applied Biosystems, Foster City, CA) allows for potential analysis of evidence that was otherwise unsuitable for STR analysis. Several casework examples of the use of MiniFiler™ on degraded non-probative evidence will be presented including the analysis of a hair root from a 1992 homicide and the successful profiling of DNA from degraded tissue from a decomposed homicide victim found in a river. In both cases, MiniFiler™ resulted in an informative STR profile, which was not attained with conventional STRs.

In addition to the application of MiniFiler™ to non-probative casework samples, we have also explored its use in the recovery of DNA from other notoriously difficult samples, including fired cartridge cases and telogen phase hairs. In both examples, DNA degradation is suspected to be the cause poor of STR typing success. Gun chamber temperatures, upon firing, are known to reach up to 1980°C. Any DNA present on the cartridge is believed to be degraded, thus conventional STR profiling typically fails. In this study, cartridge casings of varying metallic composition, caliber, and surface area were handled by one of three different individuals, identified as shedders, then loaded into the firearm. The ejected cartridge cases were swabbed using the double

swab technique[1] and extracted using an automated DNA IQ method.[2] The resulting extracts were amplified using MiniFiler™, Identifiler™, and PowerPlex® 16 BIO. The results from all three amplifications indicate that the MiniFiler™ kit performed equally well or better than the Identifiler™ and PowerPlex® 16 BIO kits in all samples. In select samples, the MiniFiler™ kit allowed for recovery of useable DNA profiles in samples where the conventional STR kits failed.

Another commonly-encountered type of problematic evidence is telogen-phase hairs. These hairs are characterized by having no identifiable cells at the root end of the hairs,[3] thus making them unsuitable for typical nuclear DNA analysis. During the telogen phase, cells in the hair root undergo apoptosis and dehydration, followed by the keratinization of cellular proteins by proteinases. The hair cell organelles, including the nuclear membrane, are broken down during the process. The nuclear DNA is then subjected to the action of specific deoxyribonucleases, causing the DNA to degrade.[4] As a result, these hairs deemed unsuitable for STR analysis are often directed to mitochondrial DNA analysis instead. This study employed the use of MiniFiler™, to amplify the degraded DNA recovered from the telogen phase hair roots. The performance of the MiniFiler™ kit was compared to the conventional STR kits including Identifiler™ and PowerPlex® 16 BIO. In all cases, the performance of the MiniFiler™ kit was equivalent to or better than the Identifiler™ and PowerPlex®16 BIO kits.

MiniFiler™, Fired Cartridge Casings, Telogen Hair

B66 The Effect of Primer Melting Temperature, Sequence, and Amplicon Length on PCR Inhibition

Kerry L. Opel, MA, and Bruce R. McCord, PhD, Florida International University, Department of Chemistry and Biochemistry, 11200 South West 8th Street, Miami, FL 33199*

After attending this presentation the attendee will be familiar with the impact of various parameters on PCR inhibition, and the basic mechanism of a selection of PCR inhibitors.

This presentation will impact the forensic community by providing information on PCR inhibition which can be utilized to improve analysis of DNA samples where PCR inhibitors are present.

The presence of source contaminants commingled with DNA template presents a challenge in forensic human identification. The effects of these compounds on the PCR reaction can vary from attenuation to complete inhibition. PCR inhibitors can be endogenous or exogenous to the reaction. Endogenous contaminants usually originate from insufficiently purified DNA template, and the inhibitor is co-extracted with the target DNA during the extraction or purification step. Exogenous contaminants arise due to improperly controlled hygienic or laboratory conditions.

This project involves the utilization of real time PCR to study the mechanism of various PCR inhibitors, as well as the examination of the effect of amplicon length, primer melting temperature, and sequence on PCR inhibition. It is reasonable to assume that smaller amplicons would be less susceptible to inhibition due to the mechanism of primer extension by Taq polymerase. However, based on preliminary studies in our laboratory, inhibition mechanisms are more affected by the sequence than length. Since the presence of inhibitors can affect the amplification efficiency of any primer set, studies were initiated to examine a variety of parameters on the DNA typing process.

In this study, inhibitors which may be present in the sample itself were examined. These inhibitors can commingle with the DNA sample upon exposure to various environmental conditions. Although a wide range of PCR inhibitors have been reported, several common PCR inhibitors known to affect forensic samples were chosen for these studies: hematin, found in blood; indigo, a dye found in denim; melanin, a pigment found in skin and hair; humic acid, found in soil and other environmental samples; collagen, found in bone; calcium, another component of bone sample; tannic acid, a component of leaf litter; and others. The inhibitors were tested singly and in combinations that were likely to be present in forensic samples.

Experiments were conducted to determine the range of inhibitor concentration at which a consistent and significant change in signal was observed during rt-PCR (qPCR) analysis at a standard template concentration. The threshold inhibitor concentration was defined as the lowest concentration of inhibitor that shifted the signal to a higher Ct threshold. A range of concentrations for each inhibitor was then selected, and the inhibitors were added singularly and then were combined in different ratios to determine the effect of the mixtures.

Studies were also performed to further determine the effect of amplicon length sequence and primer melting temperature on the threshold inhibitor concentrations. For this study, a single locus comparison was made using primers with three different melting temperatures and three different amplicon lengths. After determining the normal uninhibited amplification efficiency for each primer pair, a range of concentrations of inhibitors was tested on each primer pair. Finally the level of inhibition for each primer pair was calculated and the results were compared between amplicon lengths and primer melting temperatures as well as among the different types of inhibitors.

DNA, PCR Inhibition, Rt-PCR

B67 SNPs by MIPS - SNP Typing Using Molecular Inversion Probes (MIPS)

Marie Allen, PhD, and Hanna Edlund, MSc, Department of Genetics and Pathology, Uppsala University, 751 85 Uppsala, SWEDEN*

The goal of this presentation is to discuss a method to improve the multiplexing capacity for forensic SNP analysis. Attendees will be presented with a convenient method based on molecular inversion probes.

This presentation will impact the forensic science community by presenting a convenient method based on molecular inversion probes.

Background and purpose: Routine forensic DNA analysis is commonly performed using STR markers. However, when the DNA in the samples is fragmented, the routine analysis might fail due to the requirement for amplification of quite large fragments in the PCR. SNP based DNA typing, on the other hand, has the potential to be highly sensitive as the PCR products can be kept very short. Therefore, SNP testing holds promise for future analysis of degraded and compromised samples. However, SNP typing has a limitation in the multiplexing capacity of multiple targets in the PCR step. In this study the possibility of using molecular inversions probes (MIPS or Padlock probes) for forensic SNP typing was investigated. MIPS are linear oligonucleotides, 70-100 nt in length, with end-segments that are complementary to a target sequence. The allele specific nucleotide is located at the 3' end of the probe and hybridization to target sequence leads to circularisation of the probe by DNA ligase. Using two allele-specific MIPS for each locus provides a robust distinction between SNP variants. After hybridisation and ligation to perfectly matched targets the probe is cut and universal PCR-primers can be used to amplify and analyse a large number of targets in parallel.

Methods: In this initial study a total 20 SNPs were selected from http://www.cstl.nist.gov/div831/strbase/SNP.htm. At first, SNP detection was done by Pyrosequencing, but the assay will be transferred to an array platform in the future for easy and fast SNP detection.

Results and conclusions: SNP detection by Pyrosequencing gave correct genotyping. However, further optimization of the protocol is required as well as sensitivity tests. The high multiplexing capacity of MIPS make them a suitable for large scale SNP genotyping, but for use on forensic materials further evaluation is required.

DNA Analysis, Multiplax Analysis, Molecular Inversion Probes

B68 The Rate of DNA Degradation in Fragmented Body Parts

Eleanor A.M. Graham, PhD, Victoria Bowyer, MSc, and Guy N. Rutty, MD, Forensic Pathology Unit, RKCSB, Leicester Royal Infirmary, Leicester, LE2 7LX, UNITED KINGDOM*

The goal of this presentation is to provide quantitative and qualitative data to describe the rate of DNA degradation observed over a twelve month period in human body parts exposed to differing environmental conditions and will relate this data to disaster victim identification projects.

The presentation will impact the forensic DNA typing and disaster victim identification communities by demonstrating that full DNA profiles can be obtained from heavily infested and decomposed body parts, which may not usually be considered useful for DNA analysis. It will also provide data to compare the sensitivity and accuracy of two DNA quantification techniques and demonstrate the usefulness of miniSTR analysis when template DNA is severely degraded.

The rate at which soft tissues decompose can impact DNA based identification of whole or disrupted corpses. Environmental factors such as temperature, humidity, and pH along with additional factors such as, infestation, submersion in water or burial will affect the rate at which DNA contained in soft tissues degrades. In order to determine the effect of temperature, humidity and submersion donated human limbs will be sampled once a day for two weeks and assessed for DNA quality and quantity recovered.

Ethical approval was gained (LREC: 06/Q2501/17) before this project was undertaken. Amputation patients at the Leicester Royal Infirmary were consented for donation of post-operative tissue samples. The donated limbs were then exposed to differing environmental conditions for two weeks. This was carried out over a 12 month period. Small tissue samples and photographs were taken each day during the two week period. DNA was extracted from tissue samples using the QIAamp DNA mini kit following the tissue protocol. Extracted DNA was quantified by Spectrophotometry and Real Time PCR. DNA quality was assessed by 1% agarose gel electrophoresis. DNA profiling was carried out on all samples using the SGM Plus PCR Amplification kit, initially at 28 cycles. Samples displaying drop-out or no amplification were re-amplified at 34 cycles and were additionally amplified using the MiniFiler™ PCR Amplification kit. PCR products were analyzed on a 3130 Genetic Analyzer and were analyzed using GeneMapper ID v. 3.2.

Sampling for the full 14 day period could not be undertaken in 8 of 16 limbs due to advanced infestation. The results of gel electrophoresis indicate that DNA degradation to fragments below 10kb begins within 1 – 4 days. The rate of DNA degradation is affected by the ambient temperature, with limbs sampled during the winter months showing slower degradation than warmer months. The results also show that rate of DNA degradation for samples submerged in water are similar to that of samples on dry land. The results of Real Time DNA quantification indicate that the amount of DNA recovered from samples decreases as decomposition progresses and that PCR inhibitors were not present in the extracted samples. The results of DNA profiling demonstrate that full SGM Plus profiles can generated even from highly infested remains by use of a standard 28 cycle protocol. When partial profiles were observed, the missing DNA profile components could be recovered by re-amplification at 34 PCR cycles. Additional and corroborative DNA profile information could also be obtained by amplification with the MiniFiler™ kit.

DNA profiling is an extremely useful tool for DVI, and in many cases, such as body fragmentation, represents the only primary identification technique applicable. The data presented here will demonstrate the rate of DNA degradation in amputated limbs over the period of one year, carried out in Leicester, UK. The data presented will also demonstrate that it is possible to produce full SGM Plus DNA profiles, using a standard 28 cycle protocol, from highly infested and decomposed body parts, which may not usually be considered as suitable for soft tissue sample collection.

DNA, Decomposition, Degradation

B69 Clandestine Laboratory, Synthetic Drugs, and Precursor Chemicals Trends in the United States Over a Seven Year Period: 2001-2007

Liqun Wong, MS, Christine Sannerud, PhD, and Susan Carr, BS, Drug Enforcement Administration, Office of Diversion Control, 600 Army Navy Drive, Arlington, VA*

After attending this presentation, attendees will have an enhanced understanding of the trend and distribution of clandestine laboratory, synthetic drugs and precursor chemicals over a seven year period (2000 through 2007) and geographical regions. The presentation will be based on clandestine laboratory seizure, drug and precursor chemical seizure, and analysis data from international, federal, state and local sources.

This presentation will impact the forensic community by providing an overall view and changing trends on clandestine laboratory, synthetic drugs especially methamphetamine, and precursor chemicals used to product these drugs.

The number of clandestine laboratories seized by U.S. law enforcement agencies declined for the past several years. The number of clandestine laboratory peaked in 2003, then dropped in subsequent years. The decreasing trend mainly attributed to the increasing controls on precursor chemicals at the national, state and local levels. However, methamphetamine is continuously appearing as one of the top four drugs seized in the country, and the abuse is still at epidemic levels. Over 98 % of the clandestine laboratories in the U.S. were producing methamphetamine. According to the National Seizure System (also known as Clandestine Laboratory Seizure System), the number of clandestine laboratories declined about 50% between 2001 and 2006, from 13,000 to 7,000 after peaked at 17,000 in 2003. Methamphetamine is the most widely used synthetic drug in the U.S. Nationally, the number of methamphetamine seizure reported by state and local laboratories increased 24% between 2001 and 2005, from 199,271 in 2001 to 247,288 in 2005. From 2005 to 2006, however, the number of methamphetamine seizure dropped 16% to 208,262, based on the National Forensic Laboratory Information System. Most of the methamphetamine used in U.S. is made with chemical precursors such as pseudoephedrine and ephedrine that are diverted from the international stream of commerce. Reported by the International Narcotics Control Board, over 1,640 kilogram of pseudoephedrine and ephedrine was seized by U.S. government, comparing to 1,450 kilograms in 2005.

Clandestine Laboratory, Methamphetamine, Pseudoephedrine/ Ephedrine

B70 Trace Elements in Illegal Drugs — X-Ray and Position Tagged Spectrometry-Marijuana, Cocaine, and Heroine

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Upon completion of this paper, participants will learn a simple method, x-ray and position tagged spectrometry to identify the trace elements in illegal drugs rather than time consuming chemical modifications and subsequent instrumental analysis. The advantage of this technique is that it involves no hazardous solvents, and requires only very minute amounts of the sample and needs no sample preparation.

This presentation will impact the forensic science community in tracing connections in the illicit traffic. Moreover it will give an awareness of the actual chemical substances, the dose being purchased, or the contaminants that may be present in the illegally purchased drugs.

Drug abuse is a national problem that plagues university campuses all over the world, which makes identification and characterization of illicit drugs more important and demanding more research attention. Drugs prepared for street sale are either typically impure or mixture of psychoactive chemicals. The users of illegally purchased drugs are totally unaware of the actual chemical substances, the dose being purchased, or the contaminants that may be present in the sample. Many of these contaminants produce toxic reactions. The study of amount of trace element will also throw light on the toxic effects of metals on the drug users.

The purpose is to propose a simple method, X-ray and position tagged spectrometry to identify the trace elements in illegal drugs rather than time consuming chemical modifications and subsequent instrumental analysis. The advantage of this technique is that it involves no hazardous solvents, and requires only very minute amounts of the sample and needs no sample preparation.

Initial visual examination of the sample is done with a light and polarized microscope. A cam Scan 44 electron microscope equipped with energy dispersive X-ray spectrometer fitted with a PGT prism 2000 thin window Si(Li) is employed for morphology and composition analysis. Spot light/position tagged spectrometry is carried out to identify and follow the distribution of trace elements present in the sample.

Marijuana, heroin and cocaine are studied using this method. The illicit marijuana usually appears as a brown mixture of dried, shredded leaves, stems, seeds, and flowers. But only microscopic examination can identify each part in detail. The surface features help the botanical identification. Cystolithic hairs on the surface of the leaf pointing to the tip of the leaflet are characteristic of marijuana. These hairs are short and fat due to calcium carbonate deposits in the base of the hair. The spectrum reveals the presence of calcium, potassium, and silicon in the marijuana sample. The presence of calcium is ascribed to the presence of calcium carbonate in the base of the cystolithic hair. Other elements are due to the soil in which the plant has cultivated. The element iron is also encountered in the spectrum analysis of the other specimens of the same sample.

Electron micrograph combined with the X-ray spectrum is also used for the characterization of heroin and cocaine. V- Shaped brilliant colored microcrystal under a crossed polar identifies the cocaine where as blade like crystal in rosettes confirm heroine. However no trace elements that characterize the illicit nature are found in the spectrum. The presence of chlorine in both these drugs shows that they are in the hydrochloride salt form.

Illegal Drugs, Scanning Electron Microscopy, Marijuana

B71 The Detection of Gamma-Hydroxybutyric Acid Through the Use of a Rapid Colorimetric Test

Kimberly A. Michalik, BS, and Thomas A. Brettell, PhD, Cedar Crest College, Department of Chemical and Physical Sciences, 100 College Drive, Allentown, PA 18104*

After attending this presentation, attendees will have a better understanding of the ferric hydroxamate test.

This presentation will impact the forensic science community by serving to provide an effective color test for the detection of GHB in evidential samples.

During the course of the investigation, the use of color tests was explored to screen for the presence of gamma-hydroxybutyric acid (GHB) in beverages. GHB, a CNS depressant, similar to sedative/hypnotics like barbiturates and benzodiazepines, is commonly used in drug-facilitated sexual assaults (DFSA). Over the past few years there has been an increase in public awareness about the problem of DFSA. In addition, forensic laboratories have had to develop screening procedures for the detection of GHB in evidential samples. As it stands, many laboratories are using tedious means to determine if GHB is present in a sample. Often these tests take much preparation work and require a long period of time to run and obtain results. Recently, the ferric hydroxamate test has been used to detect GHB. This is a simple test that requires little sample preparation, and takes just a few moments to accomplish. The test is able to detect GHB and GBL down to low sensitivity levels. The goal of this project was to create a modified color test the detection of gamma-butyrolactone (GBL) and gamma-hydroxybutyric acid (GHB).

This goal was met through the validation of and comparison with, other color tests employed to detect GHB as well as through modification of the known ferric hydroxamate test. Three rapid colorimetric tests for the detection of GHB were tested side-by-side with the ferric hydroxamate test. These color tests consisted of the following: Color Test #1: Chlorophenol red and modified schwepps reagent (3:1 v/v); Color Test #2: Bromocresol purple and bromothymol blue (1:1 v/v); Color Test #3: Bromocresol green and methyl orange (1:1 v/v). The three color spot tests were conducted using: (1) aqueous GHB, (2) solid GHB, and (3) tap water. The spot test was conducted as in any laboratory setting, with a small amount of sample and reagent, placed in a spot plate. It was found that all the three tests were effective in detecting GHB in the samples as predicted. When determining the detection limits of the three tests, it was found that Test #3 had the lowest detection limit of 1mg/mL and thus was the most effective at detecting GHB in a given sample. It should also be noted that all three test were successful in not detecting GBL in the sample, which was expected based on the prior information obtained about the tests.

The major result of the ferric hydroxamate test was the creation of a new colorimetric spot test for the determination of GHB and GBL. Also, in the determination of the detection limit for the modified ferric hydroxamate test, it was found that the detection limit for the test was approximately 1mg/mL. Through the use of the ferric hydroxamate test, a new spot test was developed for the detection of GBL and GHB in a sample. The test was effective in the fact that it had a low detection limit and therefore was fairly sensitive in detecting GHB. Also, because the amount of each reagent used in the test was decreased, and the elimination of the boiling step in the original procedure, it was developed into a “spot-plate” friendly test, that was quick, and required little to no prep work. Another positive characteristic of the test was that the magenta color seen with a positive result was distinctly different from the color of the ferric chloride solution, which was light yellow in color. This made the positive result extremely definitive and obvious. Based on these facts, the test could readily be used in the field of forensic science for the detection of GHB and GBL in a particular sample.

GHB, GBL, Ferric Hydroxamate Test

B72 Detection of GHB in Various Drink Matrices Via AccuTOF-DART

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At the conclusion of this presentation, attendees will become familiar with the results for the detection of gamma-hydroxybutyric acid (GHB) in various drink matrices using the Direct Analysis in Real-Time (DART) ion source and an exact mass, time-of-flight mass spectrometer.

The potential benefits of this screening method relative to current GHB analysis using color test(s) will also be offered.

This presentation will impact the forensic science community by presenting the validation of a new and reliable method of GHB detection using the DART ion source, a relatively new mass spectrometer ion source to the forensic community.

GHB, also known as a "date rape drug" is of interest to the forensic community because it has become increasingly prevalent in sexual assault cases. GHB is considered a strong central nervous system depressant, and has long been studied for its ability to induce short term comas, as well as a potential use in surgical anesthesia. Current screening of GHB can be accomplished by using the GHB Color Test #3 (Smith Test). Current mass spectral analysis of GHB involves time consuming steps such as derivitization and subsequent analysis using gas chromatography/mass spectrometry. Most mass spectrometer ion sources require the introduction of samples into a high vacuum system. The DART ion source allows for the analysis of suspected GHB samples under atmospheric pressure conditions without the time and vacuum restrictions present in traditional gas chromatography/mass spectrometry analysis. The focus of the present project was to determine whether the AccuTOF-DART can be utilized to quickly and reliably screen various drink matrices for the presence of GHB.

This study consisted of four main steps: (1) Determination of the lower limit of detection (LLOD) of GHB using the AccuTOF-DART, (2) Determination of interferences of various drink matrices, (3) Detection of GHB in drink matrices after being spiked at various levels, and (4) Performing GHB Color Test #3 (Smith Test) at a concentration of 1 mg/mL in representative drink samples. Fifty drink samples were collected and classified as either soda, liqueur, wine, beer, juice, or other (i.e., well water).

The lower limit of detection of GHB on the AccuTOF-DART under the established parameters was determined to be 0.05 mg/mL in methanol. Blank drink matrices were sampled to evaluate if there were any interferences in each respective drink at the targeted mass range of GHB ([M-H] $^-$ of 103.0322 ± 20 mmu), and to help in establishing an administrative cutoff for each respective drink type tested. Established cutoffs for positive GHB detection were determined by multiplying the average area count within the described mass range for each respective drink type by three. Drinks were then spiked to obtain concentration levels of 1 mg/mL, 2 mg/mL, 3 mg/mL, and 4 mg/mL, respectively, representing established levels of GHB known to induce various levels of impairment. Area counts for each respective spiked drink were compared with the established administrative cutoffs for the corresponding drink type to determine if GHB was present. Each of the 50 spiked samples in the 6 different categories tested showed levels of GHB greater than the established administrative cutoff values, thus indicating positive detection of GHB in each respective sample. GHB Color Test #3 (Smith Test) was performed on 25 of the 50 drink samples (all six categories included) spiked at 1 mg/mL of GHB, as well as a positive and negative control. Only two samples (well water and soy milk) showed positive results for GHB.

This method for the screening of GHB using the DART ion source will be presented in order to offer a new, more sensitive, specific and efficient method of GHB analysis.

GHB, DART, Mass Spectrometry

B73 Techniques in Drug Sampling

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After attending this presentation, scientists and chemists, especially those working in drug laboratories, will get an opportunity to learn about the various internationally recognized sampling techniques available for them to be employed, to solve the problem of analyzing large drug cases, those containing multimple units/items of CDS.

With the phenomenal increase in drug seazures across the country, in recent times, it is becoming imperative on the drug laboratories in U.S. to employ appropriate sampling techniques, which are not only internationally recognized and scientifically sound but also fulfill the legal requirements.

From the practical point of view, this presentation will impact the forensic science community by presenting here, a set of ready to use sampling techniques which while satisfying the above requirements, dramatically reduce the actual sampling size during drug analysis, and hence capable to in turn solve the problem of chronic backlog of drug cases waiting to be analyzed in a specified time.

In recent times, with the increase in quality of drugs, there is also a tremendous increase in the quantity of the drugs being seized in the United States. This puts a large burden on the law enforcement agencies and specially the drug laboratories throughout the country. It entails a long and chronic backlog of cases to be analyzed by the drug laboratories, as one seen in author's lab, and that too has to be cleared in a court specified time period.

This critical situation brings home the need to employ appropriate scientific/statistical sampling techniques, which would not only satisfy the legal requirements, but also help us alleviate the present backlog problems.

The author will present here a broad review of the various sampling techniques available to a drug chemist to choose from.

Depending on the situation, in a sequence of increasing workload, if one is required to prove: (i) is a drug present in (more than) a specified proportion of the items? This means increased sampling; or (ii) is a drug present in all the items? This means maximum sampling (this will require full analysis of all items, which will lead to unrealistic costs, especially for large number of units); or (iii) is a drug present? This means minimal sampling (this may require one positive result). Selection of any of the above three criteria, depends on the chemist and also on the prevailing local legal and scientific/technical situations.

Before selecting a sampling technique for its application, one has to bear in mind to ensure that two principles are maintained, which are quite important, viz: (i) the properties of the sample are true reflection of the properties of the population from which the samples were taken, and (ii) each unit in the population has an equal chance of being selected.

General/basic definitions concerning the sampling in a typical drug case, like seizure, population, unit, sample, mean (both mean of a population and sample) and standard deviation (both standard deviation of a population and sample), are elucidated.

The various sampling methods applied in drug laboratories in U.S.A. and in other parts of the world like, n=N, n=0.05N, n=0.1N, n=square root of N, n=square root of N/2, n=20+10%(N-20) and n=1 (where 'n' is the sample size and 'N' is the total population) are shown. Advantages and disadvantages entailing each one of them are discussed.

The popular square root method recommended by International Drug Control Program of United Nations and accepted by AOAC International, is also elucidated.

Broadly there are three major statistical sampling techniques like, the hypergeometric distribution, the binomial distribution, and the Bayesian approach. Results obtained by applying hypergeometric distribution are discussed. Interestingly, with increasing sample size, the Law of Diminishing Returns wherein, after certain proof (~70-80 %), further increase in sample size does not concomitantly increase the number of positives, become more significant. Hence, as a caveat, drug chemists should particularly bear this in mind, when deciding the size of the sample.

Nevertheless, last but not least, the reason why a typical sampling technique gains importance in a given situation is highlighted by the following dramatic statement, which states that "If one sample out of a population of 10 is taken, and the analysis of the sample shows cocaine,

the hypothesis that this is the only one containing cocaine is much more unlikely (10 %) than the hypothesis that the majority of the ten items contains cocaine (more than 50%)." (Source: European Network of forensic Science Institutes Drugs Working Group. "Guidelines on Representative Drug Sampling" 2003 P30).

Drug Sampling Techniques, Square Root Method, Hypergeometric Distribution

B74 Iodine Recovery From Povidone-Iodine Solutions and Its Use in Clandestine Methamphetamine Synthesis

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After attending this presentation, attendees will be familiar with elicit extraction methods used to remove iodine from Povidone-Iodine (PVP-I) solutions and its use in clandestine methamphetamine synthesis.

This presentation will impact the forensic community by demonstrating information on the use of PVP-I solutions to manufacture methamphetamine in clandestine laboratories by the conversion of pseudoephedrine/ephedrine utilizing the red phosphorus – iodine synthesis. The goal of this research is to provide definitive proof that iodine from PVP-I solutions can successfully be used to synthesize methamphetamine in a clandestine laboratory, providing a resource for the law enforcement, forensic and judicial communities.

Povidine-iodine (PVP-I) is an aqueous based polymer-iodine complex. The iodine is bound to the polymer as triiodide (I_3^-) to increase its solubility in aqueous solvents. PVP-I solutions are available under several different brand and generic names, the most common of which is Betadine®. It is intended primarily for use as an antiseptic based on the antimicrobial activity of iodine. PVP-I can be found in any grocery store or local pharmacy in the first aid section. It can also be found in the feminine hygiene section, marketed as medicated douche for the treatment of vaginitis.

Recent law enforcement intelligence has indicated the increase in the presence of PVP-I solutions along with other methamphetamine precursors. This experiment explores two methods of extracting iodine from PVP-I solutions. Both methods researched were located by a search of the internet and were easily accessible to the general public. The extracted iodine is then used to produce hydriodic acid and subsequently used to synthesize methamphetamine. One method of extraction which utilizes a modified distillation method was successful in extracting and collecting all of the available iodine in a PVP-I solution and the products were successfully used to produce a small batch of methamphetamine from pseudoephedrine. The research shows that although this method is possible, it is time consuming and requires a large amount of PVP-I solution to produce the required amounts of iodine which may inhibit its widespread use.

Methamphetamine, Iodine, Betadine

B75 Forensic Applications of Liquid Chromatography Mass Spectrometry (LC-MS)

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The goal of this paper is to present applications of LC-MS in the forensic chemistry laboratory.

This presentation will impact the forensic science community by demonstrating the use of LC-MS for routine forensic analysis.

The development of the soft ionization technique of electrospray ionization (ESI) during the mid eighties extended the application of mass spectrometric (MS) techniques to the analysis of large, polar, non-volatile molecules. During the last 20 years, applications of ESI and other ionization techniques have exploded and these days the use of LC-MS instrumentation is relatively common in academia and the pharmaceutical industry. However, the adaptation and utilization of these techniques in forensic laboratories has been slower, as the traditional technique of choice for mass spectrometric identification is usually gas chromatography – mass spectrometry (GC-MS). During this presentation, the principles and applications of LC-MS in the forensic chemistry laboratory will be discussed.

The presentation will include a discussion of the atmospheric pressure ionization techniques of ESI and APCI. Many laboratories and forensic chemists are very familiar with the principles and applications of electron ionization (EI) as it is used in commercial GC-MS instruments. Similarities and important differences between this ionization technique and the soft ionization techniques used during LC-MS will be discussed. In addition, significant differences between GC-MS and LC-MS instruments will be addressed.

Electrospray ionization allows for the analysis of a wide variety of compounds by producing singly or multiply charged pseudo-molecular ions that can be transported from solution into the gas phase with minimal fragmentation. Highly basic compounds like phenethylamines and natural alkaloids are easily ionized, and analysis via ESI produces intact pseudo-molecular ions that provide molecular weight information, often absent in GC-MS data. Further analysis of such pseudo-molecular ions via fragmentation or collision induced dissociation (CID) experiments provides for confirmatory identification of unknown compounds, either by interpretation of fragmentation patterns or by comparison with reference standards.

This presentation will also include the discussion of LC-MS qualitative methods for the analysis of phenethylamines, tryptamines, cocaine, heroin, and other controlled substance exhibits. Direct injection (non-LC) applications will also be discussed, as they provide a way to perform rapid screening and analysis of multiple-unit exhibits and purified standards. The use of ESI-MS for monitoring the synthesis of clandestinely manufactured compounds will also be presented.

Additional discussion and examples will include the use of the recently developed technique of desorption electrospray ionization (DESI) mass spectrometry for the rapid screening of tablets, plant material, THC-containing exhibits, opium, and cocaine base samples. The use of APCI during the analysis of steroids, GHB, GBL, and 1,4-butanediol will also be illustrated.

LC-MS, Electrospray, Controlled Substances

B76 Headspace Sampling and Detection of Cocaine, MDMA, and Marijuana via Volatile Chemical Markers; Solid Phase Microextraction-Ion Mobility Spectrometry

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The goal of this presentation is to describe headspace sampling and detection of low vapor pressure drugs using SPME-IMS via related volatile chemical markers.

This study will impact the forensic science community by demonstrating the detection of volatile components in the headspace of cocaine, MDMA, and marijuana samples using SPME as sampling and

pre-concentration device. IMS operating conditions are set at optimal configurations previously reported for these volatile markers.

This presentation shows evidence of successful headspace sampling and detection of cocaine, 3,4-methylenedioxy-methylamphetamine (MDMA), and marijuana under new optimized IMS instrumental conditions for methyl benzoate, piperonal, and limonene, and α/β-pinene respectively.

The parent compounds of drugs like cocaine, MDMA, and marijuana have very low vapor pressure and are consequently not readily available in the headspace for vapor sampling. Canines are trained to detect and alert to the volatile components present in high enough concentration in air rather than the parent compounds with low vapor pressures. However, current IMS instruments are configured to detect primarily particles of the parent compounds, thus making headspace sampling and detection ineffective for low vapor pressure drugs, and detection is limited to sampling by surface swipe.

The current research presents the progress in headspace detection of these drugs via the previously identified volatile markers. This is a significant step forward in trace detection of drugs, especially useful in confined spaces such as cargo containers where these volatile markers compounds can be found in high enough concentration. This study reports the minimum mass required in order to detect these drugs in the headspace at equilibrium inside a container of a given volume. In addition, this study reports the analysis of several potential interference compounds at these new IMS settings, and the associated percentages of false positive peaks.

The analytical instrument used in this research is a commercially available IMS fitted with a novel solid phase micro-extraction (SPME) interface previously designed in the Almirall research group. This interface enhances sampling and pre-concentration of volatile compounds of drugs and explosives. The IMS operating conditions were programmed at settings previously reported by our group for successful detection of the volatile chemical markers of the above compounds of interest.

Headspace Detection, SPME-IMS, Drugs

B77 The Rapid Non-Destructive Identification of Drug Tablets Using Single Particle Aerosol Mass Spectrometry

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Upon completion of this presentation, attendees will have learned the operating principles and broad application range of Single Particle Aerosol Mass Spectrometry. Attendees will be aware of a new promising technique for the non-destructive analysis of drug tablets.

This research will show a novel method of non-destructively identifying drug tablets in real-time. This presentation will impact the forensic community by providing a new, efficient and accurate method to identify drugs with high throughput. Humanity will be best served if techniques such as SPAMS are used to identify drugs and prosecute those who synthesize and traffic drugs.

This presentation will demonstrate the ability to detect drug tablets in a real-time, non-destructive manner using Single Particle Aerosol Mass Spectrometry, a technique that has been developed for homeland security applications including biological, chemical, and explosives detection.

The rapid identification of drugs is essential due to the high number of cases involving drugs and large sample volume commonly seized by law enforcement. The ideal detection system would provide instant information about the components in a suspected drug tablet as well as information that may aid law enforcement to prosecute those involved in illegal drug synthesis. Commonly, visual information, such as size, color, shape, and imprint, is used for such attribution, so the ideal detection scheme would keep such information intact during analysis.

Single Particle Aerosol Mass Spectrometry (SPAMS) is an on-line detection system that individually analyzes single particles. In the SPAMS system, each individual incoming particle is tracked and sized by laser light scattering before a short energetic pulse from a laser (266 nm) desorbs and ionizes the molecules. Time-of-flight mass spectra from both positive and negative ions are recorded simultaneously and are analyzed and classified at a rate of 20 particles per second. SPAMS is capable of low concentration detection of target particles in a high background environment, and has previously been applied to the detection and identification of viruses, toxins, fungi, Mycobacteria, *Bacillus* spores, explosives, and chemical agents. The real-time data analysis program used in conjunction with SPAMS allows the facile and immediate identification of threat compounds, presenting SPAMS as a viable point detection system for airport screening, personnel screening, ambient air analysis, or border control. In addition to these homeland security applications, SPAMS can also be used for forensic analyses. It was hypothesized that SPAMS would provide a non-destructive, fast, simple, sample preparation-free method of analyzing drug tablets. Over-the-counter drugs were analyzed as a proof-of-concept study for illicit drug detection. A single drug tablet was placed in a glass vial modified with tubing to transport particles to the instrument. By shaking the glass vial, particles were dislodged from the tablet due to collisions with the sampling container. These particles were sampled into the instrument and analyzed in real-time without destroying the identifying characteristics and markings of the tablet. Batch analysis of multiple tablets was possible by placing multiple tablets into a single glass vial. Mass spectral data from studies involving several over-the-counter drugs will be presented and SPAMS will be discussed as a prototype universal particle detection system and a promising forensic technique.

This work was performed under the auspices of the U.S. Department of Energy (DOE) by University of California, Lawrence Livermore National Laboratory under Contract W-7405-ENG-48.

Drug, Mass Spectrometry, Real-Time

B78 Chiral Analysis of Methorphan and Citalopram Using HPLC

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After attending this presentation, attendees will have a better appreciation for the chiral separation by HPLC using vancomycin columns.

This presentation will impact the forensic science community by serving as a key aspect in describing a new method for analyzing methorphan and citalopram stereoisomers in forensic drug and toxicology specimens using vancomycin columns by HPLC.

The analysis of drug and toxicology evidence makes up an enormous part of the caseload in the New Jersey State Police laboratory system. State-of-the-art instrumentation and a qualified staff are essential components for analyzing and identifying the wide variety of controlled and non-controlled substances seen in drug casework. Although established methods exist for the analysis of most drugs, some drugs, such as methorphan and citalopram because of their chiral nature, still present problems for analysis.

Chiral compounds are optically active compounds that exist in two isomeric forms. The optical isomers are mirror images of each other as a result of the tetrahedral arrangement around the chiral center, usually a carbon atom. One of the biggest problems with analyzing and identifying chiral compounds using HPLC, or any other chromatographic method, is effectively resolving the enantiomers. Before the mid-1980s and early 1990s, the routine separation of stereoisomers was difficult. Over the last 20 years the development of chiral columns has allowed analysts to resolve many chiral analytes, however not always with optimal efficiency or selectivity. Until around 1994, most chiral columns were made using cyclodextrin stationary phases. At that time another class of chiral selectors for liquid chromatography made up of macrocyclic antibiotics was developed showing a greater range of success than the traditional cyclodextrin phases.

Recently, a research study by the Finland National Bureau of Investigation and the University of Helsinki effectively used a macrocyclic antibiotic phase column based on vancomycin to perform chiral separations of numerous drugs, including methorphan. That research, done in 2004, appears to be the first time vancomycin columns for HPLC have been used for the separation of methorphan isomers. In addition, it appears the HPLC procedure has not been widely recognized in forensic drug laboratories in this country. Like methorphan, there have been few examples of enantioseparation of citalopram in chromatography literature. However, there were some successful pharmaceutical studies which achieved chiral separation of citalopram and its metabolites in plasma samples using HPLC with the same vancomycin column mentioned above.

Unfortunately, there is no published data concerning the use of this column for both methorphan and citalopram chiral separations in forensic drug and toxicology samples. It was the purpose of this study to produce a method for analyzing methorphan and citalopram based on these studies and apply it to forensic drug and toxicology samples. Several forensic drug and toxicology specimens were collected and analyzed using this HPLC method and with successful results in many of these cases.

Chiral Analysis, HPLC, Citalopram

B79 LC/MS Electrospray Applications and the Use of In-Source Collision Induced Dissociation (CID) in the Confirmatory Analysis of Drugs of Abuse

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The primary objective is to present the versatility of LC/MS electrospray ionization for the analysis of drugs of abuse that are routinely encountered by drug chemists.

This presentation will impact the forensic science community by demonstrating how LC/MS has been established as a confirmatory technique for the analysis of drugs of abuse and is complementary to standard gas chromatography mass spectroscopic techniques that have been used for years.

The presentation will focus on the applicability of liquid chromatography mass spectrometry (LC/MS) and the use of in-source collision induced dissociation (CID) as a routine confirmatory technique in the analysis of seized drugs of abuse. The use of electron ionization (EI) gas chromatography mass spectrometry (GC/MS) has been considered the standard in the confirmatory analysis of controlled substances and adulterants encountered in illicit drugs. The capabilities of mass spectrometry has expanded over the years to include softer ionization techniques such as electrospray ionization (ESI) and atmospheric pressure chemical ionization (APCI), making the analysis of drugs by LC/MS more routine.

The complementary technique of LC-ESI-MS provides molecular weight information in the form of a protonated or deprotonated molecular ion depending on the structural functionalities of the compounds of interest and the ionization mode of polarity.

Since electrospray sources yield low fragmentation, spectral specificity can be achieved with a single quadrupole LC/MS via in-source CID. In-source CID occurs when energetic collisions in the electrospray source are induced by colliding ions with a neutral gas such as nitrogen. This is achieved by varying the ion energies in the mid-transport region between the ion transfer capillary exit and the first skimmer. The collision energies are directly proportional to the fragmentor voltage. The ability to dynamically ramp ion energies, in which fragmentor voltages are ramped in unison with the *m/z* scan, is an available option. These processes introduce sufficient internal energy into the protonated or deprotonated molecular ions resulting in more extensive fragmentation providing an additional level of specificity for spectral identification.

The optimization of the chromatographic separation is critical using a single quadrupole LC/MS system since a complete separation of compounds is necessary to maximize fragmentation efficiency. All separations were performed using either a C-18 bonded phase or an ether linked phenyl phase (Phenomenex 15cm X 3.0mm) columns. Mobile phase conditions utilized a 10mM ammonium formate buffer pH3.7 /0.1%formic acid with either acetonitrile or methanol as the organic modifier. Electrospray parameters were optimized via flow injection analysis and collision induced dissociation experiments were performed to optimize fragmentation of compounds studied. Actual case applications will be presented focusing on the most commonly abused licit and illicit drug types encountered at our laboratory. This will include class specific methods for compounds such as phenethylamines, piperazines, anabolic steroids, benzodiazepines, tryptamines, cocaine, opium alkaloids, and common adulterants. Compound specific methods will focus on applications for LSD, psilocybin/psilocin in hallucinogenic mushrooms, fentanyl in heroin, cathinone in khat, thermally labile compounds such as thiamine, aspirin in heroin, creatine/creatinine and the screening of common pharmaceutical tablet preparations.

The availability of the LC/MS has allowed for the analysis of polar, thermally labile, and higher molecular weight compounds not readily analyzed by GC/MS. This technique has become a versatile analytical tool at our laboratory for the confirmatory analysis of seized drugs, and offers a number of advantages for the forensic drug chemist. It possesses the versatility to collect multiple mass spectral signals in a single analysis run at different fragmentor voltages, sensitivity levels exceeding GC/MS, ease of use, and overall ruggedness for high throughput analyses.

LC/MS, Collision Induced Dissociation, Drugs of Abuse

B80 Sources of Error in Fire Investigation

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

After viewing this presentation, attendees will understand some of the influences that result in erroneous determinations of fire origin and cause. Most forensic scientists are familiar with the processes involved in chemical analysis of fire debris, but such testing represents only a small portion of the overall fire investigation.

This presentation will impact the forensic science community by making the attendees aware of the significant difficulties involved in making an accurate determination of the origin and cause of a fire. An analysis of the types of errors that have caused incorrect determinations will be presented.

These errors generally fall into one of the following categories:

1. Overlooking critical data
2. Misinterpreting critical data
3. Misinterpreting irrelevant data
4. Ignoring inconsistent data
5. Two-dimensional thinking
6. Poor communication
7. Faulty chemistry or engineering

Deciding what data is critical often depends on one's point of view. Data sometimes becomes critical only when a fire investigator declares it to be so. "Irrelevant data" refers to the persistent collection of arson investigation myths and misconceptions held by a significant cadre of the investigator's performing fire investigation today. These myths persist in spite of efforts by the community of scientific fire investigators to convey the results of experiments that have proved that the myths are false. Some investigators still insist on their right to tell a jury about interpretations that have no scientific basis, and, in fact, have been proven wrong through experiments with test fires.

The potential for a miscarriage of justice exists when the determinations (or divinations) of a fire investigator are at variance with the description of events provided by an eyewitness. The investigator believes his determination; therefore the eyewitness must be lying. The perception that sets in motion a chain of events that can be very difficult to stop, because the people who act on this perception are lawyers, judges, and juries, and none of them are likely to be aware of the high potential error rate in fire origin and cause determinations.

The mythology of arson investigation has been handed down through an oral tradition in a community where scientific education is the exception rather than the rule. The myths have been particularly long-lived; however, because of their promulgation by otherwise credible government agencies including the National fire Academy and the National Bureau of Standards. Numerous fire investigation textbooks have cited these government documents, and remain in many fire investigators' libraries today. Individuals who were presented with misinformation at the National fire Academy during the 1980s and 1990s are today in charge of the fire investigation profession. They are our State Fire Marshals and leading fire investigators. Many of these individuals have come to realize that what they "learned" at the Academy was erroneous, but neither the Academy nor the National Bureau of Standards (now NIST) have officially repudiated the misinformation to date.

In addition to the errors that are peculiar to fire investigation, the field is subject, like many forensic science fields to context effects, expectation bias, and confirmation bias. So-called "peer review" of fire investigations usually consists of one law enforcement officer signing off on another law enforcement officer's determination (or in the private sector, a senior investigator signing off on a subordinate's work). In this situation, the chances of any disagreement are miniscule. The incentives for the reviewer to "go along" are very strong, and the incentives against disagreement are equally strong. As with most forensic sciences, there is a need for actual critical analysis of reports and real peer-review.

Fire Investigation, Arson Mythology, Expectation Bias

B81 An Evaluation of E-Z Mix® E-Z View™ Clear Cans as Containers for Packaging Fire Debris

Brenda B. Christy, MS, Virginia Department of Forensic Science, 830 Southampton Avenue, Suite 400, Norfolk, VA 23510*

This presentation will introduce E-Z View™ Clear Cans as a container for the packaging of fire debris. Several studies will be presented that directly compare the suitability of the E-Z View™ Clear Cans to traditional metal cans. These cans performed comparable to, if not better than, metal cans when tested under appropriate conditions.

This presentation will introduce cans constructed of polyethylene terephthalate (PET) as favorable containers for the packaging of fire debris. When used under appropriate conditions, these containers provide a transparent, rust-free, puncture-resistant container for packaging fire debris which may assist investigators, laboratory examiners and individuals present in the court room to view the contents without opening the container.

The E-Z View™ Clear Cans are constructed of polyethylene terephthalate (PET) and provide several immediately apparent advantages over traditional metal paint cans. Primarily, the cans are transparent, thereby allowing the investigator at the scene, the laboratory examiner, as well as the individuals present in the courtroom to view the contents without opening the container. Secondly, the PET containers will not rust like traditional metal cans and will not puncture as easily as heat resealable nylon evidence bags. These advantages, as well as the favorable laboratory evaluation, may justify a place for these containers as an option for the packaging of fire debris. This study is not intended to endorse the use of these containers but rather to introduce them to the fire debris community as an option for consideration.

Several laboratory studies directly comparing metal cans to the PET cans are presented which tested the container's durability, any background observed from the container alone during both solvent (pentane) and passive adsorption/elution (charcoal strip) extractions, the loss of petroleum product sample from the container over time, the possibility of cross-contamination between containers in a closed environment and the recovery of trace levels of various petroleum products over time. In each of these tests, the PET cans performed comparable to, if not better than, the metal cans. Negligible background was observed from both the metal and PET cans using both the solvent and passive adsorption/elution extractions.

Several factors need to be evaluated by each laboratory system before adopting these containers. The PET cans do not perform well at charcoal strip extraction temperatures exceeding 65°C. The lids must be securely taped to the body of the cans to prevent "popping" during the heated charcoal strip extraction. Experimental techniques using magnets to hold the charcoal strips in place would need to be altered to use strings threaded between the lid and the can because magnets do not hold well on these containers during the extraction. Finally, investigators and lab staff should practice placing and removing the lids from the PET cans prior to their use as an incorrect technique can damage the lids. One additional advantage offered by these containers is that with proper technique the lid can be sealed tightly without the use of a hammer or other instrument.

In addition to fire debris, these containers present a unique option for other types of evidence submitted to forensic laboratories. The lack of metal makes these containers ideal for the collection and storage of chemical reaction bottle bombs. Liquid samples, such as those used to store handguns recovered from and stored in the water in which they were found, are also ideally collected in the PET containers. The PET paint cans may prove themselves an asset to forensic laboratories for use with a multitude of evidence types.

Fire Debris, Packaging, PET Paint Cans

B82 A Survey of 2-Cycle Oils and Their Implications in the Analysis of Fire Debris

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After attending this presentation, attendees will have knowledge of the various different types of 2-cycle oils that are available and understand the difficulty of identifying such oils when they are mixed with gasoline.

This presentation will impact the forensic community by assisting fire debris analysts in the analysis, interpretation, and identification of ignitable liquid residues containing gasoline/2-cycle oil mixtures. It will also provide information for additional research into the detection and identification of such mixtures.

During the course of casework in the fire debris laboratory, various mixtures of different ignitable liquids may be encountered. Some of these mixtures consist of manufactured products that have a specific use, user prepared mixtures with a specific use, and haphazard mixtures that result from mixing anything that might be available. The research contained in this presentation is primarily concerned with mixtures of the second type, particularly gasoline/oil mixtures that are prepared by the user for the operation of various forms of motorized equipment.

It is not uncommon to receive a sample in either the liquid form or as debris suspected of containing volatile residues that is thought to contain gasoline/2-cycle oil mixtures. During routine casework it has been noticed that the 2-cycle oil component of the mixture is typically difficult to identify. This should not be surprising considering the relatively high dilution and low volatility of the 2-cycle oil components. Therefore, the presence of such mixtures may be a source of confusion when interpreting results. The generally high ratio of gasoline to oil (typically either 50:1 or 30:1) might preclude an analyst from identifying the presence of the oil when even a relatively pristine sample is encountered. As samples become weathered, the contribution from the oil component may be enhanced producing a pattern that will reveal itself as a mixture.

The primary goals of this study were: (1) to analyze various different 2-cycle oils to determine the range of products that are available; 2) to determine if these products could be detected in their proper gasoline/oil mixtures; and 3) to examine the effects of evaporation on the patterns that are observed. To this end, sixteen different brands of 2-cycle oil were obtained and analyzed using gas chromatography-mass spectrometry. Analysis of the 2-cycle oils revealed the presence of two distinct components in the product, namely a fuel and a lubricant. The fuel fractions of the sixteen different brands were separated into six different product groups in the medium to heavy range according to the system laid out by ASTM E-1618 (Standard Test Method for Ignitable Liquid Residues in Extracts from Fire Debris Samples by Gas Chromatography-Mass Spectrometry). Analysis of the prepared gas-oil mixtures revealed that it was generally difficult to determine the presence of 2-cycle oils in such mixtures. However, it was easier to do so after evaporation had taken place. Some possible volatile markers for the identification of 2-cycle oils in gasoline that were identified include; elevated alkane profiles in the range of the 2-cycle oil fuel fraction, heavy alkane peaks beyond the gasoline range, 2-cycle oil additives (e.g. anti-oxidants), and non-petroleum lubricant compounds.

This presentation will include brief discussions on the use and application of 2-cycle oils, the various types of 2-cycle oils that are available, and the potential for their detection in mixtures with gasoline. In order to illustrate the points to be discussed, various data will be presented. A brief discussion of future research in this area will also be presented.

Fire Debris Analysis, Gasoline, 2-Cycle Oils

B83 Practical Aspects of Analyzing Vegetable Oils in Fire Debris

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The goal of this presentation is to provide valuable tools to forensic scientists and crime scene investigators and technicians alike, as findings will indicate proper storage conditions and illustrate the data that can be obtained through this analytical scheme.

This research will impact the forensic science community by providing a valuable tools for vegetable oil analysis in fire debris furthering the possibilities for data that can be obtained.

Vegetable oils can be found in fire debris as a result of burning, self-heating, or spontaneous ignition. For this reason, it is important that this debris be properly collected, stored and analyzed to obtain the most informative data. Passive and dynamic headspace concentration methods are not appropriate means of analysis for fire debris samples containing vegetable oils as those methods are only useful for volatile compounds.

Vegetable oils are primarily composed of triglycerides of three fatty acids on a glycerol backbone. Each oil type differs, depending on which fatty acids are present and the amount of each. Unsaturated fatty acids are typically found as liquids at room temperature, as with vegetable oils, while saturated fatty acids are mainly solid fats such as butter. It has been reported that different processes of burning, self-heating or spontaneous ignition can affect the fatty acid content of vegetable oils.[1] Knowledge of these changes can be used to identify the vegetable oil present and account for any variations in the data.

In this research, fatty acids in vegetable oils were esterified to fatty acid methyl esters through a base-catalyzed reaction and analyzed by gas chromatography-mass spectrometry (GC-MS). This analytical technique was used to monitor any changes in the fatty acid content produced from burning and spontaneous ignition or from environmental variables while being stored prior to analysis.

Wood spiked with vegetable oils and subsequently burned via piloted ignition were stored under conditions ranging from desirable (refrigeration) to nonideal (outdoors in the summer). The anticipation was that refrigerated and completely sealed cans would result in little to no change in fatty acid content, while cans with broken seals exposed to changing weather conditions would exhibit changes in the type and amount of fatty acids present. It has been shown through previous research in this laboratory that piloted ignition does not affect the presence or peak ratios of the fatty acids.

The vegetable oils that have the greatest propensity to self-heat and spontaneously ignite are those that are most unsaturated, such as linseed oil. The unsaturated double bonds undergo auto-oxidation which is an exothermic reaction that in turn, will catalyze the process. As this heating and catalysis cycle continues, the temperature will rise to the point of ignition providing the oil is present in an environment where the generated heat will not be dispersed to its surroundings, and there is sufficient oxygen for the oxidation reaction to progress. This characteristic was utilized to study the effects of spontaneous ignition of vegetable oils with the expectation that changes will be seen in the fatty acid peak ratios. Rags spiked with vegetable oils were introduced to circumstances to promote the occurrence of spontaneous ignition. The resulting debris was analyzed for the fatty acid content.

This research will present valuable tools to forensic scientists and crime scene investigators and technicians alike, as findings will indicate proper storage conditions and illustrate the data that can be obtained through this analytical scheme.

Reference:

1 Coulombe R, Gélin K. Spontaneous ignition of vegetable oils: chemical composition. Laboratoire de sciences judiciaries et de medicine légale, 2001.

Vegetable Oils, Fire Debris, Spontaneous Ignition

B84 Evaluation of the Self-Heating Tendency of Vegetable Oils by Differential Scanning Calorimetry

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The goal of this presentation is to demonstrate the use of differential scanning calorimetry to determine the self-heating tendency of vegetable oils.

This technique can bring one more piece of information in a fire investigation where a vegetable oil is suspected to have caused a fire. While vegetable oil residues analyses are useful, DSC brings a complementary answer. As such, this presentation will impact the forensic science community by demonstrating how laboratories may start using DSC to improve the information provided to the fire investigator.

Spontaneous ignition is a common cause of fire. Different reactions of biological or chemical origin can lead to such a phenomenon. Among chemical reactions, the self-heating of vegetable (and animal) oils is well known and has been reported in the literature as the cause of many fires.

When determining the cause of a fire, the fire investigator must rely upon the application of thermodynamics to develop and test the different hypotheses regarding the production of the initial activation energy. Fire investigators must also comprehend the chemistry and physics of the self-heating process of vegetable oils in order to properly assess suspicions of spontaneous ignition. In any case, hypothesis testing must include the evaluation of the oil as a source of energy and its configuration in the particular scenario.

Similarly to regular fire debris analysis, from which the presence of ignitable liquid residues is determined, it is possible to analyze fire debris samples for the presence of vegetable oil residues (VOR). However, the determination of the presence of VOR does not imply in any manner that a phenomenon of spontaneous ignition took place: It merely answers the question of whether residues of a vegetable oil are present in the debris. When comparison samples of an oil are available, gas chromatographic-mass spectrometric (GC-MS) analysis provides the investigator with the composition of the oil in terms of its fatty acid content; however, it does not take into account additives that may be present in the oil and that can significantly influence its self-heating capacity. Therefore, in these instances, the investigator typically relies on laboratory reconstruction experiments that evaluate the self-heating propensity of an oil. Laboratory-scale calorimetric tests, such as the Mackey test, are standardized and often used; however, they are long and cumbersome to perform, and they require a substantial amount of oil.

The development of a faster and simpler technique to evaluate the self-heating propensity of a vegetable oil is interesting to the fire investigator. As a result, he or she would be much more inclined to test the different hypotheses, thus guaranteeing a more thorough scientific investigation. One such technique that appears very promising is differential scanning calorimetry (DSC). In the current research, DSC is evaluated as a technique to determine the thermodynamics associated with different vegetable oils and, more particularly, their propensity toward self-heating.

Five different vegetable oils were tested in this study: edible linseed oil, boiled linseed oil, safflower oil, corn oil, and peanut oil. These different types of oils were selected based on their saturation degree, which is often linked to their propensity toward self-heating. For each type of oil, a small amount (between 2 and 5 mg) was introduced into a 40-µl aluminum cup and weighed. A Mettler-Toledo (Greifensee, Switzerland) differential scanning calorimeter, DSC 25, equipped with a TA4000 ceramic sensor was used for the analyses.

The DSC curves allowed for the observation of the induction period, characterized by the consumption of natural and/or artificial antioxidants present in the oil. The presence of the first exothermic event defines the end of the induction period. This event was followed by a second peak, which was attributed to the decomposition of hydroperoxides. Finally, a third peak likely represented the termination phase, which constitutes the polymerization of the oil.

The use of DSC allowed for the observation of the differences in induction times between oils composed of different inhibitor/drying agents. This information can be very helpful to the fire investigator during his or her reconstitution of the events and hypothesis testing.

Fire Investigation, Spontaneous Ignition, Fatty Acids

B85 Detection of Explosives in Soil Utilizing Pyrolysis-GC-MS

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After attending this presentation, the audience will become familiar with the application of pyrolysis gas chromatography-mass spectrometry (Py-GC-MS) as a method for the detection of explosives in soil.

This presentation will impact the forensic community by providing an alternative, rapid method for the extraction and detection of explosives in soil. In the future, this method may be expanded to other difficult matrices such as fingernails, toenails, and insects.

Generally, pyrolysis is a technique used to study the thermal degradation products of a substance by applying high heat. These high temperatures can also be used as a mechanism to extract analytes from matrices. Coupling this technique with an analytical tool such as GC-MS provides structural and confirmatory information of the resulting products. Py-GC-MS has been previously used in forensic science to study a wide variety of analytes such as drugs of abuse, paints, photocopier toners, polymers, and fibers. Prior studies of the pyrolysis of hair samples have given this method a promising future as an extraction tool. The present work employed a pyroprobe coupled with a GC-MS for the pyrolysis analysis of explosives in a soil matrix. Explosive compounds and degradation products are commonly found in the soil of post blast environments. EPA methods using liquid chromatography-UV-vis and gas chromatography-electron capture detection are still the most widely used for the detection of explosives in soil. Disadvantages to using these methods include the laborious sample preparation and time intensive extraction procedure and instrumental analysis.

An advantage to using this method includes little or no sample preparation, therefore, eliminating the extraction step that normally increases the analysis time. With the elimination of the extraction step, Py-GC-MS can be used as a sample profiling tool that is not only rapid, but semi-quantitative as well. In addition, this method is widely available for laboratory use. While the list of advantages is extensive for Py-GC-MS, the method remains underutilized in the forensic laboratory.

This study focused on new and extended applications of Py-GC-MS in the field of forensic science. In this experiment, the explosives and degradation products listed in the EPA 8330 method were pyrolyzed in soil. These analytes include 2,4,6-trinitrotoluene, 2-amino-4,6-dinitrotoluene, 4-amino-2,6-dinitrotoluene, 2,6-dinitrotoluene, 2-nitrotoluene, 3-nitrotoluene, 4-nitrotoluene, tetryl, 1,3-dinitrobenzene, 2,4-dinitrotoluene, HMX, RDX, nitrobenzene, and 1,3,5-trinitrobenzene. The conditions of the pyroprobe consisted of an initial temperature of 400°C and with a ramp rate of 100°C/sec, reached the final temperature of 1000°C. The GC conditions included an oven temperature of 320°C held for 10 min and a carrier split ratio of 20:1. The Py-GC-MS method shows potential in the area of explosives detection through direct analysis of soil samples. This technique shows promise to be utilized in pre and post-blast investigations as well as in environmental forensic analyses.

Pyrolysis, Explosives, Soil Analysis

B86 Comparison of U.S. Environmental Protection Agency and Accelerated Solvent Extraction Explosives Contaminated Soil Sample Analysis Methods

Amy R. Aylor, BS, and Suzanne C. Bell, PhD, West Virginia University, Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26508*

This presentation will discuss the comparison of the U.S. Environmental Protection Agency's sample preparation technique for soils containing explosives with that of accelerated solvent extraction. Attendees will learn of the potential for each of these methods and which is the most efficient for applications involving explosives in soil matrices.

This research will have a direct impact on the forensic community by comparing two established extraction methods and providing a basis for choosing an extraction technique for the analysis of explosives in post-blast or contaminated soil environments.

In 2001 The U.S. Army Corps of Engineers (Corps) estimated spending between $15 billion and $20 billion to remediate thousands of properties, located throughout the United States, formerly owned, leased, possessed, or operated by the Department of Defense (DOD) or its components.[1] These properties are known as Formerly Used Defense Sites (FUDS) and include sites used for military training and testing.

The area of the Monongahela National Forest known as the Dolly Sods Wilderness Area in eastern West Virginia is a Formerly Used Defense Site. Most of this region was acquired by the U.S. Federal Government between 1916 and 1939 and was used for military testing during World War II. From 1943 to 1944 the area was used for maneuvering exercises and artillery/mortar practice.[2] When the military testing concluded, the site was cleared of any ordnance before being returned to the United States Forest Service. In 1995, the Army Corps of Engineers performed site inspections and confirmed the presence of unexploded ordnance within this area.

Scenes of forensic interest, such as those found after an improvised explosive device (IED), could contain the same type of explosives, propellants, and degradation products as the FUDS areas. Therefore, the same type of analytical methods and techniques used on the abandoned military sites could be used on such crime scenes.

The current research is part of an effort to identify concentrations of exploded and unexploded ordnance, their degradation products, and related contaminants in soil matrices found in post-blast environments. Control soil samples were taken from an arboretum in Morgantown, WV and spiked with known concentrations of explosives. Soil samples recovered from old Department of Defense firing ranges within the Dolly Sods Wilderness Area were used as unknowns to further test the suitability of these extraction techniques. All samples were extracted and analyzed for explosives listed in the Environmental Protection Agency (EPA) 8330 and 8095 methods using high performance liquid chromatography (HPLC) and gas chromatography/electron capture device (GC/ECD). Among others, the explosives analyzed for were 2,4,6-Trinitrotoluene (TNT), 2-Amino-4, 6-dinitrotoluene (2-ADNT), 4-Amino-2,6-dinitrotoluene (4-ADNT), Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX), and Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). Two extraction techniques, the EPA 8330b method and the use of an accelerated solvent extractor (ASE), were compared for sample pre-treatment to determine which was most efficient.

The samples extracted using the EPA 8330b method were allowed to air dry and then homogenized using a sieve and a mortar and pestle. Using a shaker table, 10 gram samples of the homogenized soil were then extracted in 20 mL of acetonitrile over a period of 18 hours. The ASE method had separate 10 gram samples mixed with diatomaceous earth and extracted at a temperature of 100°C, a pressure of 1500psi, over a period of 15 minutes. The ASE method required 50 mL of acetonitrile.

Explosives, Soil Analysis, Accelerated Solvent Extraction

B87 Soil Standards for Explosives

Katie M. Phillips, Amy R. Aylor, BS, and Suzanne C. Bell, PhD West Virginia University, Bennett Department of Chemistry, 217 Clark Hall, Morgantown, WV 26506*

This presentation will discuss the use of a portable, hand-held ion mobility spectrometer (IMS) for the detection of RDX, 1,3,5-TNB, 1,3-DNB, Tetryl, NB, 2,4,6-TNT, 4-Am-DNT, 2-Am-DNT, 2,4-DNT, 2,6-DNT, 2-NT, and 4-NT in soil matrices. Attendees will become familiar with this application of portable IMS and how the method can be applied in the field, outside of a laboratory setting.

This research and presentation will impact the forensic and environmental science communities by providing a validated method for a variety of explosives in soil matrices to be used with a field portable instrument. This application could potentially be used in post-blast scenarios or scenes where the presence of explosive materials is suspected.

During World War II, the Dolly Sods Wilderness Area of the Monongahela National Forest in West Virginia was used as an artillery and mortar training site for troops destined for combat in the mountains of Italy. In 1995, the Army Corps of Engineers performed site inspections and confirmed the presence of unexploded ordnance (UXO) within this area. As propellants and explosives leach from unexploded ordnance and explosives into the ground, they may be absorbed by soils, taken up by vegetation, or migrate into surface and groundwater. This research, performed in collaboration with the West Virginia Water Research Institute, Army Corps of Engineers, and the West Virginia Parks and Recreation Service, seeks to determine the concentrations of explosives in these abandoned firing ranges. Similar environments, such as post-blast zones of improvised explosive devices, could also be subjected to such analysis. Once the concentrations of these compounds have been determined in soil, water, and plant samples, environmental parameters can be used to model the migration of the explosives and predict the explosives' environmental fate.

The explosives used in this study were chosen from EPA Method 8330, a method used to determine the concentration of HMX, RDX, 1,3,5-TNB, 1,3-DNB, Tetryl, NB, 2,4,6-TNT, 4-Am-DNT, 2-Am-DNT, 2,4-DNT, 2,6-DNT, 2-NT, 3-NT and 4-NT in a water, soil, or sediment matrix. Due to availability in the laboratory, HMX and 3-NT were not used in this study.

Since the explosives used in this study form negative ions, the portable ion mobility spectrometer was used in the negative ion particle mode. Using a desorber, soil samples are heated and volatiles are driven into the gas phase where they interact with a radioactive ionization source. The gas phase ions are introduced to a drift tube via a gated ion shutter. The time it takes for the ions to travel the length of the drift tube is recorded and used to plot a plasmagram (detector response vs. drift time). The differences in drift times are dependent on the size, shape, and charge of the ions, allowing the individual explosives to be detected qualitatively.

The following IMS conditions were applied for the analysis of all explosives: 113 ˚C drift heater, 180 ˚C inlet heater, 160 ˚C desorber heater, 200cc/min drift flow, 0.025s analysis delay, 22ms scan period, 25s analysis duration, 57 segments per analysis, 20 co-added scans per segment, 23 segments per analysis, 50µs sampling period, and 419 sample points per scan.

Explosives, Portable IMS, Soil

B88 Evaluation of the Analysis of Diamondoid Compounds in Kerosene Residues by Gas Chromatography/Mass Spectrometry for Use in Fire Debris Analysis

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After attending this presentation, attendees will be able to better understand the gas chromatographic analysis of fire debris for diamondoid compounds, including adamantanes and diamantanes.

This presentation will impact the forensic science community by serving as new information and as a possible additional method in detecting kerosene residues in fire debris from suspicious fires.

Arson investigation has presented many problems for forensic scientists. For an investigation to be successful, being able to identify the accelerant and where it came from is of extreme importance. It has now been found that diamondoid compounds can be found in oil distillates of low or medium molecular weight, such as diesel or jets fuels, which can be used to determine a specific ion pattern for the fuel. This study will present an evaluation of the possible use of these diamondoid compounds for use in the analysis of fire debris samples, specifically where kerosene and other heavier fuels have been used.

Diamondoids are rigid, three dimensionally fused cyclohexyl alkanes which are naturally found in oil. The diamondoids can have anywhere from one cage (adamantane) to seven cages (heptamantane). The compounds may also have various functional groups attached increasing their molecular weight. The types of diamondoids and the ratio of the compounds found in a particular sample of oil have been found to be specific to the region of origin. These diamondoids have a high thermal stability and the heavy compounds are not easily affected by weathering or biodegradation which make them ideal for fire debris analysis. They are also conserved and concentrated during oil refining, creating a good internal standard. By using a combination of gas chromatography and mass spectrometry (GC/MS), a molecular ion fingerprint for the diamondoid component may be used to identify these fuels in fire debris. One microliter of carbon disulfide extract, or one milliliter of headspace, was injected into the gas chromatograph/mass spectrometer and a predetermined method ran with selected mass ions for particular diamondoid compounds. On the basis of GC/MS analysis, the principal diamondoids can be detected and monitoring in fire debris samples. Adamantanes were successfully isolated from liquid kerosene and adamantanes and diamantanes were isolated out of the headspace of kerosene samples. The diamondoids were confirmed through certified standards by GC/MS.

Currently most laboratories conducting fire debris analysis of fire debris samples use GC/MS, and have incorporated into their compilation of methods The American Society for Testing Materials (ASTM) standard methods (ASTM E-1618-06, June 1, 2006). The GC/MS method utilizes mass chromatography, the most widely used approach for the identification of flammable liquids in fire debris. This method is based on a chromatogram created from a series of ions in the mass spectrum which indicate the presence of a particular product. Monitoring the diamondoids could add another set of mass ion standards to search for, adding increased specificity to then identification. Since diamondoids are relatively heavy compounds and resist evaporation, they are ideal to search for in an evaporated sample. The fact that the types and amount of diamondoids found vary according to region or origin may also provide a way to distinguish the origin and possibly the brand of accelerant. This information could provide important investigative leads in arson investigations.

Fire Debris, Diamondoids, Adamantane

B89 Association and Discrimination of Diesel Fuels Using Chemometric Procedures for Forensic Arson Investigations

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The goal of this presentation is to demonstrate the practical use of statistical and chemometric procedures to associate and discriminate diesel samples based on chemical composition. The presentation will further demonstrate the potential of linking a burned diesel sample to its unburned equivalent as a practical application for forensic arson investigations.

This presentation will impact the forensic community by providing an alternative, more objective procedure for the association and discrimination of accelerants in forensic arson investigations.

The identification of a petroleum-based product in fire debris is indicative of an intentional fire and hence, is significant evidence in arson investigations. Currently, gas chromatography-mass spectrometry (GC-MS) is the conventional analytical technique used for the identification of accelerants through chromatographic pattern matching. Visual analysis of chromatograms can easily distinguish different classes of accelerants *e.g.* gasoline from kerosene. However, in order to link an accelerant extracted from fire debris to one found in the possession of a suspect, discrimination of accelerants of similar type is necessary—a difficult process through visual assessment of chromatograms alone. In this work, chemometric procedures were used to statistically associate and discriminate burned and unburned diesel fuels from different sources, to eliminate subjectivity associated with visual chromatographic assessment.

Thirty diesel samples were collected from the mid-Michigan area and analyzed by GC-MS. Pearson Product Moment Correlation (PPMC) coefficients were calculated to allow pairwise comparisons of diesels based on similarity in chromatograms. Principal component analysis (PCA) was used to identify clusters of similar diesels using total ion chromatograms (TIC). Extracted ion chromatograms (EIC) corresponding to characteristic compound classes in the diesel samples were also generated and subjected to PPMC and PCA in order to compare the discrimination ability offered with that of the TIC.

The Pearson correlation coefficients served to reduce the differences in a pair of chromatograms to a single value to which other pairs of chromatogram could be compared. On the whole, the coefficients were considered high by conventional statistical standards. These higher correlations were expected, due to the similar chemical nature of diesel fuels. Although correlations generated for the TICs began to show discriminatory capabilities, the power of the PPMC procedure was demonstrated in the EIC correlations. The mass-to-charge (m/z) 57 ion, which corresponds to linear alkane fragments, did not appear to provide any more discrimination than the TIC. However, other more characteristic ions, such as m/z 91, which corresponds to alkylbenzene fragments, demonstrated a wider spread in the correlation values, and hence greater potential for discrimination. The discrimination potential of other characteristic ions will also be discussed.

Analysis by PCA was performed in order to show natural clusters of the diesel samples and to determine the factors contributing the most to the variance among the diesel sample set. The clusters formed in the PCA scores plots served as another method for associating samples that are similar based on chemical composition. The loadings plots generated from the PCA highlight the chemical markers that cause the clustering to

occur. In the same manner as the PPMC calculations, specific EICs showed more discriminating potential than the TICs after PCA. Therefore, the combination of sample comparison and feature selection from PCA for the association and discrimination of diesel samples is demonstrated.

To explore the idea of association and discrimination of burned and unburned diesels, a subset of the diesels was spiked onto different matrices commonly found in the home, such as wood, carpet, and vinyl. Spiked samples were burned under controlled conditions and the residue was extracted and analyzed by GC-MS. In addition, extractions of an unburned matrix, a burned matrix not spiked with diesel, a matrix spiked with diesel but unburned, and lastly a burned diesel not spiked onto a matrix were also gathered and analyzed in an attempt to further investigate the factors that significantly alter diesel during burning. The data generated from the burnings was compiled into the same set as the data generated from the neat diesels so that PPMC and PCA could be applied to the entire data set. The potential for association of the burned diesel to the corresponding unburned diesel using these procedures will be discussed.

Diesel, Chemometrics, Arson

B90 Demonstration of the Utility of a Planar Geometry Solid Phase Microextraction Device for Use With Ion Mobility Spectrometers

Patricia Guerra, BS, and Jose R. Almirall, PhD, Florida International University, 11200 South West 8 Street CP 194, Miami, FL 33199*

After attending this presentation, attendees will understand the principles and utility of a novel planar SPME geometry coupled to IMS.

This presentation will impact the forensic community by demonstrating a novel SPME extraction geometry that when coupled to IMS will provide forensic examiners increased sensitivity for threat agents without compromising the ease of use, reusability, and ruggedness of commercially available SPME.

Solid Phase MicroExtraction (SPME) is a simple technique that is useful for the pre-concentration and extraction of trace level explosives from air or aqueous samples. The use of SPME is advantageous for explosives analysis since it requires no elution solvent which would otherwise dilute the already trace level samples. A representative portion of the analyte is extracted from the sample matrix and introduced entirely into the analytical instrumentation for detection. An Ion mobility spectrometer (IMS) has been successfully coupled to SPME,[1] and is commonly used in screening checkpoints around the world for the routine detection of explosives and illicit drugs. This interface converts IMS from a particle sampler to a vapor sampler, increasing sensitivity and enabling the extraction of the taggants and odor signatures of explosives rather than simply the parent compounds. Furthermore, the interface utilizes a modified-syringe geometry for the SPME extraction device, yet unlike a gas chromatograph, IMS is not limited by this configuration for sample introduction. A planar coated substrate used as the SPME exhibits increased surface area and capacity in comparison to the commercially available modified-syringe SPME. The current study aims to demonstrate that the planar SPME geometry exhibits improved extraction efficiency, and is as reusable, rugged, and user-friendly as the commercially available SPME when coupled to IMS. The sampling scheme is static, whereby a known amount of analyte is contained in a vessel in which the extraction device is exposed. The sampling occurs at equilibrium and then the SPME, either planar or modified syringe, is thermally desorbed into the heated port of the IMS or the SPME-IMS interface, respectively. This can simulate a scenario where the extraction device is placed in a fixed volume space such as a cargo hold or a shipping container, allowed to sample, and is then desorbed into an IMS. The extraction phases evaluated for planar SPME are PDMS and sol-gel PDMS.[2] The latter is introduced as an alternative to PDMS, an already versatile liquid phase, as a result of its enhanced thermal stability which is useful in applications which require high desorption temperatures. The techniques used to coat the planar substrates with the extraction phase (PDMS or sol-gel PDMS) are also statistically evaluated for repeatability of coating thickness, since this is important for obtaining consistent extraction efficiencies. Additionally, the planar SPME also requires minimal surface roughness for uniform extraction, which is monitored by SEM imaging. Lastly, a study of the performance of the planar SPME when exposed to a moving current of 2,4,6-trinitrotoluene (TNT) in air demonstrates this geometry's capability to sample effectively by either dynamic or static extractions.

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SPME, IMS, Explosives

B91 A Novel Concept for the Complete Automation of Established Spin Column Based Extraction Processes: QIAcube

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After attending this presentation, attendees will have learned about utilization of a spin column automation system that may help further standardizing and replacing conventional manual processes for nucleic acid extraction.

This presentation will impact the forensic community by presenting comparative data generated by using a novel device for the automation of spin column based DNA evidence handling.

Spin-column based kits have been widely established for the extraction of nucleic acid evidence. These prefabricated formats relieved forensic scientist from preparing reagents themselves, improved quality control of materials and helped to minimized process variation. Laboratory processes could be standardized by spin columns, resulting in improved accuracy and run-to-run consistency.

However, no automated solutions are available that would enable walk-away processing of spin columns. For the first time, an innovative robotic concept is introduced to the field of molecular forensics that facilitates complete automation of spin columns. The QIAcube platform is a novel system that provides fully automated purification of genomic DNA from two to twelve samples per run. The systems allows forensic scientist to instantly translate their established spin-column based processes into a completely automated workflow.

Standardized processing and elimination of handling errors are key factors for forensic sample preparation to ensure reliable results. Automated nucleic acid extraction offers many advantages compared to manual extraction methods: minimal hands-on time, further reduction of operator-dependent variation, and maximal safety in handling of samples.

Data will be presented on the automated extraction of DNA from reference and case work samples using the QIAcube.

Spin Column Automation, Nucleic Acid Extraction, QIAcube

B92 The Development of an Entangled Polymer Solution for Improved Resolution in DNA Analysis Using a Portable Microfluidic Instrument

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After attending this presentation, attendees will understand the research being conducted in polymer solutions in DNA analysis. Upon completion of this research, the effect of mixing two different linear polymer solutions in DNA separation techniques such as Capillary Electrophoresis and Micro Electrophoresis systems will be known. The mixing of those two polymers at certain concentration and ratio has the potential of yielding very efficient coating capabilities and also improved resolution in DNA analysis. Other factors such as viscosity and migration time are also considered in the study.

This presentation will impact the forensic community by discussing hoe the development of this new polymer in DNA analysis will be advantageous to the forensic community by improving separation resolution and increasing the accuracy of many electrophoresis methods. Another important factor is that it could be used as a cheaper substitute to other commercially available polymer solutions.

The purpose of this project is to develop a novel entangled polymer solution that will permit the separation and genotyping of DNA in microfluidic channels. This solution will consist of a combination of two different polymers, polyvinyl pyrrolidone (PVP) and hydroxyethyl cellulose (HEC) in an appropriate buffer. PVP is a low viscosity polymer with excellent wall coating characteristics while HEC is more viscous but less interactive with the channel wall. The effect of various mixtures of these two polymers on the separation and resolution of various DNA fragments will be examined using capillary electrophoresis. By determining the effect of various parameters such as concentration, weight percent, and viscosity on the resolution, the authors will work to develop an optimal separation media for use in microfluidic separations.

In these experiments, different concentrations of the aqueous polymers were pumped into silica capillaries. Then ROX labeled DNA was separated and detected at 15kV using an ABI 310 genetic analyzer (capillary electrophoresis system with laser induced fluorescence detection). A factorial based experimental design was then used to determine the optimal concentration and weight fraction of the two polymers. After finding the optimal sieving matrix, its capability to separate and detect genomic DNA will be examined using microchip based electrophoresis.

DNA, PVP, HEC

B93 Rapid Genotyping of a Global Collection of Bacillus Anthracis Isolates Using Pyrosequencing

Richard A. Winegar, PhD, Kelly Brown, PhD, Caron Stonebrook, BS, Joseph Carrano, BS, Robert O'Shea, BS, and Michael Cassler, PhD, Midwest Research Institute, 1470 Treeland Boulevard, Palm Bay, FL 32909*

After attending this presentation, attendees will have a greater understanding of the genetic diversity present among Bacillus anthracis (BA)—the causative agent of anthrax, the technology used to obtain genotyping results, and how such information can be used to aid investigations of bio-crimes.

The proposition underlying the work is that new technologies such as Pyrosequencing will impact the forensic science community by allowing rapid genotyping using a greater variety of sample types and with greater ease than traditional methods.

The 2001 anthrax attacks using the U.S. postal system have led to the development of an emerging discipline: microbial forensics. Broadly, this field is dedicated to the use of science to solve crimes using biological agents. One of the potentially most powerful pieces of information is genetic material obtained from the organism used in an attack. Strains or isolates of bacteria and viruses often may be distinguished from one another and assigned to a genotype based on sequence variations. Matching genotypes of material used in an attack with possible natural or laboratory sources may provide investigative leads.

Traditionally, genotyping of *Bacillus anthracis* has used DNA fingerprinting methods such as AFLP (Amplified Fragment Length Polymorphism PCR) and MLVA (Multi Locus VNTR Analysis). These powerful techniques allow strain- and sub-strain-level identification. However, these methods are technically challenging and not suitable for mixed environmental samples, especially if there are no viable isolates. An additional method of genotyping is based on sequencing of the protective antigen (*pag*A) toxin gene. Using standard sequencing methods, Paul Keim's lab discovered several single nucleotide polymorphisms (SNPs) that allowed BA stains from around the world to be categorized into six *pag*A genotypes (I-VI).

Pyrosequencing is an alternative technology for obtaining genetic information based on sequencing by synthesis. Using the published SNPs present in the *pag*A gene, pyrosequencing assays were designed to allow genotyping of BA. The authors are currently genotyping a global collection of BA isolates, with 118 isolates from 35 countries and 18 human and animal hosts. To date, the most commonly observed genotypes have been Types I and V, which respectively represent the Sterne-Ames and Western North American diversity groups. Additionally, genotyping was performed directly on soil samples associated with anthrax outbreaks in cattle in Texas and South Dakota. Genotyping can be obtained within 3.5 hours of receipt of either environmental samples or pure isolates and requires only basic molecular biology laboratory skills. In conclusion, pyrosequencing is a rapid, simple, cost-effective means for performing high throughput genotyping with a wide variety of sample types.

Microbial Forensics, Bacillus Anthracis, Genotyping

B94 Optimizing Collection, Shipping, and Storage of Forensic Biological Samples

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The goal of this presentation is to evaluate the stability of DNA stored at room temperature in SampleMatrix™.

This presentation will impact the forensic community by demonstrating reliable method for storing and shipping forensic source DNA at room temperature.

Reliable sample storage is of paramount importance in forensic, epidemiological, clinical and genetic laboratories. Sample stability after long-term storage is critical, particularly when the amount of DNA is limited. For example, forensic evidence samples collected from hair, teeth and sexual assault evidence may contain less than 100 pg of DNA. Advances in PCR technology have enabled successful analysis of minute quantities of these samples, including low quality and quantity DNA.

Forensic DNA sample analysis involves several steps, each of which can contribute to sample degradation, making reliable DNA storage an issue of significant concern in the forensic science community. First, the biological sample must be collected at the crime scene or obtained from the individual, and then transported back to the laboratory. Samples not immediately processed must be stored until the DNA can be isolated and purified. Amplification is routinely performed using a variety of techniques, followed by analysis and reporting of data. Finally, storage of the sample may or may not occur, depending on the jurisdiction and/or the standard operation procedure of the lab.

Sample stability after long-term storage is critical; especially when the amount of DNA is limited (*e.g*. trace evidence) and the sample must be re-tested. Sample re-testing is a vital component of forensic work, where trace evidence can lead to the exoneration of the innocent or identification of a suspect or victim. Unfortunately, inconsistent sample handling and storage is a common occurrence, particularly across jurisdictions, leading to highly variable and unreliable results. Thus, proper storage of samples containing small amounts of DNA is crucial for maintaining sample integrity over time. The objective of this study is to develop an efficient transport and long-term storage strategy for DNA samples. The current work focuses on forensic samples; however, this technology is applicable to all DNA laboratories.

Sample quality may be compromised due to degradation, UV exposure, temperature fluctuations, repeated freeze-thaw cycles, and other sub-optimal storage conditions, among other factors. To explore alternative methods of sample storage, an international consortium of forensic, academic and government laboratories has formed to evaluate the feasibility of using a novel technology (DNA-SampleMatrix®) that allows for the stable, dry storage of biological materials at ambient temperatures. Based on the natural principles of anhydrobiosis, the synthetic matrix forms a protective shield around the sample as it dries, preventing further damage and degradation over time.

Results will be presented from consortium studies evaluating the ability of DNA-SampleMatrix® to store and protect samples previously extracted and typed from proficiency tests, samples collected from crime scenes (blood, semen and buccal swabs), degraded DNA samples, DNA extracted from bones and teeth, low copy number samples, and samples shipped via USPS to evaluate protection during transport. Preliminary results from qPCR analysis indicate that sample integrity is maintained after dry storage as compared to conventional cold-stored control samples. Samples stored in the matrix were also amplified using a variety of STR multiplex systems. No detectable inhibition of amplification of STR multiplexes was observed even in the presence of high concentrations of DNA-SampleMatrix®.

The development of room temperature dry storage of forensic DNA samples will have a significant impact on forensic DNA analysis, as well as other fields of DNA research, if it can be found to eliminate some of the detrimental variables associated with sample collection, transport, and storage.

DNA, Forensic Sample, Room Temperature Storage

B95 A Ten Year Study of DNA Blood References Collected on Untreated Filter Paper and Stored at Room Temperature

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The goal of this presentation is to inform and to present to the audience the results of a long-term study examining the storage of whole blood DNA reference specimens collected on untreated filter paper and stored at both room temperature and at -20 ºC at the Armed Forces Repository of Specimen Samples for the Identification of Remains (AFRSSIR).

This presentation will impact the forensic community by discussing the results of a long-term study investigating the need to store blood reference specimens at -20 ºC versus room temperature.

The Department of Defense DNA Registry, a component of the Armed Forces Medical Examiner System (AFMES), consists of two operational branches supporting the identification of human remains from current death investigations. The first branch, the Armed Forces DNA Identification Laboratory (AFDIL) includes a nuclear DNA section that conducts PCR testing of the core CODIS STR loci to establish the genetic profile of the fallen service member. This profile is then compared to a whole blood DNA reference specimen profile that was collected from the individual upon enlistment into military service.

Since 1992, the storage and maintenance of over 5.1 million blood reference cards has been the responsibility of the second operational branch, the Armed Forces Repository of Specimen Samples for the Identification of Remains (AFRSSIR) located in Gaithersburg, MD.

Presently, whole blood is collected and spotted onto untreated filter paper. The reference cards are then allowed to air dry, and are sealed in a foil pouch with a desiccating agent and stored in a -20 °C freezer until it becomes necessary to generate a known genetic profile for comparison to the decedent.

The authors investigated the continued necessity to store blood reference cards at the AFRSSIR at -20 °C. A previous collaboration with the National Institute of Standards and Technology (NIST) investigated the short-term (~19 months) recovery of DNA at ambient temperatures (Kline et al. 2002). Since 1997, randomized, duplicate specimen storage study has been conducted of 500 samples stored on untreated filter paper maintained at both room temperature and at -20 °C. The 500 selected specimens represent collections from 437 separate locations world-wide. No more than two sets of specimens were used from any one collection site.

The results from these bloodstains extracted will be presented with three methods: Chelex, Qiagen, and DNA IQ (Promega), and quantification of these samples using the Applied Biosystem's Quantifiler Human DNA Quantification kit on the ABI 7000 Sequence Detection System. Preliminary results indicate there is no evidence of inhibition in either storage condition as measured by the internal positive control (IPC) from the Quantifiler results. Qualitative analysis of the electrophoretic data generated from the Promega PowerPlex 16 STR kit (as measured by peak height intensity) will also be presented. The evaluation will compare the results generated for each extraction method/storage condition combination. The results of this investigation will be used to evaluate the necessity of the AFRSSIR to maintain blood stain reference cards at -20°C for the foreseeable future.

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Blood Reference Storage, DNA Typing, Untreated Filter Paper

B96 Rapid Collection of Dental Pulp Tissue for DNA Analysis

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At the conclusion of the presentation the participants will be familiar with a technique for the collection of pulp tissue from inside a tooth for DNA analysis; be familiar with the instruments needed for cleaving tooth structure; and be familiar with pulp canal morphology to help understand the best teeth for producing DNA.

The presentation will impact the forensic science community by allowing for the rapid, effective removal of pulp tissue using common dental instruments that do not require the training and skill of a dentist to perform. It will also suggest ways that forensic odontologists and DNA Analysts can collaborate to produce the best chance of obtaining useable DNA.

Tooth enamel is the hardest structure in the human body. The durability of the dentition is well documented and has historically allowed Forensic Odontologists to play an important role in the post mortem identification of victims of a mass fatality event. In cases where advanced decomposition, fire or severe trauma has made identification by other means difficult or impossible, often the dentition remains remarkably intact. In the past, dental identification has been accomplished by comparing post mortem dental radiographs of an unidentified victim with antemortem radiographs of a known patient. This method of identification works very well provided an antemortem dental record can be obtained for comparison. In the absence of antemortem dental records, dental identification had little to offer other than to assist anthropologists in age determination. Even then, using the dentition for the determination of age is only accurate within certain age ranges during which there is active tooth development.

In recent years, the use of DNA has proven to be an extremely valuable tool in post mortem identifications. In the course of developing the science and technology for DNA analysis, it was discovered that an excellent source of DNA was dental pulp tissue. The dental pulp, found in a small canal within the tooth, is commonly referred to as "the nerve". Although it does contain unmyelinated nerve fibers, it is actually connective tissue made up of many other components. In addition to the nerve fibers, the dental pulp also contains highly specialized tooth-forming cells, undifferentiated cells that can become whatever cell type is needed, defense cells, blood vessels and ground substance. The durability of the tooth structure encasing the dental pulp provides protection so that its DNA survives in cases where it may be destroyed in other areas of the body. Thus recovery of dental pulp tissue can be very useful in recovering DNA from an unidentified victim. However, removal of the tissue from the tooth can be difficult, in some cases even for trained dentists, requiring significant time, instrumentation and skill.

The literature often describes recovering pulp tissue for DNA analysis by grinding away tooth structure until the pulp is encountered. This presentation discusses a fast, inexpensive, and efficient alternative technique that involves splitting the tooth to access the pulp. Using readily available, inexpensive dental tools, the presentation will describe the technique and the instruments required for accessing the pulp space that does not require the training and clinical skill of a dentist. It is designed for those who perform DNA analysis and who would like to learn a fast, efficient technique for accessing the pulp in any setting.

At the conclusion of the presentation, the participants will have a basic knowledge of pulp canal morphology for single and multi-rooted teeth, the instruments recommended for cleaving the tooth structure, the best areas on the tooth to accomplish splitting of the tooth and the role forensic odontologists can play in collaboration with DNA Analysts in the recovery of useable DNA.

The presentation will have an impact by suggesting a fast, efficient technique for collecting DNA from the dental pulp by DNA Analysts. It will also suggest ways that DNA Analysts and dentists can work together to maximize the chance of obtaining useable DNA from the pulp.

Dental Pulp, DNA, Collection

B97 Methods for Accurate STR Sex Typing of Ancient Bone and Tissue Samples

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The goal of this presentation is to discuss current methods including two new ones for generating sex markers for ancient bone and muscle.

This presentation will impact the forensic science community by stimulating thought and discussion as to problems and issues observed with different methods.

The Smithsonian Institution provided two ancient bone samples and two ancient muscle samples. These samples were taken from skeletons found within a cave in the southern Mongolian Gobi desert. Radiometric dating revealed the bones originated between AD 1270 and 1400. The first sample, designated 1-G, consists of muscle tissue from the mid-shaft of the right humerus. Sample 1-G represents the lower portion of a skeleton and, based on position, matches with the skeleton of the second muscle tissue sample, designated 1-A/D. Sample 1-A/D is from the distal end of the right femur from a skeleton consisting of an upper body with male characteristics, including a penis. Sample 1-G, on the other hand, was determined to have derived from a female skeleton based on examination of the pelvic region. The two bone samples, labeled 1-D-1 and 1-D-2, are rib fragments from a skeleton determined to be female based on morphological characteristics. The purpose of DNA testing in this presentation was to clarify the gender of the sample and to use 1-D-1 as a control female sample.

Samples 1-G and 1-D-1 were pulverized using the SPEX Freezer/Mill 6770. The Freezer/Mill 6770 freezes the samples and then crushes the material to a fine powder. A forensic DNA extraction kit by Invitek (Invitek, Germany) was used to obtain DNA for amplification following the manufacturer's protocol. Additionally, longer digestion times and double the volume of the bone lysis enhancer were used to obtain more DNA fragments. DNA profiles were obtained using either the Identifiler or Minifiler STR amplification kits (Applied Biosystems, Inc., Foster City, CA) and detected with an ABI 310 DNA Sequencer and GeneMapper software (Applied Biosystems, Inc., Foster City, CA).

Identifiler did not provide any useful information about the DNA extracted from sample 1-G regarding sex typing. Minifiler, on the other hand, revealed a large X allele peak with a very small Y allele peak for the amelogenin locus. Based on the relative amplitude (RFU) of the peaks, it is probable that the presence of a Y allele is due to surface contamination. The next step for this problem is to type the

Y-chromosome of male laboratory personnel and the sample with Y-Filer (Applied Biosystems, Inc.). The Y allele peak was so small compared to the X allele peak that it is likely the sample is derived from a female skeleton.

When additional PCR cycles were added to the process, the 1-G sample typed as exclusively female. This result confirms the results of anthropological analysis determination of sex. However, this raises some more anthropological questions since the upper portion of this skeleton contained a penis and male characteristics.

Minifiler results posed a similar problem for the bone sample 1-D-1. The amelogenin locus revealed a large peak representing the X allele and a very small peak representing a Y allele. Further testing will be done to determine whether the Y allele is simply due to contamination or if the allele is actually an accurate representation of the STR profile. However, like sample 1-G, the sample is probably female since the X allele peak is much larger than the Y allele peak. Other possibilities include a mutation in the primer binding site which can be determined by DNA sequencing or an artifact of the Minifiler kit and the age of our samples.

Unlike DNA from bone samples, the DNA from the muscle tissue is more likely to contain contaminant DNA. The DNA of the bone samples is protected, and often sealed, from surface contamination due to collection and handling. Additionally, since the samples are hundreds of years old and the location of the cave is well known among nearby residents, the amount of potential surface contamination is infinite. With ancient samples it can be difficult to determine whether the results are true representations of the genetic profile. The authors are in the process of establishing a standard procedure for DNA typing of ancient muscle and bone samples using two new kits in combination with standard procedures such as grinding methods and extended PCR cycles. In addition, to obtain cleaner STR profiles, post-PCR purification steps will be implemented because it has been shown to significantly reduce background noise in low copy number DNA samples and may eliminate the small Y peak that we observed with Minifiler.

A combination of these new technologies and methods can provide enough information to more conclusively determine the sex of each sample and whether the two samples, 1-G and 1-A/D, were derived from the same skeleton and, subsequently, the same person. These technologies have a tremendous impact on the forensic community by providing useful information about difficult and highly degraded samples that have been nearly impossible to analyze in the past.

DNA Typing, Degraded DNA, PCR and Bone or Muscle

B98 A Comprehensive Review of Data From the DNA Analysis of Firearm Evidence at the San Diego Police Department Crime Laboratory

Shawn Montpetit, MSFS, and Patrick T. O'Donnell, PhD*, San Diego Police Department, Crime Lab, 1401 Broadway MS 725, San Diego, CA 92101*

After attending this presentation, attendees will be informed on the viability, usefulness, and typical results obtained in the forensic DNA examination of firearms evidence.

This presentation will impact the forensic science community by educating the forensic community on an optimized method developed for DNA analysis on firearms in terms of sample collection sites as well as DNA extraction and PCR amplification methodologies.

The presentation will seek to highlight the probative nature of this evidence and its significant role in criminal cases. The need for communication between, and cooperation among, the various laboratory sections will be discussed as a key element to obtaining the most successful and complete information from the evidence. Knowledge of the affect of one discipline on the ability of obtaining results in a second discipline is vital to the implementation of a program for performing DNA analysis on firearms evidence. The current model of inter-section collaboration at the San Diego Police Department Crime Laboratory will be presented.

The authors will present data suggesting the necessity for this type of analysis from national, state, and local perspectives. Firearms are pervasive in society and are routinely involved in crimes. In 2005 alone, nearly 400,000 gun crimes were reported nationally and approximately 9% of all non-fatal violent crime involved a firearm. The prevalence of the use of firearms in the commission of crimes exemplifies the need for the allocation of additional DNA resources to the analysis of firearms evidence. Conducting DNA analyses in felon in possession of firearms cases must be viewed as keystone in any effort to proactively reduce gun violence.

Firearms evidence has traditionally been submitted to the Laboratory for functionality tests, firearms comparisons, and latent print development. Estimates of the successful latent print development from firearms evidence at the SDPD Crime Laboratory suggest that only 5% of firearms yield latent prints. Of that 5% only a small fraction have enough ridge detail for meaningful comparisons. The advances in DNA technology have created an opportunity for the science to play a critical role in determining who has come in contact with a firearm.

The presentation will introduce an optimized method of analysis for firearms evidence, developed by the SDPD Crime Laboratory, such that 90% of firearms examined yield some DNA information. The presentation will highlight this method and detail the areas on firearms most likely to yield DNA. It will also demonstrate the superiority of magnetic bead based extractions over the classic organic extraction method, and how supplementing AmpFlSTR® Identifiler™ amplification reactions with additional T*aq* DNA polymerase and bovine serum albumin (BSA) leads to a greater success in obtaining DNA results.

The San Diego Police Department Crime Laboratory has compiled the data from the analysis of firearms evidence since 2004 and the presentation will break down this data to reveal insights into the typical DNA results from firearms evidence in order to demonstrate the challenges faced when performing this type of analysis. The authors will discuss the limitations of the DNA analysis of firearms evidence and demonstrate the critical need for laboratory staff DNA databases through examples of actual casework. The authors will present cases that demonstrate the benefits of the improved methodology and how probative findings may influence criminal cases in court.

DNA, Firearms, Forensics

B99 A Forensic Laboratory Tests the Berkeley Microfabricated Capillary Array Electrophoresis Device

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The objective of this presentation is to demonstrate to the forensic community that ultra-fast capillary electrophoresis can be achieved in the forensic laboratory by the use of a microchip capillary array electrophoresis device.

This presentation will impact the forensic science community by providing a better sense of how the microchip is operated, how well it performed, and what this may portend for the future of DNA typing of forensic casework.

The Berkeley microfabricated capillary array electrophoresis (μCAE) device, a 96 microcapillary array capable of simultaneously separating and capturing data for PowerPlex® 16 amplified samples in less than 30 minutes, was demonstrated at Berkeley to provide high

quality STR profiles using both simulated and non-probative casework samples.[1] A pre-commercial prototype instrument was installed at the Virginia Department of Forensic Science (VDFS) for testing by forensic scientists as part of a collaboration between VDFS, the Palm Beach County Sheriff's Office (PBSO) and the Mathies' laboratory. The initial step was mastery of the instrument operation which was verified by the successful electrophoresis and short tandem repeat (STR) profiling of concordance samples amplified with PowerPlex® 16. The practical application of the μCAE device was then demonstrated by accurate analysis of nineteen non-probative casework samples, the results of which were consistent with previous typing data. Both sensitivity series and mixture samples were successfully typed with Powerplex® 16 as well as mock sexual assault samples analyzed using PowerPlex® Y. Both a student intern and a scientist from PBSO were able to successfully operate the μCAE system following several days of training.

The microchip instrument performance was assessed as a function of both resolution and precision. Resolution measurements were performed following the protocols outlined in Buel *et. Al.*[2] Successful replacement of the Hjerten capillary coating method with a dynamic coating polymer (polyDuramide) was assessed using resolution measures and ultimately adopted given its improved ease of use and the greater number of successful capillaries.

This mastery of operation of the μCAE device by forensic scientists establishes the capacity of this technology to be transported out of the research venue and into a practitioner laboratory. Moreover, it demonstrates the feasibility of the paradigm shift from large conventional capillary electrophoresis systems to microfabricated devices. Next generation microcapillary systems slated for testing will contain additional integrated features, such as sample clean-up prior to capillary injection[3] and on-chip PCR, thus propelling the development and potential usefulness of the microchip capillary system for forensic sample analysis.

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Micro-Chip, Capillary, Electrophoresis

B100 Base Composition Analysis of Human Mitochondrial DNA by Electrospray Ionization Mass Spectrometry: Applications for Forensic Examinations

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The goal of this presentation is to demonstrate the power and utility of base composition analysis of human mitochondrial DNA (mtDNA) by electrospray ionization mass spectrometry (ESI-MS).

Base composition analysis by ESI-MS is highly reproducible, precise, and sensitive. Moreover, the method provides the ability to detect and quantify heteroplasmy and mixtures of different mtDNA types. This presentation will impact the forensic science community by demonstrating how base composition analysis by ESI-MS is a rapid, robust method capable of capturing individual specific variation and resolving mixtures of mtDNA types.

Mitochondrial DNA analysis plays an important role in criminal investigations, identification of victims of mass disasters, and association of unidentified remains with family members. The conventional method of typing human mitochondrial DNA relies upon amplification of hypervariable regions 1 and 2 (HV1 and HV2) of the control region by the polymerase chain reaction (PCR) followed by cycle sequencing. Fluorescently labeled sequencing fragments are then separated by capillary electrophoresis. The resulting sequence is described relative to the published revised Cambridge Reference Sequence (rCRS). Sequencing of human mtDNA is often considered the gold standard for detecting variation due to the single base resolution achieved. However, sequencing is a time consuming and laborious process that is not quantitative. Moreover, when confronted with a mixture of different mtDNA types, sequencing results are often difficult to interpret. Additionally, sequencing requires substantial post-PCR processing of samples.

Electrospray ionization mass spectrometry (ESI-MS) offers an attractive alternative to traditional sequencing because it is a rapid, sensitive, automatable method for the quantitative analysis of human mtDNA that affords exquisite mass resolution. With this process, PCR generated fragments are purified and ionized. The molecular masses of the ionized amplicons are used to determine the base compositions of DNA products which are directly correlated to sequence variation. The molecular mass measurement obtained for each product strand is used to derive a list of possible base compositions. By exploiting the base complimentary nature of DNA, the masses of both the forward and the reverse strands are used to constrain the list of potential base compositions to one configuration. The reliability of the base composition determination is due to the fact that it is derived from an intrinsic property of the PCR product, the molecular mass, which is independent of environmental conditions. A feature of ESI-MS analysis is that two samples with different molecular masses will have different sequences and each ionized component is detected independently. Each signal in a mixture can be deconvolved and the intensities can be used to measure the relative amounts of mtDNA types. Thus, quantitation and resolution of mixed mtDNA samples is possible.

To investigate the utility of this method, known mtDNA types were analyzed by ESI-MS base composition analysis. Known mtDNA types were selected to include types with insertions, deletions, point (or sequence) heteroplasmy, and length heteroplasmy. Also, biological samples were selected to mimic those typically encountered in forensic mtDNA casework. Samples types included blood, hair, saliva, and bone. Matching buccal swabs and hair samples from the same donor were processed to explore tissue-specific variation. Samples were extracted and amplified using a multiplex PCR consisting of 24 overlapping reactions. The sensitivity of the method was assessed by processing diluted samples of known mtDNA types. Mixed mtDNA samples were generated by mixing two known mtDNA types at predetermined ratios prior to multiplex PCR amplification.

Base composition analysis by ESI-MS is highly reproducible, precise, and sensitive. Moreover, this method provides the ability to detect and quantify heteroplasmy and mixtures of different mtDNA types. Base composition analysis by ESI-MS is a rapid, robust method capable of capturing individual specific variation and resolving mixtures of mtDNA types.

Mitochondrial DNA, Mass Spectrometry, Base Composition

B101 New Tools for Mitochondrial DNA Sequencing and Analysis at the University of North Texas Center for Human Identification Laboratory

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After attending this presentation, attendees will understand the strategy for mitochondrial DNA sequencing in use at the University of North Texas Center for Human Identification.

This presentation will impact the forensic community by demonstrating new techniques and strategies to improve sequence quality, increase efficiency, and reduce costs.

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. The services offered by this program are available to criminal investigators nationwide to help identify missing persons and skeletal remains and provide guidance and kits for the collection of appropriate family reference samples. As of May 2007, 43 states have submitted approximately 1,000 human remains and 2,000 reference samples which have resulted in over 100 identifications.

Both mitochondrial DNA analysis and nuclear DNA analysis are evaluated since the DNA from many of the recovered remains is highly degraded and/or since family reference samples are often limited. Substantial effort is attempted at UNTCHI to incorporate new techniques that improve quality, increase efficiency, and reduce costs. The bottlenecks in sample processing are regularly assessed. Since this program began, the UNTCHI has validated and implemented new kit assays, upgraded instrumentation and software, and adapted robotics. With the success of individual cases and the appreciation of the program by investigators, medical examiners, and families, there is an anticipation of an influx of human remains and reference samples in the very near future. The UNTCHI has positioned itself with ample staff and high throughput capabilities to meet the future demands.

The focus of this paper is to share the many changes and improvements made at UNTCHI for mitochondrial DNA testing and describe how each process is being integrated into the case workflow. Much progress in the mitochondrial DNA process has been made and published in forensic sciences in the areas of extraction, amplification, use of robotics, sequencing, quantitation, and quality control measures. The UNTCHI staff has adopted many of these procedures, made modifications to other procedures, conducted comparison studies, and developed new techniques.

During this presentation, the authors will share results in conventional extraction procedure of skeletal remains as compared to the demineralization procedure published by Loreille et al. The success of robotics and the high throughput extraction process (Plopper, FJ et al.) and sequencing (Roby, RK et al.) implemented for the family reference samples will be reported. For sequencing of smaller amplicons, the presentation will also include a comparison of a new cycle sequencing strategy to replace dRhodamine Terminator Cycle Sequencing Kits (Applied Biosystems, Foster City, CA). This procedure consists of a reduced reaction of BigDye® Terminator v. 1.1 Cycle Sequencing Kit (Applied Biosystems) by adding a sequence enhancing and dilution buffer followed by a simple bead purification method to remove unincorporated BigDye® terminators. Lastly, the authors will share the validation performed of new versions of analysis software and present the use of a software tool to quickly assess sequence quality.

Mitochondrial DNA, Missing Persons, High Throughput

B102 Optimization and Validation of an Assay for the Determination of Telomere Length Using the ABI Prism 7500 Real-Time PCR Instrument

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The goal of this presentation is to discuss a research project to optimize and validate an assay for the determination of relative telomere length using the Applied Biosystems Prism 7500 Real-Time PCR instrument, an instrument already in use in many forensic laboratories. The assay utilizes the ABI Power SybrGreen Master Mix, thus minimizing reagent preparation. This assay validation is a necessary first step in a series of experiments to determine if age range can truly be determined for forensic samples using telomere length. Telomeres are hexamer repeats located at the ends of chromosomes that protect terminal genes; studies report that telomere length shortens throughout an individual's lifetime as their cells replicate.

This presentation will impact the forensic community by demonstrating an age range determination technique. Detection of relative telomere length using the ABI Prism 7500 allows for rapid and easy analysis of large numbers of samples in a forensic laboratory. This technique proved to be highly precise and reproducible from run to run, both between and within lot numbers of reaction mix. A successful age range determination technique would potentially have a significant

impact on the forensic community by providing investigative leads for cases with no active suspect.

The real-time PCR telomere length measurement technique employs the use of unique primer sets that hybridize to and amplify the hexamer repeats found at the telomeric regions of chromosomes, while at the same time minimizing the amplification artifacts commonly seen when targeting repeating sequences. The relative telomere length assay using quantitative real-time PCR measures two targets for each sample: the telomere repeat regions and a single copy gene (36B4, a gene that encodes acidic phosphoprotein PO). Relative telomere length is determined by comparing the C_t ratio of the telomere and 36B4 amplifications (T/S ratio) against the ratio of a known standard or pooled sample.

While the development of the relative telomere length assay has been reported in other fields, successful modification and validation of the assay for use with instrumentation commonly used in forensic casework was necessary. The ABI Prism 7500 Real-Time instrument has been validated for use in the forensic community, and the ease of use as well as programmability makes it amenable to other forensic uses in addition to human DNA quantitation. In addition, the ABI Power SYBR Green Master Mix simplifies sample preparation by integrating most of the reaction components into a single master mix, and makes for simple quality control records. The Power SYBRGreen master mix includes all necessary components for amplification.

A DNA sample, extracted from whole blood using the Qiagen DNA Mini kit, was quantified using the Applied Biosystems Quantifiler kit. A single set of standard curve samples was made from this sample and used for the entire validation series. Once the method was optimized for use with the ABI Prism 7500, several replicates of both telomere and 36B4 standard curves were analyzed for both between- and within-run precision analysis.

Standard curves were generated for both telomere and 36B4 reactions using the ABI Prism 7500 SDS software over multiple runs. Between run slope values for telomere and 36B4 reactions averaged -4.20 ± 0.48 and -3.15 ± 0.3, respectively (n=9 for each assay). R^2 values averaged 0.987 ± 0.02 and $0.996 \pm .01$, respectively (n=9). Both telomere and 36B4 amplifications were shown to be reliable and reproducible over a large range of template quantities tested. When samples were measured multiple times, average standard deviations were 0.182 and 0.262 (telomere) and 0.086 and 0.228 (36B4), for within and between run, respectively. Lower limits of detection were also investigated: 36B4 was detectable from 100 ng to .2 ng, and telomere amplification product was detected from 100 ng down to 3.125 ng of sample. Sample quantities were not tested above 100 ng.

Genomic DNA extracts from several individuals were tested in duplicate for final validation of the technique. Relative telomere length for each sample was measured by determining the ratio of the real-time amplification of the telomere repeats (T) versus the single copy 36B4 (S), as compared to a reference sample, also known as the T/S ratio. While most replicates had only small variations in the T/S ratios as calculated, others had larger variations, but were still well within the expected range. Actual telomere length was also calculated, and found to be concordant in most cases.

Detection of relative telomere length using the ABI Prism 7500 allows for rapid and easy analysis of large numbers of samples in a forensic laboratory. This technique proved to be highly precise and reproducible from run to run, both between and within lot numbers of reaction mix. A successful age range determination technique would potentially have a significant impact on the forensic community by providing investigative leads for cases with no active suspect.

Telomeres, Real-Time PCR, Age Determination

B103 Laser Induced Breakdown Spectroscopy (LIBS) and X-ray Fluorescence (XRF) Analyses of Biological Matrices

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After attending this presentation, attendees will learn how elemental analysis by LIBS and XRF can provide important information about the elemental analysis of biological matrices.

This presentation will impact the forensic community by demonstrating how qualitative and quantitative analysis of the elemental distributions in hair, nail, and bone samples may play a significant role in revealing key information in various types of forensic investigations including provenancing of human remains, monitoring of environmental exposures to metals, and detection of intentional poisoning with heavy metals. Elemental profiling of biological matrices has been accomplished using Laser-Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF).

Elemental profiling of biological matrices has been accomplished using Laser-Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF). Qualitative and quantitative analysis of the elemental distributions in hair, nail and bone samples may play a significant role in revealing key information in various types of forensic investigations including provenancing of human remains, monitoring of environmental exposures to metals and detection of intentional poisoning with heavy metals.

Methods for the quantitative and qualitative analysis of hair, nail, and bone samples were developed by using both LIBS and XRF analyses. Certified NIST standards for bone, hair, and fingernail were used in the development of the analytical protocols and to determine the precision, accuracy and repeatability of the LIBS and XRF analysis. The LIBS instrumentation consisted of a single pulsed Continuum 1064 nm excitation wavelength laser and an Andor intensified CCD detector with an optical delivery system designed and built in our laboratory. Double pulse LIBS experiments provided improved precision and sensitivity to the target emission lines of the elements of interest and included combinations of the 1064, 532 and 266 nm wavelengths as excitation sources. The XRF instrumentation consisted of an IXRF Mo tube operated at 50KV with a 50 um beam installed in a FEI SEM microscope equipped with an EDAX Energy Dispersive Detector (EDS) detector. Elemental mapping of the matrices was possible with the SEM-EDS while elemental analysis was improved using the XRF (with an EDS detector). The element menu previously determined to provide good discrimination by LA-ICP-MS by other workers in our group was used as a starting point in the method development for this study. The elements of interest in the bone provenancing work, for example was: Ca, Al, Mg, Fe, Mn, Ba, Pb, Rb, Sr, and Y. Calibration curves were constructed for the quantitation of these metals by varying concentrations of standards in graphite pellets and spiked resins. The results obtained by LIBS and XRF were compared to the competing technique of Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS). LA-ICP-MS has already been shown to provide excellent sensitivity and accuracy, but this technique is very complex and expensive to use and may be out of range for the typical forensic laboratory. The incorporation of LIBS and/or XRF may provide a viable alternative to the more complex LA-ICP-MS technique at a fraction of the price.

LIBS and XRF methods were developed for elemental analysis of bone, nail and hair standards and these two methods were applied in the analysis of a small set of bone samples from nine different individuals to determine if the individuals could be differentiated. The XRF and LIBS results were compared to the already established LA-ICP-MS method results. The XRF and LIBS methods offer the advantages of lower cost,

ease of use, similar precision and accuracy and good sensitivity for the elements of interest for the characterization of these matrices.

LIBS, XRF, Bone

B104 The Use of Standardized Microsoft® Office Excel Templates for Forensic Casework to Reduce Human Error and Analyst Time

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After attending this presentation, attendees will understand the steps needed to create a standardized, multi-instrument and sample input / output Excel template system. The audience will be lead through an example of template use and be shown that a simple, yet effective, Excel template will help ease the processing of samples, especially in a batch process laboratory where different analysts will work on various stages of the STR analysis process.

This presentation will impact the forensic community by demonstrating how templates built using the ubiquitous Microsoft® Office spreadsheet program, Excel, can more efficiently manage sample and data organization, as well as perform repetitive calculations without error. Standardization of documentation in the forensic community is of the utmost importance. Templates allow analysts within a given lab to seamlessly integrate different instruments, record quality control data effortlessly, and reduce transcription and manual calculation errors.

Reducing human error will result in more accurate reports. As well, decreased analyst time per case will mean that a single analyst can process more cases overall. Improved accuracy and efficiency benefits the criminal justice community and the public that a laboratory serves.

Until recently, a DNA analyst or technician at the Harris County Medical Examiner's Office (HCMEO) had to manually record sample names at all steps using Microsoft Office WORD forms, input all sample names into all instruments used, calculate appropriate dilutions and normalization volumes, and calculate master mix volumes for all reactions. On all forms used, quality control (QC) information, such as kit and lot ID numbers, were manually entered. Since all documents and worklists were produced manually, there was no soft copy backup of the documents being generated for routine casework. The hard-copy forms resided solely within each case file.

Human error can be introduced at any of these steps. In order to meticulously avoid error, the DNA analyst and reviewer were required to spend considerable time checking and re-checking the forms, calculations, and data. This was especially difficult in our high-throughput, batch process laboratory. In addition, the process of completing the forms was not standardized among analysts making the review process even more difficult. With many DNA analysts working at different stages of the STR testing in our batch-process laboratory, the importance of stream-lining these tasks throughout the Quant/Amp/Run stages became apparent.

By employing Microsoft Office EXCEL, a template was prepared that allows the user to input sample names and, using a series of links, formulas, data validation lists, and macros, the template generates all required documentation, QC data, normalization calculations, master mix volumes, and import sheets for various instruments.

The user inputs sample names into a blank template initially and this sample is populated through all sheets in the template automatically. After typing in all samples into a quant grid sheet, master mix volume for the reaction is calculated automatically. An import sheet is also generated automatically through a series of links in order to import plate setup information into the ABI Prism® 7000 Sequence Detection System or the Applied Biosystems 7500 Real-Time PCR System. Following quantification on either machine the results are exported from the sequence detection software and subsequently added to the template. The next step involves the template recognizing, without analyst intervention, which samples require dilutions, due to extremely high quantitative value (>1000 ng/µL), and which samples are reagent blanks. The template then automatically performs normalization calculations for optimum amplification input DNA levels, as well as master mix volumes for both AmpFℓSTR® Profiler Plus® PCR Amplification reactions and for AmpFℓSTR® COfiler® PCR Amplification reactions. All QC data, including kit lot IDs, expiration dates, and thermocycler used, is available as a drop-down menu selection in the worksheet itself. Through a series of links, grid sheets for amplification and loading on the capillary electrophoresis (CE) instruments are produced automatically in order to show sample well position. On the CE grid sheet, once the instrument that will be used is selected (the ABI PRISM® 3100-Avant Genetic Analyzer or the Applied Biosystems 3130xl Genetic Analyzer), an import sheet is automatically generated. The import sheet adjusts columns such as Analysis Method, GeneMapper ID number, and Results Group in order to be able to import into different CE instruments. Injection times of the samples are also varied according to quantification data, with some samples that have low quantification values allowing a longer injection time, all without analyst intervention or manipulation. The import sheet allows import of plate setup information into the various CE instruments.

After substantial validation, all automatic links, formulas, calculations, and macros within the template have been verified using various sample and data possibilities. The template has been implemented at HCMEO and used in routine casework, validation, and training August of 2006.

Excel, Multi-Protocol, Standardization

B105 The Evidential Value of Forensic Glass Analysis Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS): Application to Casework

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After attending this presentation, attendees will learn about a multivariate likelihood ratio approach in forensic glass cases.

This presentation will impact the forensic community by demonstrating the application of multivariate likelihood ratios in glass cases.

For the forensic analysis of float-glass a method using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is in use at the NFI. The concentrations of ten elements in small glass fragments are measured with this method. Previously the method was validated[1, 2] and accredited by the Dutch accreditation council. An important question is how to evaluate the results as evidence that glass samples originate from the same or from different sources.

Currently the comparison of glass particles is done by using confidence intervals. Overlaps in confidence intervals for each of the ten elements are evaluated. The number of overlaps is used as a measure of similarity or difference between the samples. Based on a validation with known float-glass samples matching criteria have been defined to conclude whether glass fragments originate from the same source. However, this method has some disadvantages. First of all, the comparisons are univariate and therefore possible correlations between the concentrations of some elements are not taken into account. Secondly, small differences in the confidence intervals can result in a match or non-match, the well-known 'fall-off-the-cliff' effect. Finally, population data i.e., the relative frequency of occurrence of the glass composition could not be incorporated.

An alternative method which does not have these disadvantages is based on a Bayesian approach. In this study the use of multivariate Likelihood Ratio's (LR) as proposed by Aitken & Lucy[3] is evaluated. For the calculations a program written in R, based on Lucy's work, was applied. The underlying database consisted of 203 known float glass samples measured by LA-ICP-MS (10 elements). A multivariate kernel density estimate was used for the between-source variability and a multivariate normal distribution for the within-source variability.

In this study the results of both methods are illustrated with several glass cases. For glass fragments originating from a single source often very large likelihood ratios are calculated.

For the time being both the Bayesian approach as well as the confidence interval method will be run in parallel to gain more experience. Also the glass database will be expanded to improve the accuracy of the calculations.

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Likelihood Ratio, Glass, LA-ICP-MS

B106 Evaluation and Validation of a Forensic Chemical Coding System to Assist Law Enforcement

Steven Wise, BSc, Yisenny Delgado, BSc, Jose R. Almirall, PhD, and Tatiana Trejos, MSFS, Florida International University, 11200 South West 8th Street, CP194, Miami, FL 33199*

The goal of this presentation is to present to the forensic community results of a validation study designed to evaluate the performance of an innovative chemical tagging system.

This presentation will impact the forensic community by reporting an evaluation study conducted on the chemical coding system and adding scientific support for the future application of this fingerprint system within the U.S.

Trace evidence can be of critical use in many cases where other types of evidence such as DNA or fingerprints are not readily available. The amount of trace evidence left at the crime scene or the chemical characteristics associated with the exhibits may not be enough to associate an individual to a crime scene, an individual to a particular object or two objects to each other.

SmartWater Technology Ltd. has created innovative chemical coding systems to mark property for subsequent identification or to spray individuals involved in breaking and entering scenarios in order to assist law enforcement in the reconstruction of the crime and to link an individual to a specific event.

Two of the systems developed and evaluated in this study are the SmartWater tracer and the SmartWater index solutions. The tracer is designed for the protection of commercial and personal items, such as jewelry, computers and other types of equipment, while the index system is a spray activated when a break-in is detected, spraying the perpretrator in a controlled manner with a water-based solution. Both products are invisible to the naked eye but their traces are fluorescent under the UV light and can be visualized. The chemical composition of the products can be varied to produce unique chemical combinations for each solution. Millions of combinations are possible resulting in unique chemical taggants for each application and user.

The aim of this work was to validate the method of analysis and recovery of these products and evaluate their discrimination capabilities.

Solution ICP-MS and laser ablation ICP-MS methods were used to analyze the elemental profile of a total of 100 tracer and 50 index solutions. The analyses were performed at our facilities as a "blind test" and compared with the chemical fingerprint of the company's data base to evaluate the discrimination potential.

Tracer and Index standards and blanks were analyzed for quality control purposes. Reagent blanks, working blanks, index blanks and tracer blanks were analyzed in seven replicates in order to estimate the instrumental limits of detection (LOD) and the method limits of detection (MDL). The cut off level to establish absence/presence of the chemical markers was based on the estimation of the method limit of detection.

The combined discrimination power of the chemical components of the solutions was evaluated statistically. The index set consisted on 50 samples, which would form 1,225 possible comparison pairs, or n(n-1)/2 pairs where n is the number of samples. The tracer solution can generate a total of 4,950 possible pairs. All tracer and index samples evaluated where distinguished from each other when analyzed either by solution ICP-MS measured or LA-ICP-MS (100% discrimination).

Transfer, recovery and persistence studies were performed on a variety of matrices such as wood, metal, plastic, polymers, fabrics, and human hair. Scraping and swabbing were used as the preferred recovery method. Persistence studies were conducted over a period of a month and after washing fabrics with water and detergents.

The study demonstrated that both Smartwater tracer and index products represent an effective tagging source due to its high discrimination potential, selectivity, ease of recovery, and persistence on objects.

Chemical Tagging, Trace Evidence, Laser Ablation

B107 Cell Separation and Solid Phase Extraction on a Single Microfluidic Device: Evaluation of Alternative SPE Matrices

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The goal of this presentation is to discuss the separation of sperm cells from epithelial cells with subsequent on-chip DNA extraction from each cell fraction on a single microdevice. Several solid phase extraction matrices are evaluated.

This presentation will impact the forensic community by presenting work that represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

Microchip technology offers the potential of a rapid, cost-effective alternative to conventional DNA analysis methods. The research presented will highlight the development of an integrated microdevice that combines cell separation and solid phase extraction (SPE) of DNA from the separated cells, two of the procedures necessary for analysis of sexual assault evidence where male and female DNA must be separately identified. This presentation will demonstrate the application of microchip technology to forensic casework analysis, illustrating the significant potential impact these devices might have on the forensic community.

The proven utility of forensic DNA evidence has increased the demand for DNA analysis services. Although conventional DNA analysis techniques are effective, they are time-consuming and laborious, which has contributed to an overwhelming backlog of forensic casework samples with possible biological evidence. Research efforts have focused on the development of more rapid and efficient analytical methods to reduce the time and cost of forensic analysis, as well as the magnitude of the existing casework backlog. Techniques performed on microchips are particularly advantageous because they can be integrated with upstream or downstream analytical steps on a single microfluidic device in the form of a lab-on-a-chip. These integrated systems, which incorporate all the sample processing steps required for forensic DNA analysis, will reduce analysis times, and therefore, the forensic casework backlog.

An integrated microdevice combining sedimentation-based pressure-driven cell sorting and solid phase extraction (SPE) of DNA has previously been presented.[1] The microdevice was designed with a domain for cell sorting and two separate regions for the simultaneous purification of DNA from the separated cells. Preliminary attempts to attain an STR profile from DNA purified from the sperm cell separation product saw some success with a silica bead/sol-gel hybrid SPE matrix; however, simultaneous DNA purification from the two cell types was not possible due to variability in packing the two separate SPE beds. In addition, simultaneous DNA extraction from the separated male and female cells was possible with the use of silica beads alone, but only partial STR profiles were obtained.

Alternative SPE matrices have recently been developed and demonstrated on microchips[2, 3] which provide higher extraction efficiencies than silica-based extractions; therefore, it was of interest to evaluate different SPE matrices using the integrated microdevice. The research presented here describes the use of these matrices, as well as efforts towards optimization of extraction conditions for each matrix. Results from PCR amplification of genomic DNA isolated from cells sorted based on their physical properties are also presented. The sperm and epithelial cells were lysed on-chip in their separate areas, followed by isolation and purification of their respective DNA fractions; DNA amplification and separations were performed using conventional laboratory methods. The presented work represents a major step towards the development of a fully integrated microdevice capable of total DNA analysis for forensic casework.

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DNA, Cell Separation, Solid Phase Extraction

B108 Validation of Feline, Bovine, Equine, and Cervid Quantitative PCR Assays

Christina D. Lindquist, MS, Jeffery J. Evans, BS, and Elizabeth J. Wictum, BS, Veterinary Genetics Forensic Laboratory, University of California at Davis, One Shields Avenue, Davis, CA 95616-8744*

After attending this presentation, the attendees will understand the detailed information on the development and validation of quantitative real-time PCR (qPCR) assays targeting four species of animal. The viewer will learn about the application of qPCR to non-human samples and our methods and reasoning for modifying the validation standards presented in the *Revised Validation Guidelines - Scientific Working Group on DNA Analysis Methods (SWGDAM)* to qPCR assays. Case studies are also presented to show the applicability of these assays to casework seen in crime labs around the world.

This presentation will impact the forensic community by providing details of the assays and the validation processes. As quantitative real-time assay validation has not been specifically addressed by SWGDAM guidelines, it is important to present possible validation schemes to the community for feedback and discussion. It is also important to keep our peers informed of the advances occurring in this sub-specialty, as it is receiving increased attention from law enforcement and the forensic community.

In recent years, animal DNA analysis has been increasingly used in forensic investigations. While many of the procedures are similar to those in human casework, laboratories analyzing animal DNA face additional challenges. One of the largest is addressing the diverse species that are present in forensic casework. Although many species-specific genotyping panels have been developed, methods for quantifying the DNA of those various species have not. The advantages of quantifying target DNA for human genotyping applications have been thoroughly demonstrated in the literature. By quantifying the DNA, the amount used in subsequent analyses can be optimized to yield high-quality results while limiting the consumption of valuable samples. A real-time polymerase chain reaction (PCR) assay for the quantification of canine DNA was published previously, but the need for quantitative PCR assays for other species has not been met.

Four quantitative-PCR assays have been developed to accurately quantify feline, bovine, equine, and cervid DNA—all species of forensic interest. Each Taqman®-based assay has two targets: one set of primers targets a portion of the *Melanocortin-1 Receptor (MC1R)* gene unique to the target species and is detected with a FAM-labeled TaqMan MGB probe; a second set of primers target a piece of synthetic DNA that acts as an internal positive control (IPC) allowing determination of inhibition using a VIC-labeled TaqMan MGB probe. For each species, these two primer-probe sets are run in duplex allowing quantification and determination of inhibition in one assay. The assays were optimized to allow accurate quantification of a target species' DNA in mixed-species samples that are encountered in animal-related casework.

Developmental validation was carried out for each assay following the revised guidelines of the Scientific Working Group on DNA Analysis Methods (SWGDAM). The validation included verification of optimal primer and probe concentrations, precision, accuracy, lower detection limit determination, reproducibility, and species specificity. Studies on the effects of inhibition and DNA mixtures were completed. Upon validation, the assays were incorporated into the Standard Operating Procedures for casework. The incorporation of these assays into forensic casework analysis has both conserved laboratory resources as well as optimized genotyping of the samples being profiled. Examples in the application of these assays to animal forensic casework are also presented.

This research will impact the forensic community by providing details of the assays and the validation processes. As quantitative real-time assay validation has not been specifically addressed by SWGDAM guidelines, it is important to present possible validation schemes to the community for feedback and discussion. It is also important to keep our peers informed of the advances occurring in this sub-specialty, as it is receiving increased attention from law enforcement and the forensic community.

Quantitative Real-Time PCR, Animal DNA, Validation

B109 Hair of the Dog: DNA Analysis of Probative Canine Hairs in the Wayne Williams Investigation

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After attending this presentation, attendees will be educated in the probative value of archived crime-scene animal hair. The collection, sampling, and testing strategies used in this case are presented for implementation in other laboratories.

This presentation will impact the forensic community by addressing the needs of the forensic community by assessing the potential for DNA analysis to augment microscopic examinations of animal hairs in cold case criminal investigations. Microscopy is becoming a lost art in the field of forensic science and fewer criminalists are developing the expertise this discipline requires.

Microscopy is becoming a lost art in the field of forensic science and fewer criminalists are developing the expertise this discipline requires. This presentation will address the needs of the forensic community by assessing the potential for DNA analysis to augment microscopic examinations of animal hairs in cold case criminal investigations.

Forty percent of homes in the United States have one or more dogs and thirty-four percent have one or more cats. Therefore, animal biological material is abundant in the domestic environment and is frequently present on evidence collected during crime-scene investigations. Historically, microscopical comparisons of animal hair have been made. This can be difficult due to the amount of variation found in the color, length, and texture of animal hairs both within and between individuals and the lack of published research on the validity of animal hair comparisons. The advent of molecular diagnostic tools for the analysis of animal DNA has enhanced the utility and significance of crime-scene animal hairs.

For a two-year period from July, 1979, to May, 1981, a series of murders targeting African-American children—which became known nationwide as the Atlanta Child Murders—were perpetrated on the citizens of Atlanta, Georgia. In June, 1981, 22-year-old Wayne Williams was charged with first degree murder in the deaths of two of adult male victims: Jimmy Ray Payne and Nathaniel Cater. In addition to the two murder charges, Atlanta prosecutors included ten pattern cases to establish a connection between the Payne and Cater murders and those of area children. Microscopic comparisons of fibers and dog hair from Williams' home and vehicle were made to those collected from the victims. Twenty-four deaths were ultimately attributed to Williams by Fulton County authorities.

At the request of the Georgia Innocence Project and pursuant to a court order, the Georgia Bureau of Investigation selected dog hairs that had been determined to be microscopically similar at the time of the 1982 trial and submitted them for DNA analysis. Due to the length of time since the hairs were collected, their storage on slides, and the poor condition of some of the victims upon autopsy, a strategy was developed and agreed upon that would optimize testing and minimize sample consumption. Three hairs each from the two indicted cases and three of the pattern cases were removed from their slides and dry mounted for submission to the laboratory. It has been reported that successful amplification of human hairs for nuclear profiling is dependent upon follicular material adhering to the root. Although all tested dog hairs had visible roots, none of the submitted hairs had attached follicular material. The dog hairs collected from the two indicted cases were all shorter secondary hairs while the selected hairs from the pattern cases were all longer guard (primary) hairs. In an effort to assess the likelihood of obtaining nuclear DNA (nDNA) for individual profiling, three hairs with visible roots from one of the pattern cases were pooled in a single extraction. Since the hairs were microscopically similar, it was decided that the opportunity to obtain a nDNA profile outweighed the risk of contamination had the hairs originated from different sources. However, when the pooled hairs failed to yield quantifiable canine nDNA, the course of action was clear. Further testing targeted individual hairs and mitochondrial DNA (mtDNA) sequencing of a 402 base-pair region of the canine hypervariable region 1 (HVI). Subsequent sequencing of two individual hairs from each indicted case and one hair from each remaining pattern case all yielded the same haplotype as the pooled hairs. The shorter hairs from the indicted cases necessitated amplification of shorter HVI regions that were assembled to obtain full sequence coverage. Reference hairs collected from the Williams' family dog for microscopical comparison were then tested and yielded the same mtDNA haplotype as the probative hairs. That sequence has been observed twelve times in our database of 1,219 dogs.

There was no difference in our ability to obtain a mtDNA profile between hairs that had been Permounted and those that had been dry mounted. Hairs with brownish decomposition material on their surface still yielded good mtDNA for profiling. The biggest factor in successful mtDNA amplification was hair type, with longer, thicker guard hairs being the most successful. Even with visible roots, archived dog hairs failed to yield sufficient nDNA for genotyping, but mitochondrial sequencing was valuable in supporting the original microscopical comparisons.

Dog, Hair, Mitochondrial DNA

B110 Development of an Ion Beam Analysis Method for Forensic Analysis of Glass

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The goal of this presentation is to provide an introduction to ion beam analysis techniques for use in forensic analysis and discrimination between glass samples.

This presentation will impact the forensic community by indicating that there may be a role for ion beam analysis techniques in discriminating between glass samples. Ion beam analysis techniques are applicable to a range questions involving the forensic analysis of trace evidence.

The goal of this project was to develop a relatively rapid and non-destructive method for the comparison of glass samples for forensic study. While several other instrumental techniques exist that use variations in trace element signatures to discriminate among samples from different sources, ion beam analysis might be able to provide a cost-effective solution with higher sensitivity that X-ray fluorescence, and less sample preparation and alteration than laser-ablation mass spectrometry. Ion beam analysis encompasses a suite of experimental techniques that are available with a charged particle accelerator, which for this analysis included simultaneous measurement of Particle-Induced X-ray Emission (PIXE) and Rutherford BackScattering (RBS).

With recent advances in low-energy accelerator technology, stable relatively high-flux beams of accelerated protons and alpha particles become available for rapid ion beam analysis of samples that can withstand high vacuum. The Hope College Ion Beam Analysis Laboratory has a 1.7 MV tandem pelletron accelerator which was used to accelerate protons to energies of 3.4 MeV. This beam of accelerated protons was used to irradiate sample glass fragments mounted in a target vessel with only minor sample preparation. X-rays that result from the inner shell vacancies induced by the ion bombardment are used to identify and quantify the target atoms for all trace elements heavier than

silicon. Elastically scattered protons are also detected at back angles and can be used to identify majority constituents and to normalize the incident beam intensity from run to run.

The PIXE data are recorded for multiple runs per sample and analyzed by a commercial x-ray peak-fitting program: GUPIXWin. The results, typically recorded in part-per-million concentrations of nine elements heavier than potassium, are normalized by the RBS measurements of beam intensity and are entered into a spreadsheet for subsequent statistical analysis. A protocol was developed to compare unknown glass specimens to a reference glass specimen using a z-score analysis of absolute concentration of each element, as well as elemental ratios and normalized concentrations of each element. If any sample obtained a z-score>3 for all three comparisons it was determined to originate from a different source glass material. The second step of the analysis protocol involved further ion beam analysis on a reduced number of samples that passed the first comparison test. Replicate runs on each target of interest were then discriminated using a t-test to select samples from different sources.

This presentation will provide an introduction to the ion beam analysis techniques developed specifically to optimize this non-destructive testing of glass fragments for forensic identification and sourcing. The results of a double-blind test on 17 glass samples will be presented as well as a summary of potential applications of this technique for forensic analysis. Such examples will include the possible control of surface effects by target orientation and the sample preparation technique we have developed, which might allow this analysis to be extended to very small glass samples using our proton microprobe option for ion beam analysis.

Ion Beam Analysis, PIXE, Glass

B111 Potential Degradation Problems Associated With Analysis of Heroin With GC-MS

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After attending this presentation, attendees will have learned about the potential detection and quantitative problems associated with the degradation of heroin into 6-acetyl-morphine and morphine after being exposed to humid conditions. Such information will help drug chemists more accurately determine the age and water content of the heroin sample.

This presentation will impact the forensic community by developing a method to quantify the degradation process of heroin exposed to different amounts of water. By determining the degradation rate of heroin in water, a more accurate heroin concentration in drug samples can be calculated.

Heroin is known to degrade into 6-monoacetylmorphine (6-MAM) and morphine via first order hydrolysis. The original concentration of heroin originally in a sample can be estimated by determining the rate of degradation of heroin without the presence of water.

Heroin has been extensively explored with the intention of monitoring the change in concentration by varying conditions. Previous experiments have been performed analyzing the effects of temperature, pH, organic matrices, and containers. Development of a quantitative decay curve will prove useful for real case insights. Liquid chromatography and electrophoresis, typically used for heroin analysis, can not quantitate the amount of water present in the sample, preventing accurate degradation times. Gas chromatography (GC) with mass spectrometry (MS) provides quantitative information about the drug, its degradation products, possible adulterants present, and the amount of water present in the sample.

Weather conditions, humidity, and packaging all influence the degradation of heroin. Previous experiments have confirmed a first order degradation of heroin under these conditions. However, these studies did not analyze heroin mixed with water. For this experiment, 100 ppm heroin was mixed with 5, 10, 50, 100, 150, 200, 250, 300, 350, 400, 450, 500, 550, 600, 650, and 700 micro-liters of water. Internal standards of 20 ppm caffeine and 25 ppm deuterated heroin were used for all sample analysis. Acetonitrile was used to dilute sample to 1.0 mL final volume. Samples were kept at room temperature throughout the experiment and analyzed every 15 minutes for 3 hours.

As expected, the degradation of heroin is proportional to the amount of water added, initially. Small water amounts showed elevated degradation products. As the amount of water increased, the concentration of heroin remains relatively constant. This pattern could be the result of chromatographic conditions, water still present in the MS, column degradation, or interactions between water and heroin. While the degradation of heroin may still be first order, the direct proportionality between the amount of water and the decrease in heroin is cause to re-evaluate how heroin is quantitative for forensic purposes.

The goal of this project was to develop a method to quantify the degradation process of heroin exposed to different amounts of water. By determining the degradation rate of heroin in water, a more accurate heroin concentration in drug samples can be calculated.

Heroin, Degradation, GC-MS

B112 Variables Influencing the Ease With Which Canines Match Hand Odor Samples From Individuals

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After attending this presentation, attendees will better understand the influences of human and non-human components present in hand odor samples on alerts produced by human scent identification canines.

This presentation will impact the forensic community by providing a better understanding of factors that influence alerts produced by human scent identification canines which will aid in increased successful legal challenges for the use of human scent and biological detectors in courts of law.

The human skin which is the body's largest organ is comprised of three layers; the epidermis which is the topmost layer, the dermis which is the middle layer and the subcutaneous layer which is the innermost layer. Dead skin cells known as rafts are constantly shed from the stratum corneum of the skin's epidermis and it is believed that bacterial action on these skin rafts in combination with genetic differences, diet and glandular secretions of the skin greatly influences the odor that is produced by an individual. Upon contact with objects, individuals deposit varying amounts of skin rafts which make it possible for a scent sample to be collected. Collected human scent evidence is of importance to law enforcement as this form of trace evidence can be evaluated through the use of specially trained canines to determine an association between evidence and a suspect.

Canines possess a very sensitive olfactory system and thus are able to detect odors at low concentrations. Even though it has been shown that they have the ability to detect and discriminate persons based on their odor, the basis on which the dogs are producing an alert to human scent is not yet fully understood. Of all five senses, olfaction is the most complex molecular mechanism, as it comprises hundreds of receptor proteins enabling it to detect and discriminate thousands of odorants.

Studies have shown that a single odorant can activate multiple olfactory receptors and multiple odorants can activate a single olfactory receptor. This observation has resulted in olfaction being perceived as a combinatorial effect.

Canine field trials conducted by the Netherlands National Police have shown that specially trained human scent identification canines alert differently to persons. Based on the alerts produced by the canines, the individuals were categorized into two groups; persons easily identified by canines and persons difficult to be identified by canines. This paper will investigate the influences of skin rafts, human skin micro flora and VOCs present in hand odor samples on a canine's ability to differentiate scent samples. Analyses were conducted on hand odor samples collected on pre-cleaned cotton absorbers. The identification and quantification of the VOCs present in the headspace of the collected hand odor samples were obtained using SPME-GC/MS while real time polymerase chain reaction (PCR) was used for the quantitative and qualitative analysis of the human and non-human components of the hand odor samples.

Preliminary results showed no correlation between the amount of human DNA and non-human DNA from hand odor samples deposited on the cotton swabs and the persons who are easy and difficult for the canines to identify. Initial results also demonstrate some variability in the identity of human skin micro flora components which may contribute to the volatile organic compound (VOC) patterns observed. The ratios and combinations of VOCs in hand odor samples of individuals were sufficiently different to enable discrimination of persons statistically using Spearman's Rank Correlation Coefficient and 3-Dimensional Covariance Mapping. It was also determined that recurring VOCs were similar within the easy and the difficult group but different between these groups. Additional analyses are being conducted to better understand the influences of the various parameters being studied on ease of canine alerts.

Human Scent, Volatile Organic Compounds (VOCs), Skin Rafts

B113 Solid Phase Extraction of DNA in a Plastic Microfluidic Device

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After attending this presentation, attendees will learn the advantages of utilizing a plastic disposable microfluidic device for extraction of DNA from various biological samples.

This presentation will impact the forensic community by demonstrating the use of plastic microfluidic devices for DNA extraction. The low cost associated with these devices provides disposability, a major requirement for forensic analysis.

This research project exhibits the use of low cost plastic microdevices for the extraction of nucleic acids from various biological samples.

Purification of DNA from biological samples for forensic analysis is primarily performed using solid phase extraction (SPE), most often on a silica substrate to which DNA will bind in the presence of a chaotropic salt. Current methods are labor intensive and often require large sample volumes that are not always available in forensic casework. An effective alternative is microchip based SPE, which allows for smaller sample and reagent volumes, thereby decreasing the cost and time of analysis. Microchips provide the advantages of a closed system, reduced sample handling, and the possibility to integrate multiple methods in a single device.[1] Microchip DNA extraction is most often performed on glass microchips, but the substrate and fabrication costs make these devices too expensive to be disposable after each use. This prevents their implementation into forensic science laboratories, where carry-over contamination would be a significant concern.

Plastic microdevices provide a possible substitute to the current glass substrate, allowing for low cost fabrication, on the order of pennies per device once the devices are mass-produced. This permits disposal of the device after a single extraction, eliminating contamination and carry-over from previously-analyzed samples. Plastic SPE microdevices have previously been prepared from several polymers, including polyolefin[2] and poly (methyl methacrylate) (PMMA).[3] However, these devices utilize solid phases that are often difficult to generate and not reproducible, thereby affecting the extraction efficiency. Presented here, is an easily fabricated, plastic, disposable microfluidic device with a highly reproducible extraction matrix capable of solid phase purification of DNA.

The devices developed for this work were fabricated using the LIGA process that exploits X-ray lithography to construct complex 3-D structures. The channel structures investigated consist of various designs for PMMA posts with and without silica coatings, which provide a high surface area for binding of DNA in the presence of a chaotropic salt. The optimal PMMA post layout and coating will be presented along with preliminary capacity studies and extraction profiles. Results from purification of DNA from various biological samples performed on the device will be presented to demonstrate the reproducibility and efficiency of the extractions. This research lends itself to the forward movement of implementing a cost-effective, disposable device for use by the forensic community for DNA extraction.

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Solid Phase Extraction, Microdevice, DNA

B114 Dyed Denim and DNA Extraction: A Comparative Study of Extraction Methods and Their Ability to Yield Inhibitor Free DNA Samples From Dyed Substrates

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The goal of this presentation is to identify specific dye formulations that lead to inhibition of downstream DNA analysis steps when working with commonly used DNA extraction methods. In addition, alternative approaches are presented which can reverse and prevent observed inhibition.

This presentation will impact the forensic community by providing insight into the well established challenges of dealing with denim substrates as forensic evidence.

Denim is frequently encountered as evidence in the forensic community. The dyes present in denim substrates often present

challenges as some will co-extract with DNA and interfere with subsequent analysis steps by inhibiting DNA amplification. This research evaluates three extraction methods on ten denim dye formulations. Phenol chloroform organic, Chelex-100 and Promega DNA IQ, were evaluated for their ability to minimize downstream inhibition. Two organically extracted dye formulations inhibited the polymerase chain reaction (PCR), while, Promega DNA IQ and Chelex-100 were most successful at isolating DNA free of inhibitors. Having identified inhibiting dyes, various approaches to treating the observed inhibition were employed: dilution of extract, addition of bovine serum albumin, addition of AmpliTaq Gold, post extract purification using Promega DNA IQ, and NaOH clean up method. All of the above approaches except the NaOH treatment were able to reverse the inhibition. Finally, preparations of inhibiting dye concentrate were made and added directly to amplification reactions in varying amounts to demonstrate a range of inhibition. Bovine serum albumin, AmpliTaq Gold and the two in combination were then added in varying amounts to evaluate their efficacy in reversing inhibition.

As a DNA analyst, there are many options available for isolating DNA from a variety of substrates. Based on the results observed here, the phenol-chloroform organic method is least successful with denim samples while the DNA IQ method is the optimal approach of the three examined here. Furthermore, when inhibition due to denim dyes is observed, the analyst has several approaches available: dilution of the extract, a clean up step using the DNA IQ kit, or the addition of more Taq Polymerase to the amplification reaction. All of these methods have been shown to reverse inhibition due to the dyes in the denim substrates.

DNA, Dyed Denim, PCR Inhibition

B115 Chemical Characterization of the Blue Lubricant Coating on Barns XLC Coated X-Bullets

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After attending this presentation attendees will be able to analyze GSR to determine the presence of X-Bullet residue. Barns Bullets is a small manufacturer of specialty bullets for the bullet reloading enthusiast. The Barns XLC Coated X-Bullet has a unique surface coating that reduces friction for better ballistic performance. This presentation describes the analytical methodology and chemical characterization of the X-Bullet coating. Because the use of the X-Bullet is a small percentage of all bullets, identifying the X-Bullet coating in GSR substantially narrows the investigation and strongly supports identifying the weapon used in the crime.

This presentation will impact the forensic community by describing the study of a unique projectile coating. The chemical characterization of the X-Bullet coating will provide the forensic chemist with analytical methodology and a known comparison reference that will help the firearms examiner to identify the suspect weapon and reconstruct the crime scene.

Barns Bullets is a small manufacturer of specialty bullets for the bullet reloading enthusiast. The Barns XLC Coated X-Bullet has a unique surface coating that reduces friction for better ballistic performance. This presentation describes the analytical methodology and chemical characterization of the X-Bullet coating. After attending this presentation attendees will be able to analyze GSR to determine the presence of X-Bullet residue. Because the use of the X-Bullet is a small percentage of all bullets, identifying the X-Bullet coating in GSR substantially narrows the investigation and strongly supports identifying the weapon used in the crime.

This presentation primarily impacts the forensic chemist, trace evidence and firearms examiner. The chemical characterization of the X-Bullet coating will provide the forensic chemist with analytical methodology and a known comparison reference that will help the firearms examiner to identify the suspect weapon and reconstruct the crime scene.

The blue colored XLC coating appears to be a “paint-like” polymer binder with a suspected polytetrafluoroethylene (PTFE or Teflon) additive that acts as a lubricant in this application. Organic dyes and/or inorganic pigments and fillers may also be present.

Microscope Examination: A microscopic examination of the coated bullet surface will be performed at low magnification to determine the consistency of application, layer structure and characteristic patterns that result from the application process. Layer structure will be observed at high magnification with a scanning electron microscope to describe the distribution of non-dissolved components. The coating is expected to contain a PTFE component in the form of non-dissolved flakes. The size and percent composition of the PTFE flakes will be determined.

Chemical Composition: The binder that holds the coating together and adheres to the bullet’s surface is expected to be a fast drying vinyl or enamel polymer similar to automotive finishes. The polymer will be identified from the surface of the bullet using FTIR in reflectance mode and in transmittance mode with a FTIR microscope. Organic coloring agents will be identified using FTIR or gas chromatography mass spectrometry (GCMS) as appropriate. Elemental composition will be determined with a scanning electron microscope quipped with and EDAX detector.

Gun Shot Residue (GSR): Gun shot residue will be collected at the muzzle and at distances of 6in. 12in. and 18in. from the end of the barrel. The size of the circular GSR pattern will be measured and microscopically examined to describe the burn pattern and the distribution of Teflon flakes. Chemical changes resulting from the heat and pressure of firing will be determined by GCMS.

Barrel Residue: To link recovered bullets and GSR found at the crime scene to the suspected weapon, the barrel residue will be characterized using the tests described above.

Barns XLC X-Bullets, Polytetrafluoroethylene, Blue Lubricant

B116 Revisiting 9/11: Success Rate of Reference Samples for Mass Fatality Identification

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The goal of this presentation is to focus on the ability to generate usable DNA profiles from various types of reference samples that were collected during the World Trade Center disaster. The attendee will learn about the reference samples that may be collected during a mass fatality event, and specifically, which types of samples more frequently led to the identification of a World Trade Center victim.

This presentation will impact the forensic community by serving as a guide for the collection and testing prioritization of reference samples in the event of a future mass fatality event.

When DNA testing is necessary to identify the victims of a mass fatality event, reference samples for each victim must be collected. A victim can be identified with a direct match to a personal effect or through kinship analysis. Personal effects include items or samples that can be attributed to the victim, including, but not limited to, a toothbrush, hairbrush, razor or medical specimen. Kinship analysis

requires samples from the victim's biological relatives including, but not limited to, the mother, father, siblings, and children. Over 10,000 reference samples were collected following the World Trade Center disaster. DNA testing was performed for both mitochondrial DNA and nuclear DNA, in the form of short tandem repeats (STRs) and single nucleotide polymorphisms (SNPs). In order to verify the profile generated from a personal effect truly represented the victim's profile, each personal effect was confirmed using duplicate testing, a second personal effect, or kinship verification. The results of these tests were compiled for the different types of reference samples and the different testing systems. The success rates for the different types of reference samples were based on whether or not a usable DNA profile was generated, and whether or not sufficient DNA information was available to identify the victim. The personal effects which yielded the best results were known blood samples, toothbrushes, and razors. Hairbrushes gave less reliable results, often mixtures or partial profiles, and therefore, were not used as often to make an identification. For identifications made by kinship analysis, the traditional trio of mother-father-victim was often not available, necessitating the use of non-trio pedigrees for analysis. In these cases, the relatedness and number of donors influenced the identification success of kinship analysis.

It is important to establish which sample types give the best results in order for agencies involved in future mass fatality events to assist families in donation of reference samples and better prioritize the testing of personal effects and kinship samples to maximize the efficiency of identifications.

World Trade Center, Mass Fatality, Victim Identification

B117 Analysis of Triacetone Triperoxide (TATP) for Information on the Synthetic Route and Precursor Identity

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After attending this presentation, attendees will gain a better understanding of the various methods available for the forensic analysis and the identification of the organic peroxide explosive triacetone triperoxide.

This presentation will impact the forensic community by giving them enhanced methods for the detection of the "home-made" explosive TATP, as well as demonstrating the capability in certain cases to determine the particular synthetic route and precursor materials used by terrorist in preparation of the explosive.

Triacetone triperoxide (TATP) has found use in recent terrorist acts in Europe and is a potential risk to U.S. institutions. This research is focused on the analysis of initiated and uninitiated TATP for the purpose of identifying the precursors and synthetic route. GC-MS, ESI-MS and IMS analytical methodologies developed and optimized for this research will be discussed and results will be presented to demonstrate some success in meeting the stated objectives.

GC-MS with ammonia CI provides an analytical method for the determination of TATP with low picogram detection levels and the formation of an ammonium adduct ion. ESI-MS, which has not previously been considered to be an optimal method of TATP analysis, is shown to provide information on synthetic intermediates remaining in the reaction mixture at the time the synthetic reaction is quenched. IMS is also shown to be a valuable method for the detection of TATP. Results from isotopic labeling studies will be presented in support of the structural and fragmentation mechanisms observed by ESI-MS. Optical microscopic methods for the analysis of TATP will also be presented along with sample preparation methodologies.

The internet provides a wealth of information concerning recipes for TATP and the sources of precursors. The precursors used in unauthorized TATP synthesis are generally commercial products and often include additives which can carry through the TATP synthesis and may be determined in both initiated and uninitiated samples. Results will be presented to demonstrate successes and limitations of this approach, and the potential forensic value of the analyses will be discussed.

This research was supported by the National Institute of Justice, Office of Justice Programs under award 2006-DN-BX-K009. The research was conducted at the National Center for Forensic Science, a member of the Forensic Resource Network. Views presented do not reflect the position of the government or infer endorsement.

Triacetone Triperoxide, Mass Spectrometry, Explosives

B118 Evaluation of Laser-Induced Breakdown Spectroscopy as a Contributing Technique in the Analysis of Automobile Paint Samples

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The goal of this presentation is to familiarize the audience with new technologies potentially useful in the analysis of paint.

This presentation will impact the forensic community by demonstrating how LIBS is a high information content and inexpensive technology the may assist in many areas of forensic analysis.

Laser-induced breakdown spectroscopy (LIBS) provides an inexpensive and efficient method for obtaining information on the elemental composition of a sample. The method holds potential as an analytical tool to aid in the analysis of paint samples. This presentation reports on the use of LIBS in combination with other analytical techniques, FTIR(ATR) and SEM/EDS for the analysis of automobile paints. The report focuses on the development of sampling and data comparison methodologies.

The analytical methodology was developed and tested on a set of 51 automobile paint samples. The sample set was taken from range of automobile makes and models ranging in manufacture year from 1987 – 2006 and is comprised of a range of colors and modifiers supported on metal and plastic substrates. LIBS analytical methods involved a drilldown approach in which a series of successive spectra were collected from subsequent laser ablation events, and an approach wherein a paint chip was interrogated from the edge so that all paint layers were sampled in a single laser ablation event. FTIR spectra were collected for the exterior paint layer only using an FTIR-microscope with an attenuated total reflectance (ATR) attachment. Quantitative analysis was performed on samples using SEM-EDS. Samples were carbon coated for analysis and carbon and oxygen were excluded from quantitative analysis based on copper and/or cobalt standards.

LIBS spectra for the different paint samples were compared by calculation of a Euclidean distance and a Sorenson index to determine similarity. The Euclidean distance method was used to compare the FTIR spectra for each sample. Relative integrated elemental

concentrations from EDS were compared between samples. The utility of FTIR and LIBS spectra for the identification of paint samples in a library/database search was evaluated through receiver operator characteristic (ROC) analysis. Results from the comparisons will be discussed and the potential development of a multi-instrument database for automobile paint identification will be presented.

This research was supported by the National Institute of Justice, Office of Justice Programs under award 2006-DN-BX-K251. The research was undertaken in collaboration with the South Carolina Law Enforcement Department and conducted at the National Center for Forensic Science, a member of the Forensic Resource Network. Views presented do not reflect the position of the government or infer endorsement.

Laser-Induced Breakdown Spectroscopy, Paint Analysis, Database

B119 Identification of Ignitable Liquids in the Presence of Interfering Products in Fire Debris Analysis

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After attending this presentation, participants will understand the challenges of identifying ignitable liquids from interfering products found in fire debris. A methodology for producing interfering products from pyrolysis and combustion of common building and furnishing materials has been established. The covariance mapping method developed determines the contribution of interfering products and ignitable liquids in the fire debris.

The presentation will impact the forensic community by presenting methodologies to aid fire debris analysts in the identification of ignitable liquids in the presence of interfering products in fire debris. The development of an internet accessible GC-MS database will provide fire debris analysts a tool in evaluating fire debris in their casework.

The fire debris analyst is often faced with the complex problem of identifying ignitable liquid residues in the presence of interfering products from pyrolysis and incomplete combustion of common building and furnishing materials.[1] The purpose of this research was to develop a modified destructive distillation methodology to produce interfering product chromatographic patterns similar to those observed in fire debris case work and to establish an internet accessible GC-MS database tool for fire debris analysts to use in the evaluation of casework data.

The method developed under this research for producing interfering products involved placing a known mass of material in a one-quart paint can (unlined), placing a lid containing a small number of 1 mm diameter holes loosely on top of the can, and applying heat to the bottom of the can with a propane torch. Temperatures at the bottom of the can and in the headspace were monitored and recorded during the burn. Parameters that were varied for method optimization included the size and mass of the substrate, the burn time, and the distance from the flame to the bottom of the can. The volatile products generated during the heating period were evaluated by passive headspace analysis and the effect of the variable parameters on the product profile was determined. A set of parameters were identified to optimize the pyrolysis-like interfering products obtained from the substrate and minimize the combustion-like products.

The substrates examined in this research included carpets made of nylon, polyester, P.E.T. polyester, olefin, UV olefin, olefin/nylon blend, and a polyester nylon blend, and one carpet padding. Additional substrates included various woods including maple, oak, poplar, white and yellow pine, aspen, alder, hickory, cedar, cherry, and Douglas fir. Along with the previously mentioned carpets and woods, low density polyethylene (LDPE), industrial vinyl, vinyl/linoleum, laminate hardwoods, and bamboo hardwoods were burned.

Substrates were also burned in the presence of ignitable liquids and the resulting sample analyzed by passive headspace analysis. The covariance mapping method developed at NCFS was used to model data sets as a combination of substrate-generated interfering products and ignitable liquids.[2,3] The covariance method was able to determine the contribution of the substrate and ignitable liquid.

This research was supported by the National Institute of Justice, Office of Justice Programs under award 2005-MU-MU-K044. The research was undertaken in collaboration with the Bureau of Forensic Fire and Explosive Analysis and conducted at the National Center for Forensic Science, a member of the Forensic Resource Network. Views presented do not reflect the position of the government or infer endorsement.

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Fire Debris, Interfering Products, Ignitable Liquids

B120 Studies on Methamphetamine Detection With Drugwipe® Analytical Device, Part 2

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After attending this presentation, attendees will understand the use of Drugwipe® to detect methamphetamine on the surface and confirm its identification using GC/MS analysis.

This presentation will impact the forensic community by demonstrating how Drugwipe® is a simple, non-expensive drug test.

Since the 1990s, methamphetamine has been considered the primary drug threat in Wyoming and has been a priority for state and local law enforcement agencies. Methamphetamine is a powerful stimulant which affects the central nervous system and causes behaviors such as anxiety, insomnia, paranoia, hallucinations, mood swings, and delusions. Both meth producers and abusers have been involved in violent crimes in Wyoming to obtain money to support their meth habits. A startling number of these crimes include domestic violence ranging from child neglect to homicide. Of the six neglect and abuse related deaths of children investigated by the Wyoming Child Fatality Review Board in 2003, five were associated with meth use by parents or caregivers.

This statistics alone indicates the need for a device for speedy on-site detection and identification of the presence of Methamphetamine.

Drugwipe® from Securetec meets these requirements. The main advantages of Drugwipe® are its small size, fast response time and low rate of false positives.

During the AAFS Annual Meeting in San Antonio in 2007 the preliminary studies on Methamphetamine detection using this device were presented, and discussions on sensitivity, selectivity and surface factor led to encouraging conclusions. More important, for court purposes, there is a possibility to extract the presumptively detected drug and confirm identification using GC/MS analysis.

The presentation will focus on the detection of traces of the drug on surfaces and the follow up quantitative analysis of methamphetamine extracted from Drugwipe®.

Drug loss during collection and storage of samples, as well as analysis of the samples collected in a field environment rather than laboratory will be addressed.

Drugwipe, Methamphetamine, GC/MS

B121 GendSite™ Integrated System for Automated STR Analysis

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The goal of this presentation is to describe the features of a fully integrated plastic STR DNA profiling prototype device designed to perform automated DNA extraction, DNA quantification, PCR amplification, capillary electrophoresis, and "expert system" data analysis.

This presentation will impact the forensic community by describing a device that eliminates manual handling of samples for DNA STR analysis. Additional advantages of the GendSite™ system include reduced chance of contamination, low reagent consumption, accelerated DNA extraction and PCR reaction times, excellent detection sensitivity and high-resolution separation.

In 2003, the FBI advertised through a Broad Agency Announcement the requirement for a disposable, single-use device that would be able to perform the complete STR analysis of human DNA following procedures similar to those used in the FBI Laboratory. The DNA had to be obtained from both sperm and epithelial cells (i.e., by differential extraction from mixtures) and the extract needed to be quantified, so the amount of DNA used for the STR analysis would be known. The device had to be capable of using the commercial STR kits with five-color detection. The separation of the PCR products had to be by the capillary electrophoresis method and the raw data had to be converted into alleles of the various STR loci. An expert system was required to make the analysis completely automatic and results had to be in a format compatible with the CODIS-interface. The contract was awarded to the Center for Applied NanoBioscience at Arizona State University (ASU).

The ASU team has developed the GendSite™ system that comprises a fully automated microfluidic system for rapid sample preparation and STR typing of sexual assault samples. This system has been fully developed, prototyped and tested in-house, generating data from mixtures of different ratios of sperm and epithelial cells. The system uses commercially available reagent kits for magnetic bead DNA capture, DNA quantification, and STR-typing. A key feature of the instrument platform is the use of disposable plastic cartridges that can perform the entire work-flow starting with the differential extraction of DNA from sperm and epithelial cells to the transfer to a chip-based 5-color CE-detection. The entire process from sample elution to obtaining the STR-profile takes approximately four hours.

To allow large volume and cost effective fabrication of the disposable STR-typing plastic cartridges, scalable manufacturing processing using injection molding and cold bonding were developed for the full assembly of the microfluidic devices. The feasibility of performing an automated STR-typing process on such integrated all-polymer microfluidic system was demonstrated, establishing the possibility of building a reliable low to medium throughput, sample-to-profile system.

Other instrumental features of the GendSite™ system include the following: (i) differential cell extraction module, (ii) chip-based capillary electrophoresis detection for high resolution separation, (iii) PCR thermal cycler using plastic chips compatible for RT-PCR interface, (iv) computer-controlled power supplies, (v) microfluidic device for sample preparation using microbeads assays, and (vi) STR typing software that includes data acquisition, sizing of alleles for the 13 CODIS-STR loci relative to an internal size standard, quality scoring with identification of problematic data, and compliant interface with CODIS compatible data format and CODIS-interface for upload to the National DNA Index System. The GendSite™ software platform comprise a LabView based customized user-interface, a data analysis module that can interface with most commercially available expert systems, in particular the FSS-i^3. This configuration will allow data conversion into the CODIS software to create a Local DNA Index System (LDIS).

The prototype has been tested with model systems and proof-of-concept has been demonstrated. The technology is ready to be transferred for evaluation by forensic laboratories. However, the system has not been tested with casework samples containing typical forensic background materials. A systematic validation study is the next step before the system can be deployed by the forensic community.

STR, Microfluidics, Automation

B122 DNA Analysis of Pitbull Stomach Contents Following Infant Maiming

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After attending this presentation, attendees will learn that DNA analysis can be applied to child endangerment investigations involving domesticated animals. The case study involves the examination of stomach contents of a pit-bull following the maiming of an infant child.

This presentation will impact the forensic community by providing a heightened awareness of the uses of forensic analysis in child endangerment cases. This investigation also served to heighten awareness in the community of the potential dangers of domestic canines and further work in this area serves to aid the public and legislators in making informed decisions.

According to reports published in 2001, over 300,000 dog-bites occur yearly that require medical attention (Gilchrist et al). Children are 3.2 times more likely to be the victim of a serious dog-bite than adults and breed specific studies indicate that approximately one third of fatal human attacks reported from 1981 through 1992 involved pit bull-type dogs (Sacks et al). With growing regulation concerns regarding breeds that are known for aggression, the forensic laboratory is expected to aid in the analysis of physical evidence in a growing number of cases. This presentation will demonstrate the approach taken in one such case.

A two-month-old female was presented with extensive soft-tissue damage to the left heel after being left unattended for approximately 20 minutes on the living room couch in the company of an immature pit-bull. The result of the attack was an irreversible maiming, and the heel of the child was chewed completely off. The child also sustained numerous scratches and marks to the body and was discovered with injuries on the living room floor.

The canine was euthanized post-assault and stomach contents were collected during dissection. Additionally, samples taken from the snout and muzzle of the dog were collected which were later identified as being consistent with blood using leucomalachite green. Liquid components of the stomach contents were not presumptively positive for blood. Following separation and water washing of stomach content solids, material grossly classified as soft tissue, connective tissue, and/or fatty tissue was recovered from the stomach contents. Water washes were reserved and hair/trace particulates suspended in the wash water were captured onto Whatman#2 qualitative filter paper by microfiltration; the filtered wash water was packaged for storage as were the dried filter papers and particulates. Five tissue samples and material

collected from the snout and muzzle underwent DNA extraction and recovered products were quantified using Quantifiler® Human DNA Quantification Kit. Extracts were then subjected to polymerase chain reaction (PCR) analysis and fluorescent detection using the PowerPlex ®16 STR system (D3S1358, TH01, D21S11, D18S51, Penta E, D5S818, D13S317, D7S820, D16S539, CSF1PO, Penta D, Amelogenin, vWA, D8S1179, TPOX, and FGA).

A human female DNA profile was obtained from all samples isolated from the stomach contents, two of which were complete 16-locus profiles. The material collected from the snout and muzzle also produced a complete profile, and all data indicates the source of these samples originated from a common female individual. All profiles obtained were suitable for comparison to the victim in this case.

The application of forensic DNA analysis was used to establish the criminal charge of child endangerment. The charge is additionally supported by the presence of what appeared to be marijuana and drug paraphernalia in the home, along with reports that the maternal grandmother left in charge of the child appeared to be under the influence of an intoxicating agent. In addition to supporting criminal charges, investigation of this case has also served to heighten awareness in the community of the potential dangers of domestic canines.

Pitbull Maiming, DNA Analysis, Stomach Contents

B123 Validation of PCR Reaction Setup Protocols for the Quantifiler Human DNA Quantification and AmpF*l*STR® Identifiler® PCR Amplification Kits on the BioRobot Universal System

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The goal of this presentation is to share validation and customer evaluation data for the downstream PCR reaction setup of Quantifiler™ and Identifiler® PCR assays on the BioRobot Universal System, a new platform for automated medium- to high-throughput extraction of forensic DNA evidence.

This presentation will impact the forensic community by enabling forensic investigators to combine casework or reference nucleic acid extraction in an automated workflow with downstream quantification and STR profiling reaction setup. The resulting integrated workflow minimizes hands-on times and enhances accuracy, consistency and reproducibility.

Forensic DNA laboratories continue to experience increasing submission of samples. Main drivers are legislative changes regarding the acquisition of reference or database samples, and increased utilization of molecular evidence in crime scene investigational work. A logical response to throughput increase is process automation and integration. Robotic equipment allows not only to cope with mounting sample volumes but also to improve process quality of in terms of variability and consistency of results. Additionally, valuable human resources are set free from stereotypic manual procedures and can focus on where they are needed most, such as advanced forensic techniques, result interpretation, and expert opinion.

Based on 96-well format silica membrane technology, a fully automated system was developed for the medium- to high throughput extraction of genomic DNA from both, reference database and demanding case work samples. To integrate the workflow further, reaction setup protocols have been developed for the platform to feed into downstream DNA quantification and STR profiling assays.

This presentation summarizes validation studies of PCR reaction setup protocols utilizing Quantifiler™ Human DNA Quantification and AmpFLSTR® Identifiler® PCR Amplification Kits on the BioRobot Universal System, newly released by QIAGEN.

Validation of the automated platform included processing mock forensic samples through DNA extraction and the different reaction setup protocols. Additionally, spiked swabs alternating with water blanks run in checker board patterns provided data for cross-contamination studies.

The platform reliably generated DNA extracts from the validation cohorts. The BioRobot Universal System's ability to run through extraction and PCR setup without contamination was demonstrated.

Automation, PCR Reaction Setup, Nucleic Acid Extraction

B124 Examining the Effects of Mishandling of Gun Shot Residue Evidence

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The goal of this presentation is to highlight the possibility of misinterpreting gun shot residue evidence if the material is collected or transported improperly.

The presentation will impact the forensic community by elucidating the difference between several packaging methods for gun shot residue evidence, indicating which methods yield more accurate results.

Gun shot residue (GSR) evidence is often submitted to the laboratory for interpretation. Typically the distance from the muzzle of the firearm to the garment is in question. The traditional method of analysis is to visually examine the garment and assess the overall pattern density of the particulates present. Because GSR is composed primarily of small particles of unburned and partially burned propellant, the ability of the particles to be retained by the garment will affect the pattern density at the time of examination.

There are several methods of collection, storage and transportation that can be used for GSR evidence. The method chosen, however, may have a profound effect on the interpretation of the pattern if the particles become dislodged during this process. Typically, if a considerable number of the particles become dislodged prior to the evaluation of the sample, the interpretation would suggest that the muzzle was further away from the target than it actually was. This could be a critical piece of information in a case where self-defense is claimed.

This research considers several different packaging/transportation methods to determine which might lead to inaccurate conclusions.

Several identical substrate T-shirts have been shot at known distances, resulting in GSR patterns. These have been scanned into a computer for objective pattern density analysis using digital imaging software. The digital method of analysis can allow for a more objective and quantifiable means of comparison between exemplars and questioned garments. It can also clarify how the method of packaging affects the results of distance determinations. This resultant data has been stored for later evaluation. After scanning, some of the samples were "properly" handled and some were "improperly" handled. The scanning results were compared and evaluations of the various methods were made, identifying the best and worst methods tested.

Gun Shot Residue, Mishandling, Evidence

B125 The Virginia Arrestee Databank - Observations After 5 Years of Operation

George C. Li, MS, and Jennifer C. Grubb, BA, Virginia Department of Forensic Science, 700 North 5th Street, Richmond, VA 23219*

The goal of this presentation is to present five years of experience working with arrestee alongside convicted offender databank samples, insight and observations were made about differences between handling/managing of arrestee samples vs. convicted offender samples.

This presentation will impact the forensic science community by presenting observations gained from the five years of operation of the Virginia Arrestee Databank. This information could be helpful to states in the early stages of arrestee databank operation or states contemplating an arrestee databank.

As a result of state legislation, an arrestee DNA databank was implemented in Virginia in January 2003. This additional class of databank samples was intended to complement the existing DNA databank, which has been in operation in Virginia since 1990. Until 2003, the Virginia DNA legislation covered only convicted felons, including juveniles over the age of 14 at the time of the offense "convicted of a felony or adjudicated delinquent on the basis of an act which would be a felony if committed by an adult."

The management of arrestee samples and profiles presented a set of issues that is significantly different from the management of felon samples. At the time that the arrestee databank was instituted in Virginia, there were no similar arrestee databanks in operation around the country from which to draw experience and advice. Therefore, policies and procedures specific to the collection, analysis and management of arrestee samples were created by the Department to the best of its knowledge and experience at the time, with the full knowledge that adjustments would probably be made as experience was gained in the operation of an arrestee databank.

An example of one of the changes in the Virginia databank operation due to the arrestee legislation was the transition from blood sample collection to buccal sample collection. In accordance with the Virginia arrestee legislation, an arrestee sample must be "taken prior to the person's release from custody". The drawing of a liquid blood sample would have necessitated the involvement of a nurse or health professional at the time of booking, with associated biohazard protective procedures. Such an arrangement was impractical for many reasons, one of which was the lack of such blood collection capability in many of the law-enforcement locations where an arrested individual would normally be processed. Therefore, a decision was made to change the collection of databank samples to a simple buccal collection kit which would not require the involvement of a health professional.

January 2008 will represent five years since the implementation of the arrestee databank in Virginia. Looking back, some observations have been made regarding the arrestee databank in areas such as DNA legislation, sample management, CODIS operation, and hit counting and reporting. For example, in accordance with the Virginia arrestee legislation, arrestee charges that require the collection of a DNA sample must be tracked until a final disposition of the charge is received. This clause in the legislation produced some logistical hurdles that the laboratory has had to overcome. As a result, the databank established procedures in coordination with the Department of State Police to obtain the updated charge disposition information on a weekly basis. Additionally, internal procedures were developed to coordinate the removal of the non-qualifying arrestee sample and databank record, as well as the DNA profile from CODIS.

The authors will present observations gained from the five years of operation of the arrestee databank. This information could be helpful to state laboratories in the early stages of arrestee databank operation or states contemplating the implementation of an arrestee databank.

Arrestee, Databank, Legislation

B126 How the Interpretation of Blood Spatter Evidence Can Be Affected by Varying Methods of Measuring Singular Blood Drop Stains

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The educational objective of this study is to learn how angle of impact measurements of blood drops can vary depending on the techniques used and the minute differences in measurements that may be obtained by other investigators or examiners.

This study will impact the forensic science community by helping to keep blood spatter examiners aware that the method of measuring blood drops and the person performing the measurements can have an effect on the final calculation of the angle of impact.

The purpose of this study will be to further understand how the accuracy of measuring a blood drop stain can affect the way it is interpreted by the investigator or examiner. Certain techniques normally used for measuring and interpreting blood drop stains will be tested in order to determine how the results may vary from depending on how the measurements are acquired.

When trying to determine the angle of impact of a blood drop onto a surface, the inverse sine of the length to width ratio of the blood drop is used. When measuring these blood drop stains, examiners may use a variety of tools, including a ruler, caliper, or micrometer. However, the measurements acquired of a single drop of blood may differ among the examiners and which tool or method that he or she uses. These differences can range in tenths, hundredths, or thousandths or a millimeter. This study will show how much the angle of impact can change with minute variations in length and width measurements.

In relation, making photocopies of blood drop stain photographs is a method used to enlarge the stains so that a more accurate measurement can be made on a larger scale. This study will discuss how the angle of impact measurement can differ with the photocopying method in comparison to measuring the original photograph. Observations will be made to see if any distortion of the original image is experienced during this process and if these distortions have any effect on the angle of impact determination.

Regarding the angle of impact, it is assumed that blood drops have a linear trajectory path for short distances, much like a projectile from a firearm. Part of this study will concentrate on the volume, size, and initial velocities of various blood drops to see if a non-linear trajectory path can have an effect on the interpretation of blood stain measurements.

Blood, Spatter, Trajectory

B127 Infrared Spectroscopy for Characterization of Bloodstain Age Using the Amide Spectral Regions From Blood Proteins

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After attending this presentation, attendees will better understand methods for the characterization of age of blood stains using attenuated total reflectance infrared spectroscopy (ATR/FTIR) will be discussed. In particular, the value of monitoring of the changes in the Amide III region spectra of blood for determining the age of a bloodstain will be demonstrated. Attendees will also learn how multivariate calibration

methods can be used to model variations in spectral intensity as a function of aging.

The research described in this presentation will impact the forensic science community by establishing the scientific basis for a direct spectroscopic method of dating bloodstains discovered at crime scenes.

The research described in this presentation was designed to establish the scientific basis for a direct spectroscopic method of dating bloodstains discovered at crime scenes. The estimation of age of blood stains may provide leads for the future direction of forensic investigations. Rapid tools for estimation of blood stain age might also provide investigators the ability to determine the relevance of an item of trace evidence involving blood.

Methods to replace the currently used enhancement reagents and presumptive tests for blood (such as the use of luminol, phenolphthalein, and leucomalachite green) have been sought continuously. Likewise, methods for dating blood stains have been widely proposed as well. Visible light techniques for aging of blood stains by ratioing intensities from different spectral regions (Kind et al. 1972) laid the groundwork for future spectroscopic studies. Other methods such as immunoelectrophoresis (Rajamannar, 1977) and high performance liquid chromatography (Andrasko, 1997) have also been applied to the problem of dating blood stains. Most recently, electron spin resonance spectroscopy (Fujita, et al. 2005) and DNA analysis (Anderson, et al. 2005) have also been used to assign a date to a bloodstain.

The research concerns the use of bands in the IR region from around 1650 cm^{-1} to 1200 cm^{-1} that are relevant to the secondary structure of blood proteins. IR spectroscopy is fast, reliable and ATR sampling does not require extensive sample preparation. Varying concentrations of blood were subjected to ultraviolet and visible light for controlled time intervals in an artificial light box. FTIR absorbance spectra (128 scans, 4000 to 800 cm^{-1} spectral range, 4 cm^{-1} resolution) using the ATR diamond crystal in ambient atmosphere as a background. IR spectral data sets, including replicate spectra, were modeled for a training set of data as a function of the various aging intervals using multivariate calibration techniques (partial least squares). Finally, the spectral regions most relevant to the systematic changes occurring during the aging of blood stains were identified. The predictive accuracy of the calibration was evaluated by predicted the aging intervals for a separate test set of data of equal size to the training set.

Bloodstain Aging, FT-IR, Multivariate Calibration

B128 Blood on Black Using Polarized Light to Enhance Bloodstains on Dark, Dielectric Surfaces

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The goal of this presentation is to introduce an improved method of photographing dark, bloodstained substrates without the use of chemical enhancement techniques, specialized film needs or digital imaging operations.

Accurately visualizing and documenting bloodstains and patterns are an integral part of crime scene processing and provides crucial information for both the analysis of evidence in the laboratory and crime scene reconstruction efforts.

During the course of examining evidence in cases, we have done some exploratory work using polarizing filters over the light source and the camera lens. We have observed stunningly dramatic improvement in the contrast between the otherwise subtle bloodstains and the dark or black background. This presentation will impact the forensic science community by introducing results from NIJ funded research into identifying the optimum conditions and limits for this polarized light photographic method.

Accurately visualizing and documenting bloodstains and patterns is an integral part of crime scene processing and can provide crucial information for both the analysis of evidence in the laboratory and crime scene reconstruction efforts.

Visualization of bloodstains is trivial for bloodstains on white or lightly colored surfaces. However, on darkly colored or black surfaces, this visualization can be extremely difficult. The failure to visualize and thereby recognize blood and bloodstain patterns on darkly colored surfaces has had seriously adverse consequences for important criminal investigations.

There are two aspects to the problem. First, the presence of blood may not be recognized at critical stages in the investigation. Second, where the presence of blood is recognized, the pattern of blood-staining may not be appreciated. Sampling of bloodstains for DNA typing and other analyses must take place with knowledge of the bloodstain patterns. Otherwise important information may be destroyed. In a significant number of cases knowing how the bloodstains were formed is more important than knowing the biological source of the stains. In most cases the two types of information are complementary.

Photography represents a nondestructive method of documenting stains. Traditionally, black and white photography uses color filters to either lighten or darken a stain against the surrounding background to elucidate the forensic information contained on a difficult substrate. This technique, however, provides little benefit with bloodstains on very dark and reflective surfaces. Observing and documenting bloodstains on these surfaces is problematic due to the glare reflected off of the surface as well as the lack of contrast between the stain and substrate.

Previous studies have shown the usefulness of chemical enhancement techniques on bloodstain patterns, with the drawback of potentially compromising DNA analysis and altering the stains. Performing background corrections on digital images and the combination of digital photographs taken at two or three wavelengths have also been shown to lead to enhanced visualization of blood on some strong colored substrates.

During the course of examining evidence in cases, some exploratory work using polarizing filters over the light source and the camera lens has been done. There has been an observed stunningly dramatic improvement in the contrast between the otherwise subtle bloodstains and the dark or black background.

This presentation will introduce results from NIJ funded research into identifying the optimum conditions and limits for this polarized light photographic method.

Polarized Light, Bloodstain Visualization, Photography

B129 I-Typer: Development and Validation of an Interspersed Genetic Element-Based Human Identity Kit

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The goal of this presentation is to introduce the development of a novel, 3100-based genetic system which utilizes unconventional genetic elements.

This presentation will impact the forensic community by showing the allele frequency database and the application of this system to actual casework samples for relationship testing. There will also be information given on the primer design process used to exploit these sequence similar elements. I-Typer is stable (no mutations), highly sensitive, robust, and has the potential for becoming a popular additional genetic system with the forensic and relationship testing communities.

Human identity testing methods are built on the variation that exists between individuals at particular genomic locations. These differences are typically targeted using neutral genetic markers such as VNTRs, SNPs and STRs. These have become the primary genetic tools utilized in the fields of forensics and relationship testing. There is another group of genetic candidates that have been largely unexplored as to their potential for use as markers. Interspersed elements have created a rich source of human diversity that has had minimal academic exposure as identity markers. These elements are already being used in DNA quantitation systems as well as forensic male chromosomal screening assays. Reliagene Technologies, Inc. has now designed a kit, I-Typer, which utilizes polymorphic interspersed elements as human identity markers. These elements have unique attributes that are advantages over currently used systems. This system has been designed such that intra-specific competition inherent in a locus has been eliminated completely, minimizing the possibility for allele drop-out in trace samples which is caused by stochastic effects.

Interspersed Element, DNA Testing, Relationship Testing

B130 Pattern Evidence and Conformance to the Requirements of *Daubert*

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The goal of this presentation is to focus on how pattern evidence can be evaluated to conform to the relevancy and reliability requirements of *Daubert*.

By focusing on the verbiage of *Daubert*, this presentation will impact the forensic science community by clarifying the requirements of relevancy and reliability, and discuss the concept of "error rate" as they apply to pattern evidence.

Daubert v. Merrell Dow Pharmaceuticals, 509 U.S. 579 (1993) changed the admissibility standard for scientific and technical evidence. Prior to 1993, the standard for admissibility in federal and most state courts was defined by *Frye v. United States*, 293 F. 1013 (DC Cir. 1923). "General acceptance" was the standard. In *Daubert,* the Supreme Court referenced the Federal Rules of Evidence (Rule 702) and relevancy and reliability became the requirements to determine admissibility. This session will focus on how pattern evidence can be evaluated to conform to the relevancy and reliability requirements of *Daubert*.

Many discussions on the impact of *Daubert* and the admissibility of expert witness testimony have preceded this session. However, most of these discussions have been based on what participants remember reading in the decision. Few were based on an examination and evaluation of the actual verbiage in *Daubert*. What did the Supreme Court actually say in rendering this landmark decision in forensic science? The two terms which are the cornerstones of *Daubert* are defined in the decision, but not often defined in evaluating conformance:

"Relevancy" is defined as that which has "any tendency to make the existence of any fact that is of consequence to the determination of the action more probable or less probable than it would be without the evidence. The Rule's requirement that the testimony "assist the trier of fact to understand the evidence or to determine a fact in issue" goes primarily to relevance by demanding a **valid scientific connection** to the pertinent inquiry as a precondition to admissibility.

"Reliability" is established by Rule 702's requirement that an expert's testimony be based on "scientific knowledge." The **adjective "scientific" implies a grounding in science's methods and procedures**; the word **"knowledge" connotes a body of known facts or of ideas inferred from such facts or accepted as true on good grounds**.

The next most significant words which appear in the decision, but which were not defined, and remain undefined by the courts fourteen years later are "**error rate**." What does this mean? What is the origin of the term in the decision? Ask different experts, prepare for different responses. Ask judges who are the "gatekeepers," they will probably not be prepared to answer. Where exactly is the term referenced in the decision and in what context? For the purposes of this discussion, what follows are verbatim excerpts from the decision:

Faced with a proffer of expert scientific testimony under Rule 702, the trial judge, pursuant to Rule 104(a), must make a preliminary assessment of whether the testimony's underlying reasoning or methodology is scientifically valid and properly can be applied to the facts at issue. Many considerations will bear on the inquiry, including ***whether the theory or technique in question can be (and has been) tested, whether it has been subjected to peer review and publication, its known or potential error rate and the existence and maintenance of standards controlling its operation, and whether it has attracted widespread acceptance within a relevant scientific community.*** *The inquiry is a flexible one, and its focus must be solely on principles and methodology, not on the conclusions that they generate.*

Even the Court admits that the "inquiry is flexible." The Justices were clear in emphasizing that all testimony is subject to challenge. Our system is based on advocacy, sound logic which is understandable, and the ability of participants in the judicial system to make logical arguments which are persuasive. If an argument cannot withstand rigorous cross-examination, the challenges to proof beyond a reasonable doubt are more credible. The Court wrote that scientific testimony should be presented in such a way that the jury can understand and use the scientific testimony to formulate a sound decision.

Cross-examination, presentation of contrary evidence, and careful instruction on the burden of proof, rather than wholesale exclusion under an uncompromising "general acceptance" standard, is the appropriate means by which evidence based on valid principles may be challenged. That even limited screening by the trial judge, on occasion, will prevent the jury from hearing of authentic scientific breakthroughs is simply a consequence of the fact that the Rules are not designed to seek cosmic understanding but, rather, to resolve legal disputes.

Here is where the court may have unwittingly left open the gate (remember, the judge is the gatekeeper who can either lock the gate or keep it open) for the admissibility of pattern evidence. Any testimony by any "expert" may be, and perhaps should always be "challenged." Valid, scientifically sound testimony will withstand interrogation; junk science testimony will fall under its own weight if challenged correctly.

This discussion will focus on the forensic examination and scientific basis of pattern evidence, the scientific validity of results generated by forensic examiners in presenting the resulting conclusions from these examinations, and their conformance to the actual requirements of the Supreme Curt under the 1993 *Daubert* decision. For this discussion, pattern evidence includes, but is not limited to: latent prints, questioned documents/handwriting, impression evidence such as tiretrack, footwear, and firearms/toolmark evidence. In evaluating these evidence types the resulting conclusions require the comparison of pattern features, as opposed to quantifiable data. This leads to the next questions: Does good science require "quantifiability," or will observations which lead to a valid hypothesis suffice? What is the basis for the following conclusion?

"Impression A (the latent print, projectile, toolmark)
had its source in Item B to the exclusion of all other sources."

Can this statement be made with the reliability required by *Daubert*? Where is the scientific method validation data associated with this conclusion?

The most contentious pattern evidence issues are associated with the concept of "individuality." What is the scientific justification for the assertion that pattern evidence such as crime scene latent prints, handwriting, stria on projectiles, cartridges and tools, or shoeprints, can be uniquely associated with one person or object to the absolute exclusion of all other people or objects? What scientific testing is needed to verify or reject this assertion? How should this research be carried out and who should do it? Pattern evidence practitioners assert that they are able to make assertions of individuality with total and complete confidence. Their adversaries in the courtroom respond "based on what scientific premise?" Some expert witnesses respond that the validity of such comparisons is based on "experience," or that the comparisons are an "art." To meet the requirement of *Daubert* that answer is no longer acceptable because the Court requires **scientific methods and procedures**, not art or experience.

This session will include forensic scientists and attorneys representing both side of the aisle in the courtroom. Based on the verbiage of the Court in *Daubert*, they will present their views on what constitutes reliability, relevancy, and individuality. They will attempt to answer many of the questions above. The salient question in this session remains: To meet the standards of *Daubert,* are the conclusions in pattern evidence comparisons reliable and relevant because they are based on objective, quantifiable, validated scientific methods and data? The attendees in the audience will determine if their responses withstand "rigorous cross examination."

***Daubert*, Relevancy and Reliability, Error Rate**

B131 Forensic Review Board Validation of the Complex Identification Procedure (CIP) Methodology for Identifying the Nature and Origins of Platinum Group Metal Production Materials

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After attending this presentation, attendees will have an understanding of the precious metal manufacturing processes in Russia and South Africa and of the importance of efforts being made to identify the source of stolen platinum group element (PGE)-containing materials used in international money laundering schemes. This paper will give a brief overview of the CIP analysis procedure and will discuss a Forensic Review Board's experiences in an international effort to validate the procedure both analytically and forensically.

The results of attempts by an international panel of experts in evaluating methods developed in Russia to help them meet European legal requirements will be presented. In addition to assisting in tracing the source of PGE materials, this project provides experiences that will enable increased acceptance of protocols across international legal systems.

A number of leading Russian scientific research institutes (Mining and Metallurgical Company "Norilsk Nickel", Institute of Criminalistics of the Russian Federal Security Service, State Research Institute for Rare Metals, and Russian Federal Centre of Forensic Science) have developed a combined methodology, using bulk and particle SEM-EDX, ICP-OES, ICP-MS, and XRD to characterise intermediate materials from the beneficiation process of PGE-bearing ores. It has been claimed that this methodology provides such a high degree of discrimination that samples can be traced back to their specific point of origin in the beneficiation process. This "Complex Procedure for Identification of the Nature and Source of Origin of Precious Metal containing Products of Mining and Metallurgical Operations" is referred to as the Complex Identification Procedure, or CIP.

The CIP uses several diagnostic features to determine the nature and source of origin of an unknown PGE-bearing material:

- Bulk elemental composition of the substance, including impurities is measured first by SEM-EDX and then by ICP-OES and ICP-MS for 30 and 18 elements, respectively
- Phase composition of a substance, i.e. chemical composition of compounds present in this substance, is measured by XRD;
- Distribution of particle types in accordance with their elemental composition is determined using SEM-EDX for determination of particle compositions and morphologies.

Several legal actions have been initiated in Western Europe against companies suspected of dealing in stolen PGE materials. In order for the CIP results and expert opinions derived from them to be accepted in future court proceedings, it was thought to be necessary to have the method validated analytically and forensically by a well respected independent international body. A project was initiated under the auspices of ENFSI (European Network of Forensic Science Institutes) to this end with support from the Ministry of Justice of the Russian Federation and the International Platinum Association (IPA). The objectives of the project are twofold: to peer review the CIP in order for the CIP expert results to be accepted in court and to provide advice on possible improvements.

The Forensic Review Board consists of nine members from national forensic institutes in Great Britain, Germany, Sweden, The Netherlands, The United States, South Africa, and The Russian Federation. A non-forensic member of the Board is Prof Yuri Karpov, Deputy Director of the Russian Research and Projecting Institute of the Rare Metals Industry "GIREDMET" and member of the Russian Academy of Science. Tasks of the Board are to collect information, discuss and report results, make decisions, contribute to and comment on documents and (interim) reports as used by and produced in the project, advise on the methods used and ultimately decide whether the CIP set of methods are suitable for their intended forensic application. Six industrial and scientific advisers assist the Forensic Review Board by providing specialist information based on their specific knowledge, information and experience from the perspective of the PGM industry.

The Netherlands Organisation for Applied Scientific Research (TNO) has been contracted to perform the analytical verification of the CIP and their report will be an appendix to the final project report.

The Board has supervised TNO's analytical studies of the CIP, evaluated world-wide geological data pertinent to sourcing PGE-bearing ores, and performed their own collaborative analytical and statistical studies of the protocol and the reference database. Up-to-date results of Board activities will be presented. It is expected that this project will be completed at about the time of the AAFS meeting.

Platinum Group Elements, Method Validation, Forensic Review Board

B132 Method Development and Application of High Resolution ICP-MS (HR-ICP-MS) and Laser Ablation (LA-HR-ICP-MS) for Elemental Analysis of Bone, Teeth, Nail, and Hair Samples

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The goal of this presentation is to show the method development of the elemental analysis and its application to real samples of bone, teeth, hair and nails using solution based and laser ablation with HR-ICP-MS.

This presentation will impact the forensic science community by demonstrating the development and application of robust analytical

methods for the detection and quantification of trace elemental analysis in bone, hair, teeth and nail matrices will lead to a better understanding of the potential utility of these measurements in forensic chemical analyses.

Biological matrices such as bone, teeth, hair, and nails have captured the attention of the forensic scientist during the last decades, since they are commonly found in crime scenes and/or massive burials. The elemental composition of such matrices can provide key information of environmental exposure at working places, heavy metal poisoning, discrimination between individuals and for provenance purposes. It is possible to follow up elements naturally found in the body and their concentrations by analyzing hair,[1] nails,[2] and bones or teeth.[3, 4] Recent applications of elemental composition of such matrices to human authentication[5] have resulted in the resolution of crimes. Some trace elements in bones (such as strontium) can act as geographical markers and can suggest the origin of a person either in the early ages or in the last years of his life.[6-8] Therefore biological matrices play an important role in the forensic analysis of a crime scene. The development and application of robust analytical methods for the detection and quantification of trace elemental analysis will lead to a better understanding of the potential utility of these measurements in forensic chemical analyses.

Elemental analysis of glass and paint by ICP-MS and LA-ICP-MS has shown to provide a very high degree of discrimination between different sources of manufacturing of these materials. There has also been an interest in the application of elemental analysis by these sensitive methods to the analysis of biological matrices such as bones, hair, nail, and teeth. Among the instruments used to study these biological materials are Neutron Activation Analysis (NAA), Atomic Absorption Spectrometry (AAS), X-Ray Fluorescence (XRF), Inductively Coupled Plasma-Atomic Emission Spectrometry (ICP-AES), Laser Induced Breakdown Spectroscopy (LIBS), and Inductively Coupled Plasma-Mass Spectrometry (ICP-MS). For the analysis of biological matrices, most of these techniques require consideration of: (1) high complexity of the matrices, (2) resolution of spectral interferences, (3) a wide concentration range of elements (ng/g – %wt), (4) cumbersome sample preparation procedures, and (5) contamination of these samples. Inductively Coupled Plasma Mass Spectrometry (ICP-MS) is one of the preferred techniques for elemental analysis since it can provide excellent sensitivity, accuracy and precision of the analysis. The use of a sector field High Resolution Inductively Coupled Plasma Mass Spectrometry (HR-ICP-MS) system offers the resolution of polyatomic interferences improving the detection of trace elements in complex matrices such as bone, teeth, hair, and nails in addition to improving the detection limits over a quadrupole based ICP-MS device. By coupling a laser ablation (LA) system for solid sampling, the sample preparation steps and the destruction of the sample are reduced significantly. The analytical method developed for the elemental analysis of biological matrices using HR-ICP-MS and LA-HR-ICP-MS will be presented along with a comparison of the analytical data retrieved from solution and LA-based analyses using standard reference materials (SRMs) and actual samples.

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Elemental Analysis, Sourcing, LA-ICP-MS

B133 Characterization of Microdrop Printed Calibration Standards for Ion Mobility Spectrometers

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The goal of this presentation is to introduce the use of the inkjet microdrop delivery system for standards would be of interest to researchers working in other areas.

The forensic community and especially those involved with illicit substance detection and trace detection will benefit from the development of standards as described in this presentation. This presentation will impact the forensic science community by demonstrating how these standards may be used in currently deployed IMS instruments.

Ion Mobility Spectrometers are widely used in airports and other high security areas to detect trace levels of illicit substances such as explosives and drugs of abuse. Quantitative analysis standards with known mass loadings for delivery to the IMS do not currently exist. Therefore, there is a need for calibration standards with known mass loadings to verify that these instruments are consistently detecting their target compounds at the designed level of detection (i.e., as low as ng quantities of explosives). This presentation reports the data obtained using Microdrop printing to verify the detection limits of IMS instruments and also to demonstrate the reliability of the microdrop delivery process. Persistence of some of the volatile compounds of interest after deposition onto various substrates is also presented.

Inkjet printing technology allows for the precise delivery of known amounts of analyte to a substrate for subsequent analysis by Ion Mobility Spectrometry. This technology has been investigated for its potential to provide quantitative standards for IMS instruments.[1] The piezo-electric inkjet m and the drops formed at the orifice have the µm print-head has a diameter of 60 same diameter. Each drop has a known volume and therefore known concentration of analyte.[2] By varying the number of drops, the amount of analyte delivered can also be varied. In bench-top IMS instruments, the particles of the illicit substance collected

on the surface of the swipe are introduced into the instrument through a heated desorber. Drop-on-demand printing of microdrops allows for the delivery of the analyte directly onto the swipes. Through previous studies we have been able to show that the delivery of mass in the range of 0.04 ng to 0.28 ng can be performed reproducibly. The IMS produces a linear response within this range of mass of analytes delivered. Substances tested include common drugs of abuse and explosives and their odor signature compounds. Standard solutions of Cocaine, 2, 4, 6-trinitro toluene (TNT), 3, 4 methylenedioxymethamphetamine (MDMA), Diphenyl Amine (DPA), and Ethyl Centralite (EC) were prepared and delivered onto different substrates and then introduced into the IMS.

The persistence of the printed compounds on different surfaces is an important factor affecting the development of viable standards. The persistence of the compounds depends upon the matrix/substrate properties and the physical properties of the target compound. The vapor pressures of the some of the compounds being tested are very low and they tend to persist on surfaces, however some of the more volatile compounds are lost over time. This presentation reports on the persistence of these compounds on various matrices after deposition. The substrates chosen are those suitable for introduction into IMS and also amenable for other surface characterization studies. These include solgel, PDMS, Teflon, Filter paper, and manufacturer supplied filter swipes. Analytical techniques such as GC-MS, FTIR and FT-Raman were used to qualitatively and quantitatively characterize these printed surfaces.

The studies presented in this presentation will enable further development of the microdrop printing technique to prepare robust and viable calibration standards for Ion Mobility Instruments both for the target compounds and their odor signatures.

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Ion Mobility Spectrometers, Calibration Standards, Microdrop Printing

B134 Forensic Applications of Headspace Single-Drop Microextraction

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After attending this presentation, attendees will have a better appreciation of the various headspace single-drop microextraction (HS-SDME) methods. These methods are relatively new and involve simple sample preparation. They have been used with gas and liquid chromatography to sample volatiles in a variety of matrices.

This presentation will impact the forensic science community by serving as a key aspect in describing several HS-SDME methods which offer the forensic scientist simple, effective and non-invasive sampling methods for chromatographic analysis of various forensic samples.

The sample preparation step in an analytical procedure generally involves an extraction of the analyte. This extraction typically results in isolation and enrichment of target compounds from a sample matrix with generally good recovery. Extraction processes have been developed that reduce the amount of extraction solvent, and incorporate automation and miniaturization. In 1990, solid-phase microextraction (SPME) was developed as a fast, simple, and solvent-free sampling technique. Consequently, SPME has found application in many fields including forensic science.

Headspace gas chromatography (HSGC) has been commonly used to analyze samples containing volatile compounds from various matrices. Over the last few years a very, simple sampling technique called single-drop microextraction, SDME, has been combined with headspace sampling. The first SDME publication appeared in 1996 and the first application to headspace analysis was published in 2001. The technique is simple, does not require sophisticated equipment, and like HSGC, eliminates much interference from the sample matrix.

Several different types of SDME have been described including variations of headspace methods. SDME has also been described in the literature by other names including liquid-phase microextraction (LPME). Static headspace SDME (HS-SDME) is a technique in which a single drop of solvent is suspended at the tip of a microsyringe needle and exposed to the headspace of the sample solution. Another technique has been described as "exposed" dynamic HS-SDME. This technique exposes a single drop of solvent to the headspace of the sample solution similar to HS-SDME, however after the drop is withdrawn back into the syringe barrel, the procedure is repeated several times. A third type of SDME is called "unexposed" dynamic HS-SDME where the extraction solvent is withdrawn into the syringe barrel and a gaseous sample is withdrawn into the syringe barrel, similar to normal static headspace sampling, and allowed to be exposed to the solvent within the syringe.

Various sampling parameters will affect the recovery and precision of HS-SDME methods. These parameters include the solvent, size of drop, shape of the needle tip, temperature of the sampling, equilibration time and temperature, extraction (sampling) time, effect of stirring, ionic strength of the sample solution, and ratio of headspace volume to sample volume. Good precision and linearity have been reported with several types of methods. Automated methods have been reported as well. This presentation will discuss the different types of HS-SDME including the effect of sampling parameters, and other aspects of the techniques. Forensic Science applications of HS-SDME will be illustrated.

Headspace, Single-Drop Microextraction, Gas Chromatography

B135 Statistical Discrimination of Liquid Gasoline Samples From Casework

Nicholas D.K. Petraco, PhD, John Jay College of Criminal Justice, Department of Science, 899 10th Avenue, New York, NY 10019*

After attending this presentation, attendees will be given a demonstration of how techniques from computational pattern recognition and statistical learning theory can be applied to evidence analysis.

The intention of this study was to differentiate casework liquid gasoline samples by utilizing multivariate pattern recognition procedures on data from gas chromatography-mass spectrometry. A supervised learning approach was undertaken to achieve this goal employing the methods of principal component analysis, canonical variate analysis, orthogonal canonical variate analysis and linear discriminant analysis.

The study revealed that the variability in the sample population was sufficient enough to distinguish all the samples from one another knowing their groups a priori. Canonical variate analysis was able to differentiate all samples in the population using only three dimensions while orthogonal canonical variate analysis required four dimensions. Principal component analysis required ten dimensions of data in order to predict the correct groupings. These results were all cross-validated using the "jackknife" method to confirm the classification functions and compute estimates of error rates. The results of this initial study have helped to develop procedures to use multivariate analysis applicable to fire debris casework.

Gasoline, Chromatography, Multivariate Pattern Recognition

B136 Engineering Tools to Aid in the Collection of DNA Evidence at a Crime Scene

J.R. Aspinwall, MS, and Ashley Hall, PhD, Midwest Research Institute, 1470 Treeland Boulevard South East, Palm Bay, FL 32909*

The goal of this presentation is to introduce the community to the concept of computational fluid dynamic modeling applied to predict the location of trace levels of DNA in a particular space.

A goal of this project is the development of a general flow model that can be used as a forensics tool to aid in the recovery of DNA at the scene of a crime. This presentation will impact the forensic science community by demonstrating an empirical model for the collection of trace evidence and should be a powerful addition to the forensic scientist's armamentarium.

In 2005, the Government Accountability Office (GAO) published a report criticizing the various agencies involved in the response to the 2001 Amerithrax attack, citing their failure to use probability sampling in initial strategies, thus reducing the level of confidence in a negative result. The same principle could be applied to crime scene anaysis. Although guidelines for the collection and preservation of DNA evidence at a crime scene are well-documented, there has not been an empirical study describing the probability of finding trace levels of DNA at different sites within a crime scene. A powerful tool used in mechanical engineering is computational fluid dynamics (CFD), a modeling technique in which mathematical algorithms are applied to the analysis of fluid flows. The particulars of a space (e.g. volume, flow rates, vents) are variables in the millions of computer-driven calculations used to simulate the interaction of fluids and gases with complex surfaces.

The application of CFD to room air motion as a tool for human forensics can be broken into two categories. The first category involves enclosed, non-ventilated air spaces and requires analysis of natural convection and the associated heat and mass transfer. The second category is much more complicated and involves enclosed, ventilated air spaces. Both ventilated and non-ventilated air spaces pose a challenge to the recovery of human DNA material because of the extensive space air diffusion that occurs in a ventilated room. The use CFD to model the transport and deposition of human cells and DNA material in an enclosed air space with a goal of predicting optimum sample locations throughout that space has been evaluated.

A typical room was used to simulate a crime scene, and samples were collected in accord with standard evidence collection guidelines. Then, CFD modeling was applied to the space to identify the locations for which there was a high probability of finding trace levels of DNA. Using this technique, low levels of DNA were collected from areas that would not normally be sampled, thus representing evidence that would have been be lost in the absence of CFD modeling. The application of low copy number profiling protocols such as miniSTRs allowed for the recovery of additional genetic information. Results will be discussed.

A goal of this project is the development of a general flow model that can be used as a forensics tool to aid in the recovery of DNA at the scene of a crime. An empirical model for the collection of trace evidence should be a powerful addition to the forensic scientist's armamentarium.

Computational Fluid Dynamics, DNA Evidence, DNA Profiling

B137 FORESIGHT: A Business Approach to Improving the Nation's Forensic Laboratories

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The goal of this presentation is to inform the attendees about the FORESIGHT Project, its methods, and preliminary results.

This presentation will impact the forensic science community by providing an understanding of how forensic laboratories function as "businesses" and why, through an in-depth metric analysis, they can enhance and improve their functions.

Managers of scientific laboratories see themselves as scientists first and managers second; consequently, they tend to devalue the managerial aspects of their jobs. Forensic laboratory managers are no different but the stakes may be much higher given the importance of quality science to the criminal justice system. The need for training and support in forensic laboratory management has been recognized for many years but little has been done to transition the tools of business to the forensic laboratory environment.

A study in Europe, called Quadrupol, did an in-depth analysis of four forensic laboratories in the European Union. At the 2006 International Forensic Business and Economics Colloquium, it was decided that a similar study would benefit United States forensic laboratories. FORESIGHT is a business-guided self-evaluation of forensic science laboratories across North America. The participating laboratories represent local, regional, state, and federal agencies. Faculty from the WVU College of Business and Economics are providing assistance and guidance. The process involves standardizing definitions for metrics to evaluate work processes, linking financial information to work tasks and functions. Laboratory managers can then assess resource allocations, efficiencies, and value of services—the mission is to measure, preserve what works, and change what does not. While the Census of Public Crime Laboratories and the International Association for Identification Forensic Service Providers Survey approach the forensic industry broadly, FORESIGHT will show processes, strategies, resources, and allocations at a highly detailed level. A project of this magnitude for forensic laboratories has not been carried out anywhere. The ten laboratories involved operate at the local, state, and federal level. They are:

- Centre of Forensic Sciences (Toronto, Canada)
- Colorado Bureau of Investigation
- Georgia Bureau of Investigation
- Illinois State Police
- Minnesota Bureau of Criminal Apprehension
- Orange County Forensic Science Service (California)
- Royal Canadian Mounted Police
- Tarrant County Medical Examiner's Forensic Laboratory (Texas)
- Virginia Division of Forensic Sciences
- Washington State Patrol
- West Virginia State Police

Definitions were kept as similar as possible to the Quadrupol study. Differences in human resource and management structure made some topics unrelated or irrelevant, while others had to be redefined for use in the United States. The results of FORESIGHT will be comparable to other studies that will be conducted in Europe and in Australia. It is hoped that international cooperation will improve forensic laboratory performance and increase the quality and efficiency of their services to their respective justice systems. This project is being conducted with support from the National Institute of Justice.

Economics, Management, Foresight

B138 Tire Impressions: Does Size Really Matter?

Machelle A. Reid, MFS, Federal Bureau of Investigation Laboratory, 2501 Investigation Parkway, Quantico, VA 22135*

The goal of this presentation is to provide some insight into the variation in noise treatment/pitch sequence in tires of the same design but of different sizes and will help an examiner understand how this feature can be used to conclude that a tire impression corresponds in tread dimension as well as tread design. The attendee will learn the minimum length of an impression necessary to differentiate between two different sized tires of the same design.

This presentation will impact the forensic community by allowing an examiner to render a stronger association that a tire impression "corresponds in tread design and tread dimension" with a known tire. The majority of tire tread examiners are familiar with the concept of noise treatment/pitch sequence and its importance in the examination and comparison of tire tread impression evidence. However, many examiners lack the experience and/or confidence necessary to conclude that a tire impression was made by a tire of a particular size and will instead render a weak association that a tire impression "corresponds in tread design" alone. This presentation will stress the importance of conducting a complete and thorough examination to include making full rotation test impressions of the known tires as well as comparing the noise treatment/pitch sequence of the questioned and known impressions.

The majority of tire tread examiners are familiar with the concept of noise treatment/pitch sequence and its importance in the examination and comparison of tire tread impression evidence. However, many examiners lack the experience and/or confidence necessary to conclude that a tire impression was made by a tire of a particular size and will instead render a weak association that a tire impression "corresponds in tread design" alone. This presentation will stress the importance of conducting a complete and thorough examination to include making full rotation test impressions of the known tires as well as comparing the noise treatment/pitch sequence of the questioned and known impressions. This will allow an examiner to render a stronger association that a tire impression "corresponds in tread design and tread dimension" with a known tire.

Multiple sizes of the Michelin LTX M/S tire were collected from various sources. Full rotation test impressions were made from each tire and were used to compare the size of the tread design features and/or the noise treatment/pitch sequence of each tire one to another. Discrepancies between the size of the tread elements and/or the overall width of the impression were noted, readily differentiating a majority of the tires from the others. In other tires where the size of the tread elements and the overall width of the impression corresponded, portions of the noise treatment/pitch sequence were identified for closer comparison. The results of this study of the Michelin LTX M/S model tire demonstrated that short areas, at best, aligned.

The author will present an easy method of making full rotation test impressions from tires and discuss methods of comparing these test impressions one to another. The author will discuss the differences between the multiple sizes of the Michelin LTX M/S tire and how this information can be used to determine the minimum length of an impression necessary to confidently conclude that an impression "corresponds in tread design and tread dimension" with a known tire.

Tire Impression, Tire Size, Tire Examination and Comparison

B139 An Introduction to the In Situ Identification of Pigments in Automobile and Architectural Paints by Raman Microspectroscopy

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The goal of this presentation is to introduce the audience to raman spectroscopy and its use in identifying pigments in automotive and architectural paints.

Though a critical part of automobile finish systems and other paints, pigments are generally not critically examined in forensic analyses. This presentation will impact the forensic science community by demonstrating a means by which pigments can be effectively and efficiently studied.

Despite the significance of automotive and architectural paint in the field of trace evidence, only two of the three major components of paints (*i.e.*, binders and extenders) are presently reliably identifiable in microscopic specimens. Pigments, the third major component of paints, are only indirectly used as a discriminating factor through the study of the composite color they produce by visual examination or visible microspectrophotometry. The identity of the actual microscopic particles responsible for the macroscopic color of paint are generally ignored. In large part, this is due to the difficulty of studying and identifying pigments by methods commonly available in forensic laboratories. Polarized light microscopy and x-ray diffraction can be used to identify pigments, but, these methods are not commonly utilized due to the expertise required or the amount of available sample. A pyrolysis gas chromatogram may contain information about the pigments present; however, this information typically is not used to identify pigments but instead characterize and compare samples. Infrared spectroscopy can be used to identify certain pigments; however, the majority of peaks due to pigments are typically obscured by binder absorptions in the infrared. Raman spectroscopy, on the other hand, is normally free of scattering from the binder and often provides a great deal of information about the pigments present.

As a complimentary technique to IR, Raman spectroscopy is well suited to the examination of pigments. First, modes that are infrared active are generally inactive in the Raman spectrum. As a result, the paint binder does not usually interfere with the pigment spectrum and pigments typically show strong Raman scattering. Second, pigments in paint can be examined with virtually no sample preparation (the study of minor pigment components does require a thin sample). Third, although the detection limit within a measured sample volume are not particularly good (~5-10%, similar to other vibrational spectroscopies) compared to many other methods (e.g., ICP or XRF); microscopic and sub-microscopic pigment particles can be successfully studied individually by reducing the analysis volume using confocal Raman spectroscopy (down to ~2 μm^3).

Prior to the examination of pigments within a paint sample, it is necessary to develop a database of Raman pigments. At the present, our database consists of approximately 100 of the more commonly used commercial paint pigments. In collecting good Raman spectra, it was necessary to use two different lasers (514 nm and 785 nm) due to fluorescence that occurs in some pigments excited with a particular wavelength. Furthermore, background subtractions were often used to eliminate fluorescence backgrounds and improve the effectiveness of database search algorithms.

After building our Raman pigment database, we began to analyze various architectural and automotive paints. A series of six different colored acrylic architectural paint samples (white, gray, blue, green,

black, and red) were examined by X-ray diffraction to identify the pigments they contained. These same samples were then characterized by Raman microspectroscopy. All of the pigments identified by X-ray diffraction were also identified by Raman spectroscopy. In addition, two different phthaolcyanine pigments used in the blue and green paint that were not identified in the XRD patterns were readily identified by Raman spectroscopy.

In this study of automobile paints, one to two pigments in a given sample without any background information concerning the pigments used in a given formulation have been routinely and blindly identified.

Several difficulties did arise in the identification of pigments in a given paint sample. One inherent problem relates to the scattering efficiencies of various pigments. For example, phthalocyanines, which are excellent Raman scatterers can dominate a spectrum if present even in a low concentration. In other cases, pigments present only in minor amounts can be difficult to study due to the difficulty of obtaining a clean Raman spectrum. This is not always the case and we have been encouraged to find that, in several cases, we could identify individual pigments present within a matrix of another pigment using a combination of light microscopy and confocal Raman spectroscopy. In general, we have found that Raman spectroscopy is an effective and efficient techniques for the identification of pigments in paint samples.

Raman Spectroscopy, Pigments, Paint

B140 Soil Analysis Using Automated Scanning Electron Microscopy

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Upon completion of this presentation, attendees will have been introduced to the use of automated scanning electron microscopy for forensic soil comparisons and provided data from a blind study that validates the technique for use in the crime laboratory.

This presentation will impact the forensic science community by describing a practical means for crime laboratories to use soil as trace evidence.

The most common approach for characterizing soil is to consider its color; relative amounts of gravel, sand, and silt; the mineral composition including heavy minerals; biological materials like pollen and phytoliths; and building materials. The minerals are identified using polarized light microscopy (PLM) and the number of each mineral type is tallied.

The identification of individual mineral grains requires a skilled specialist and the resulting tally is based on the examiner's subjective observations. Therefore, more practical methods of identifying and counting the soil mineral grains might be useful to crime laboratories. The recent development of automated scanning electron microscopes employing energy dispersive x-ray spectrometry (SEM/EDS) could offer practical advantages for soil analysis. Many crime laboratories are using these instruments for gunshot residue (GSR) analysis; thus these instruments may already be available for soil analysis.

McCrone Associates currently uses automated SEM/EDS to search for specific particles of interest such as the search for GSR. The other use of automated SEM/EDS is to briefly survey and catalog all particles by stopping and analyzing all particles on the stub without regard to their composition. The analysis produces EDS spectra (elemental composition) and images (morphological features) from each particle in turn. Thousands of particles can be quickly analyzed unattended (approximately ten grains per minute), producing a count of the minerals in the sample.

Soil samples, previously collected from three rural counties in Michigan, were selected at random for a blind study. The analysts were never informed of the source of any of the samples and which were duplicates. The blind trials used soil from fourteen sites, separated into two duplicates from each site; three different grain sizes and two replicate samples of each size were prepared by reverse sieving. Approximately 2000 grains from each sample preparation were analyzed. Finally, after all analyses were completed, the soil unit from which each sample was collected was disclosed in order to evaluate the data. Each of the original samples would likely be different from the others, but the duplicates should be similar.

Soil is prepared for automated SEM/EDS analysis by reverse sieving. After sieving and cleaning a chosen grain size fraction, the grains are passed back through the same sieve and affixed to a 10 mm aluminum stub topped with conductive double-sided carbon sticky tabs. For example, grains that passed a No. 100 mesh sieve and collected on a No. 120 mesh sieve were passed back through the No. 100 mesh sieve onto the stub. The preparation results in a single layer of particles, between 125 and 150 micrometers, with none touching another in the pattern of the mesh.

An ASPEX 3025 Low Vacuum (LV) Personal Scanning Electron Microscope (PSEM) equipped with an Energy Dispersive X-ray Spectrometer (EDS) for elemental analysis was used to analyze the soil grains. Using EDS, only the mineral's elemental composition is available to differentiate between mineral classes. For example, microcline and orthoclase, which have a different crystal structure but the same chemical stoichiometry ($(K,Na)AlSi_3O_8$), cannot be differentiated except by optical crystallography. On the other hand, EDS can easily distinguish between some minerals such as rounded quartz and untwined plagioclase feldspars (oligoclase) that are not rapidly distinguished in grain mounts by PLM, without observing interference figures. The output of the EDS software is a normalized k-ratio, which is roughly equivalent to elemental weight percent. An Excel library of expected values based on elemental weight percent for more than a hundred common minerals was generated using published formulae supplemented by the analysis of known minerals from which a classification was defined. EDS data from each grain were imported into the spread sheet and the mineral identified by comparing the EDS data with the table of expected values.

Automated SEM/EDS analysis in a blind study found that soils from the same site could be matched and most soils from other sites were different in their mineral tallies. Automated SEM/EDS should be considered preliminary to PLM; morphological analysis, whether by PLM or SEM, is essential to identify anthropogenic and biogenic materials that cannot be distinguished by EDS alone. Additional studies to determine whether automated SEM/EDS is useful for comparison of soils from regions other than the American Midwest and to measure the discriminating power of the method on samples from similar soil units are recommended.

Soil, SEM/EDS, ASPEX

B141 Analysis and Discrimination of Electrical Tape Adhesives by Fourier Transform Infrared Spectroscopy (FTIR) and Pyrolysis-Gas Chromatography-Mass Spectrometry (py-GC/MS)

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After attending this presentation, the audience will be aware of current FBI protocols for analysis of electrical tapes and the common chemical compositions thereof.

This presentation will impact the forensic community by providing a better understanding of the relative discrimination powers of forensic analyses of electrical tape adhesives using Fourier transform infrared spectroscopy (FTIR) and pyrolysis-gas chromatography-mass spectrometry (py-GC/MS).

Electrical tapes are often submitted to crime laboratories as evidence associated with improvised explosive devices or other violent crimes. The FBI Laboratory performs comparative electrical tape examinations to explore the possibility of an evidentiary link between a suspect and a crime or between different crime scenes.

Submitted samples are first evaluated by visual and microscopic means to evaluate physical characteristics such as backing color, adhesive color, width, degree of gloss, surface texture, and thickness.

If the samples are consistent following visual and microscopic examinations, chemical composition of each of the tapes' components (backing and adhesive) is evaluated. Current FBI protocol calls first for chemical analysis via FTIR with a microscope attachment. FTIR analysis can provide information regarding the rubber and polymeric materials used to formulate tape's adhesive and backing as well as some information for the plasticizers and flame retardants that are present. However, typically a significant amount of peak overlap occurs, making spectral interpretation difficult. This is further complicated by the spectral scatter encountered when analyzing black adhesives. Therefore, in most instances the individual chemical constituents are categorized into general classes rather than identified. For samples that cannot be differentiated by FTIR examination, scanning electron microscopy / energy dispersive spectroscopy (SEM/EDS) is then performed to compare elemental composition. Finally, py-GC/MS is performed on each component if samples have yet to be discriminated. This technique breaks the organic components down, separates them, and provides more conclusive information as to the identity of the chemical constituents. As a result, py-GC/MS is particularly useful in identifying the rubber component(s), the type(s) of plasticizers, and any other organic additives present.

This study involved the analysis of ninety electrical tape samples utilizing the current FBI Laboratory protocol. Most of the tapes were purchased by FBI Laboratory personnel at discount stores or home-improvement retailers, are marketed as general purpose or economy grade, and cover a variety of U.S. and foreign manufacturers. Therefore, the sample set represents tapes that could be easily obtained by consumers and would be comparable to casework evidence submitted to the FBI Laboratory.

This project was designed with a number of objectives in mind. They include: (1) determination of the range of physical characteristics and chemical compositions of electrical tapes, (2) evaluation of the ability of the individual techniques to discriminate samples, and (3) assessment of the ability of the overall analytical scheme to distinguish between samples. The subject of this presentation will be the composition of the electrical tapes' adhesives as determined by FTIR and py-GC/MS. Furthermore, a comparison of the two techniques' discrimination ability will be discussed.

Electrical Tape, Fourier Transform Infrared Spectroscopy, Pyrolysis - Gas Chromatography - Mass Spectrometry

B142 The Scientific Working Group for the Analysis of Seized Drugs (SWGDRUG)

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The goal of this presentation is to update forensic drug analysts on recent work products from SWGDRUG.

This presentation will impact the forensic science community by presenting a synopsis of the history os SWGDRUG and goals of the core committee.

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:

- Uncertainty in measurements
- Reporting protocols (what should the report say?)

These topics have been discussed widely 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

Drug abuse and trafficking in controlled substances are global problems, and in recent years law enforcement has looked to international solutions for these problems. In 1997 the U.S. Drug Enforcement Administration (DEA) and the Office of National Drug Control Policy (ONDCP) co-sponsored the formation of the Technical Working Group for the Analysis of Seized Drugs (TWGDRUG), now known as SWGDRUG.

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), Africa, and South America, forensic science educators, the American Society of Crime Laboratory Directors (ASCLD), ASTM, and the National Institute of Standards and Technology (NIST). All members of the core committee have worked together over the past ten years to build a consensus on the development of recommendations which have impacted forensic drug analysis standards internationally.

SWGDRUG Core Committee members have received hundreds of responses to international surveys and requests for comments from forensic drug analysts. Methods of communication have included: an internet website site (www.swgdrug.org), MICROGRAM, presentations at numerous local, national and international meetings, and personal contacts.

Published recommendations (www.swgdrug.org) have been available since 2000 to forensic scientists around the world. These recommendations have addressed Methods of Analysis, Education and Training, and Quality Assurance issues. All recommendations were developed with input from the international forensic drug analysts community.

SWGDRUG, Drugs, Seized

B143 Optimized Location of Forensic Evidence by Canines and Instruments Through Implementation of Best Practice Guidelines and SPME/GC-MS Methods

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After attending this presentation, attendees will better understand how an optimal combination of biological and electronic detectors can maximize the collection of evidence from crime scenes and improve counterterrorism efforts.

This presentation will impact the forensic science community by providing a better understanding of how biological and electronic detectors can, in combination, improve the collection of evidence by maximizing the location of trace evidence in an efficient, cost effective manner while minimizing the collection of samples not relevant to an investigation.

This paper describes ongoing studies involving the identification and quantification of dominant odor signature chemicals that can be used by certified law enforcement detector dogs and instruments to reliably locate forensic specimens including accelerants, biotoxins, currency, drugs, explosives and humans (living and deceased). In the work presented, methods developed using Solid Phase Microextraction / Gas Chromatography – Mass Spectrometry (SPME/GC-MS) have identified the dominant odor chemicals available at room temperature. The results demonstrate that canines are generally not using the relatively low volatility parent substances but instead use characteristic volatile headspace components to accurately locate specimens. The application of these results to the optimal selection of canine training aids and the tuning of instruments for these compounds are discussed.

In addition, the latest developments in consensus-based best practice guidelines for canines and machines will be discussed from the Scientific Working Group on Dog and Orthogonal detector Guidelines (SWGDOG) which is **a** partnership of local, state, federal, and international agencies including law enforcement and first responders. This project was undertaken as a response to concerns coming from a variety of sectors including law enforcement and homeland security about the need to improve the performance, reliability, and courtroom defensibility of detector dog teams and their optimized combination with electronic detection devices. This project is developing internationally recognized consensus-based best practice guidelines developed by a membership of respected scientists, practitioners, and policy makers representing diverse backgrounds within the canine community and comprises 55 members.

SWGDOG general meetings have been held biannually for the past three years to produce the initial set of guidelines with NIJ funding the management of this project and the travel for international members and the TSA/FBI funding travel and meeting costs for the domestic SWGDOG members. The approval of each subcommittee best practice document takes at least 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 2006; Part B – October 2006; Part C – March 2007; Part D – August '07), (2) general guidelines for training, certification, maintenance, and documentation (April 2006) - Publication in FSC October '06), (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 detector dogs: Agriculture; Arson; Chem./Bio.; Drugs; Explosives; Human remains; Other/Misc. (August '07), and (9) scent dogs: Scent identification; Search and Rescue; Trailing dogs; Tracking dogs (August '07).

The adoption of these consensus based best practices by agencies certifying and/or deploying detection teams will provide a variety of benefits to local law enforcement and homeland security including improved interdiction and courtroom acceptance by improving the consistency and performance of deployed teams and optimizing their combination with emerging electronic detection devices.

Detector Dogs, Evidence Recovery, Consensus Guidelines

B144 Time Context in Criminalistics

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Attendees will understand the definition of time context, the manner in which it affects the ultimate utility of criminalistics evidence, the practical difficulties that have plagued time-context methods over the years and general approaches that have been successfully applied in the areas of forensic taphonomy and criminalistics.

This presentation will benefit the forensic community by illuminating the often overlooked issue of time context, as well as suggesting potential avenues for research.

Time Context is the set of circumstances or facts surrounding a criminal event that relate to a particular period of time. The term 'Time Context' is proposed because it encompasses other concepts such as time dating, sequencing and reconstruction.

Advances in forensic science, especially in DNA analysis, have improved the ability of criminalists to link suspects, victims and crime scenes using ever decreasing quantities of evidence. The lower detection limits allow evidence of contact to be established, even from casual interactions with the environment. However, approximately half of all violent crimes in the United States involve suspects and victims with at least an acquaintance relationship. This creates the very real possibility that evidence from casual interactions could have been transferred prior to the event in question. In fact, suspects with no prior relationship may also claim to have had legitimate access to the victim or crime scene, when confronted with strong physical evidence. If time context for casual transfer evidence can not be established, opposing counsel can sidestep its significance at trial.

Despite the degree of attention that trial counsel pay to "timelines," criminalists have continued to focus the bulk of their efforts toward the identification and individualization of transferred evidence, rather than determining when the transfer occurred. But in the area of death investigation, medical examiners and other taphonomic professionals have developed a substantial body of research for estimating the time of death (TOD) of an individual. Even though the TOD methods each have their limitations, criminal investigators and the courts rely on the estimates to exclude suspects, refute alibis and identify actions occurring before, during or after death. But time-of-death estimates are only half of the equation. Investigators also need to demonstrate that evidence linking the suspect to the crime was transferred at or near that same time of death. Without support from the criminalistics evidence, investigators and the courts are often forced to use less reliable evidence (e.g., eyewitness testimony) to fill in the gaps. In addition, time-of-death estimates are not applicable for other types of crimes.

Medical examiners and other taphonomic professionals encounter the same sources of uncertainty in time context as criminalists: environmental factors; original analyte mass; the analyte's mechanism of action; measurement and interpretational errors and undocumented alteration of evidence prior to recovery. Selected examples from criminalistics and forensic taphonomy will be presented to demonstrate the importance of time context, as well as successful approaches that

may be applied generally. Overall, there appear to be three major distinctions among time context methods: (1) whether the event produces a static effect, or initiates a dynamic progression, (2) whether the result is relative to the crime event, or indicates a fixed date and time, and (3), whether the characteristic is compared to general or individual data sets.

Time Context, Reconstruction, Time of Death

B145 Battlefield Forensics and Homeland Security

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The goals of this presentation are to provide an overview of forensic forward needs; to illustrate forensic applications in intelligence and implementing the rule of law; to illustrate how cooperative efforts between NIJ and DoD can benefit both the traditional forensic disciplines and homeland defense; and to propose a future view of how forensic science roles may be evolving.

This presentation will impact the forensic science community by demonstrating how deployable forensic and technical intelligence capabilities are directly applicable to homeland security needs.

Traditional forensic examinations are used in Iraq to track and identify bombers and snipers as the multi-national forces combat insurgency. This forensic effort includes examiners on the ground in-theater as well as reach back to capabilities in the United States. The forensic data has a range of uses from tactical forensic intelligence to support in establishing the rule of law and prosecutions in various judicial courts. Forensic analyses have been so successful that it is likely that wherever U.S. troops deploy in the future, forensic capabilities will be part of their skill set.

Unique in-theater needs drive unconventional solutions for how examinations are conducted and the types of equipment used. The U.S. Army Criminal Investigation Laboratory (U.S.ACIL), the National Forensic Science Technology Center (NFSTC), the Defense Threat Reduction Agency (DTRA), and the National Institute of Justice (NIJ) are partnering in the development of a deployable laboratory solution. In a joint DTRA-NIJ supported effort, the NFSTC leveraged this concept to develop deployable laboratories capable of augmenting traditional forensic facilities: (1) to provide a temporary addition of laboratory workspace, (2) for surge capacity to reduce backlogs, or (3) to provide a resource during crisis events (e.g., Katrina; World Trade Center).

The laboratory design provides the unparalleled ability to deploy virtually worldwide within a matter of hours, rather than days or weeks, with set up and full functionality within hours of reaching a disaster area. The deployable laboratory infrastructure is capable of delivering analysis results ranging from preliminary/presumptive tests to the absolute identification of materials. This portable forensic laboratory can be equipped to house conventional forensic applications such as DNA analysis, firearms examination, drug and toxicology testing, and serology within a certified ISO container; a shelter structure would function as an administration/communications sector. Features of the laboratories will be illustrated in the presentation.

As opposed to domestic use, the forensic capabilities of the laboratory deployed in support of the warfighter bring new challenges to the forensic community. Customer requirements range from providing immediate preliminary results to producing a "bulletproof" laboratory report for use in U.S. judicial proceedings. Traditional crime scene approaches and chain-of-custody methods cannot be transferred directly to the field. The required adaptations prompt a number of questions regarding implementation. How do procedures and protocols need to be adapted? Can traditional forensic staff make this adjustment? What staffing model supports this need? What is the impact on the accreditation of an agency providing these services? This presentation will outline some of the paradigm shifts needed to properly support the warfighter.

Warfighter, Technology Transfer, Forensic Intelligence

B146 The Good, the Bad, and the Forensic Scientist: Where Do Criminalists Belong in the Legal System?

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The goal is to present the position of the forensic scientist from the public and private perspectives. Advantages and drawbacks for each position will be presented and discussed. A critical review of the arguments made on bias of forensic scientists working for a law enforcement agency will be presented.

This presentation will impact the forensic science community by making people aware that a forensic scientist working for a public laboratory is not necessarily biased and that the fundamental values to which law enforcement agencies must obey are no different than the ones to which a forensic scientist must abide to.

Forensic scientists working for a police department are often described as prosecution biased, while private expert witnesses are often categorized as defense biased or as having gone to the dark side. These two examples illustrate the terrible cloud that casts a dark shadow over the forensic community and lead to serious misconceptions about bias regarding public and private forensic scientists.

Over the last few years, the privatization of public crime laboratories has become a recurrent topic, mostly discussed by non-practitioners who attempt to change a system without fully comprehending its ins and outs. For some reason, many people see public crime laboratories as being part of a law enforcement agency and not being able to offer fair and unbiased forensic services. Because this idea is unfounded, the proponents have little sound arguments to defend it. As a result, they merely mention that crime laboratories should be neutral in the adversarial system and, as such, they should not belong to a police department, lest they be considered prosecution biased. Unfortunately, the media does not miss an opportunity to associate a mistake made by a crime laboratory to a problem of prosecution bias. This serves to rally the proponents toward privatization. However, this idea implies that a police department is not neutral to the people, but leans toward the prosecution. Interestingly, no one in the forensic community seems to have questioned this insinuation or verified if it corresponded to the real mission and philosophy of police work.

The work of public and private forensic scientists is theoretically identical—they both apply sound scientific methods to discover facts and to establish the Truth. Conversely, the environment in which they work is quite different and each has his/her respective constraints. Private experts must make sure that their client is happy about the work performed; otherwise, their client may not come back. Private experts experience internal pressures to make a living and to keep their businesses afloat. By contrast, public employees experience intense external pressures from hierarchy and the media and work to fulfill urgent demands for information. However, public employees do not have clients to satisfy, *per se*: Their clients have to come back to them, and their paychecks remain the same no matter how much work is available. These are just a couple of examples of the differences between public and private sectors. However, even though differences exist on both sides, this does not mean that all private experts are defense biased and all public forensic scientists are prosecution biased.

This presentation offers reflection on the hot topic of privatization of crime laboratories and the fundamental concept of bias in public and private forensic laboratories. A brief but critical review of the existing literature will be presented, followed by an introduction to the philosophy of police work. The presentation will demonstrate that the role of a forensic scientist is not incompatible with the fundamental mission carried out by the police and that no prosecution bias exists *a priori* in a crime laboratory attached to a law enforcement agency. Furthermore, a discussion of the advantages and drawbacks of privatization will be presented.

Bias, Police Philosophy, Truth

B147 Cathodoluminescence Microspectrophotometry in Forensic Science

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The goal of this presentation is to provide an introduction to the principles and practice of cathodoluminescence with a specific focus on the visual and spectroscopic information that can be obtained from forensic samples and the applicability of CL to cases of comparison, authentication, and provenance.

Cathodoluminescence (CL) is a microscopical technique applicable to a range questions involving the forensic analysis of trace evidence. The visual and spectroscopic information provided by CL microspectrophotometry will impact the forensic science community by aiding in the comparison, authentication, and provenance examinations of forensic materials including soil, building materials, paints, duct tape, and glass.

Cathodoluminescence (CL) is the emission of visible or near visible light from a sample that has been bombarded by an electron beam. CL results from the alteration of band-gap energies due to the presence of trace elements or structural defects in crystalline materials such as minerals. The CL emission is characteristic of either the geological environment of formation of the mineral or, for a synthetic luminescent material, the manufacturing process. CL is observed in many materials routinely encountered as trace evidence, including soils and rocks, building materials, glass, pigments, and filler/extenders. The variation in luminescence for a particular mineral can therefore be used to discriminate among samples from different sources or, in certain cases, provide information about the provenance of a sample.

Many of the most abundant minerals (e.g., quartz, feldspar, and carbonate minerals) are cathodoluminescent. Due to their ubiquitous nature, these mineral components have typically been underutilized for forensic discrimination. However, the variation in luminescence within a given mineral type provides additional discrimination among sources and offers the potential for improving the significance of geological evidence. Prior research has demonstrated that cold cathode CL with light microscopy provides a relatively fast method to screen soil samples through visual identification of luminescent minerals, the ability to determine if multiple populations of a given mineral type exist, and a means to estimate the relative abundances of luminescent minerals in a sample. Surface information including zoning, textures, and coatings can also provide information about the origin of a sample. For minerals such as quartz, the visible luminescence color can be broadly correlated with a geological formation condition (e.g., metamorphic, volcanic, authigenic).

In addition to visual observation, high-resolution CL spectroscopy can offer more detailed information about specific activators (defects and trace elements responsible for luminescence) in a given mineral. For example, in feldspar minerals, the chemical composition can be estimated on the basis of the Fe^{3+} emission band. In heavy minerals such as zircon, monazite, and apatite, rare earth element activators, typically present at 1-500 ppm, can be identified and quantified with high resolution spectroscopy. Together, visual and spectroscopic examination of mineral components can be combined to provide a variety of information about soil and sand samples that complement more traditionally used analytical techniques. CL can also provide an additional discrimination factor for trace evidence by adding time-resolved high-resolution spectroscopy. Electron bombardment of the luminescence minerals will often alter the crystal structure or defects within it, which will cause the luminescence to change with time. The rate with which this luminescence for a material typically decreases in intensity, as well as shifts in the position of some broad spectral emission peaks, allows another method to discriminate between samples and provides additional information about provenance.

This presentation will provide an introduction to the principles and practice of CL with a specific focus on the spectroscopic information that can be obtained from geological samples and the applicability and limitations of CL in cases of comparison, authentication, and geographic sourcing. Spectroscopic information will be compared with prior data collected using visible luminescence imaging to assess the degree of additional discrimination and value to provenance determination offered by high resolution spectroscopy.

Cathodoluminescence, Geology, Soil

B148 Chemical Taggant Detection and Analysis Using Laser Induced Breakdown Spectroscopy (LIBS)

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Attendees to this presentation will understand the application of laser Induced Breakdown Spectrometry (LIBS) for use in the detection and analysis of an innovative chemical tagging system developed by Smartwater Technology, LLC, U.K.

The aim of this work was to validate the use of LIBS for the elemental analysis of these products as an alternative to the more complex and more expensive LA-ICP-MS methods already developed and used in our group. This presentation will impact the forensic science community by presenting a direct comparison of the performance of the LIBS analysis as compared to the LA-ICP-MS methods.

SmartWater Technology (Telford, Shropshire, U.K.) has developed a personal property coding system (SmartWater Tracer) which imparts a unique elemental fingerprint to any object it is applied. Using a combination of rare elements, SmartWater Tracer can be individualized to a consumer by varying the combination of the elements present. Once dry, the Tracer coding system can be removed and qualitatively analyzed by Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) for the presence or absence of any combination of possible elements. This study investigates the use of Laser Induced Breakdown Spectroscopy (LIBS) as an alternative, and perhaps more practical analysis scheme to LA-ICP-MS. Examples of LA-ICP-MS and LIBS for various solutions (and corresponding solids) at the target concentrations are presented.

The aim of this work was to validate the use of LIBS for the elemental analysis of these products as an alternative to the more

complex and more expensive LA-ICP-MS methods already developed and used in our group. A direct comparison of the performance of the LIBS analysis as compared to the LA-ICP-MS methods is presented.

Single and double pulse LIBS experiments using a variety of excitation wavelengths (266, 532, and 1064 nm) were used and coupled to a research grade Mechelle Spectrometer coupled to an intensified CCD detector and also to a very inexpensive Czerny-Turner Spectrometer coupled to a CCD detector. A comparison between the LIBS Excitation wavelength and Spectrometer combinations will also be presented.

The discrimination power of the optimized LIBS system is compared to the well established LA-ICP-MS method for elemental analysis of these samples and similar polymer based samples of forensic interest. The results of this study have demonstrated that LIBS is a viable alternative to LA-ICP-MS for the elemental analysis of the Smartwater tracer product while providing excellent discrimination potential, sensitivity and repeatability of analysis.

Chemical Tagging, Trace Evidence, LIBS

B149 Proteomics-Based Method for the Identification of Human Growth Hormone

Eric S. Wisniewski, PhD, David K. Rees, MS, and Esther W. Chege, MS, United States Drug Enforcement Administration, 1440 McCormick Drive, Largo, MD 20774*

Upon the completion of the presentation, participants will be provided with a new methodology for the analysis and identification of human growth hormone.

This presentation will impact the forensic science community encouraging the analysis and identification of suspected human growth hormone submissions to provide the intelligence community with more complete information regarding the frequency that HGH is encountered.

Recent publicity surrounding the purported use of performance-enhancing drugs such as steroids and Human Growth Hormone (HGH) by professional athletes has focused on the need for more stringent anti-doping testing protocols and the ability to identify unusual substances in laboratories. HGH is often seized and submitted to forensic drug laboratories in conjunction with steroids. The analysis of steroids is relatively straightforward; however, most forensic laboratories are not accustomed to analyzing exhibits of HGH and qualitative methods are needed to perform these analyses. Addressing this issue will enable accurate and consistent reporting of HGH and provide valuable intelligence as to the frequency in which it is encountered by law enforcement personnel. HGH is considered a small protein, but it is still approximately 50 times larger than regularly encountered drug substances. Since routine analysis is not amenable to these large biomolecules, HGH cannot be identified using the instrumentation and methodologies typically utilized in a common forensic drug laboratory.

In a standard forensic drug analysis laboratory, gas chromatography-mass spectrometry (GC/MS) is the confirmatory instrument of choice. Most controlled substances of interest have molecular weights that are less than 400 amu and are easily vaporized for multi-component separation and isolation by gas chromatography. The isolated drug is then usually fragmented by electron impact ionization and the results are compared to a standard for identification. Proteins present a unique problem for a typical forensic drug analysis laboratory. The size of proteins (> 1000 amu) and their thermal instability make them poor choices for analysis by GC/MS. Therefore, a biochemical, proteomics-based high performance liquid chromatography (HPLC) and liquid chromatography-mass spectrometry (LC/MS) approach to identifying proteins is necessary for the analysis of HGH. One aspect of proteomics analysis is analogous to using electron impact ionization in GC/MS. While energetic electrons are used to fragment gaseous molecules in GC/MS to yield a unique pattern, an enzyme can be used to cleave a protein at specific and reproducible locations to also yield a unique pattern.

HGH is a relatively small protein consisting of 191 amino acids and has an average mass of 22,125 amu. The forensic analysis of proteins such as HGH must meet the analytical sufficiency requirements for the laboratory and must consist of a binary approach. A suspected sample is analyzed as the whole protein for retention time and mass determination using HPLC equipped with a photodiode array and LC/MS. Further fragmentation of the protein using a proteolytic enzyme adds another dimension to the specificity of the analysis. Porcine trypsin digests proteins in a very predictable manner and yields peptide fragments of the original protein that can be used as a means for fingerprinting the larger biomolecule. *In silico*, or theoretical, digestion of HGH by trypsin yields 21 peptides ranging in size from 1-23 amino acids in length. Of these 21 peptides, 17 sequences are 5 amino acids or longer. The larger fragments containing higher numbers of amino acids give more specificity to identifying a protein based on a fragment produced by the digestion of trypsin.

Herein, the analysis of HGH using a proteomics approach is presented that meets the SWGDRUG recommendations for the identification of unknown substances.

HGH, Proteomics, Steroids

B150 The Analysis of Black Powder Substitutes Containing Ascorbic Acid by Ion Chromatography-Mass Spectrometry (IC-MS)

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After attending this presentation, the attendee will have learned different methods for analyzing black powder substitutes containing ascorbic acid (AA) by IC-MS.

This presentation will impact the forensic community by demonstrating a more direct and sensitive method for analyzing trace levels of black powder substitutes containing AA, including post-blast residues from pipe bomb fragments.

Every year the ATF forensic science laboratories examine evidence from numerous improvised explosive devices (IEDs), the majority of which are filled with propellants such as smokeless powder, black powder, and black powder substitutes. The current trend among black powder substitutes is the utilization of organic acids as a replacement fuel for sulfur. Ascorbic acid, commonly known as Vitamin C, is one such organic acid that is currently being used in several black powder substitute formulations, such as American Pioneer™ Powder, Jim Shockey's Gold™, and Goex Pinnacle Replica black powder. While Hodgdon Pyrodex® continues to be the most commonly encountered black powder substitute in ATF's explosive casework, these ascorbic acid powders are starting to appear in casework more often.

The rapid degradation of ascorbic acid is a well-documented phenomenon that complicates the identification of these black powder substitutes, especially in post-blast devices. Although recent Liquid Chromatography-Mass Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS) methods have been successful in identifying ascorbic acid and/or its degradation products in intact powders, a method sensitive enough to identify ascorbic acid in post-blast residue has yet to be reported. Here, a more sensitive and direct IC-MS method of analyzing ascorbic acid through its degradation products is presented. Water extracts of both intact powder and post-blast pipe bomb fragments were analyzed by IC-MS. Although the

organic fuel (ascorbic acid) is not detected in its original form by this IC-MS method, three diagnostic degradation products of ascorbic acid can be identified in the intact powders: oxalate (m/z 89), threonate (m/z 135), and monohydrated diketogulonate (m/z 209). Oxalate and trace levels of additional as yet unidentified ascorbic acid degradation products were detected in post-blast residues. The full anion profile for the intact powders consisted of NO_3^-, oxalate, threonate, monohydrated diketogulonate, and ClO_4^- (for those powders with a $KClO_4$ oxidizer). The full anion profile for the two post-blast powders analyzed contained a large amount C_l-, and lower levels of ClO_4^-, ClO_3^-, NO_3^-, NO_2^-, HCO_3^-, and oxalate. The monohydrated diketogulonate and threonate could only be identified in some of the post-blast samples. It is important to consider that the identification of post-blast ascorbic acid black powder substitutes should be based on the complete anion profile, not merely the presence of the oxalate anion, for example. The presence of other ions, such as chloride, nitrate, perchlorate and bicarbonate, in addition to the lack of sulfur-containing ions are all key components of the anion profile.

Black Powder Substitutes, Ion Chromatography-Mass Spectrometry (IC-MS), Ascorbic Acid

B151 Discrimination of Black Electrical Tape Using Attenuated Total Reflectance and Pyrolysis-Gas Chromatography/ Mass Spectrometry

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Upon completion of this presentation, attendees will have learned about the nature of the components in electrical tape that facilitate differentiation of tapes from different manufacturers from one another.

This presentation will impact the forensic science community by presenting the development of procedures for the discrimination of black electrical tape by attenuated total reflectance (ATR) IR, and pyrolysis-gas chromatography/mass spectrometry (GC/MS). Multivariate analysis is performed to visualize differences between the spectra and pyrograms of tapes as well as to investigate possible adaptation of procedure to forensic casework samples.

The goal of this presentation is to present procedures for the discrimination of black electrical tape by attenuated total reflectance infrared spectroscopy, and pyrolysis-gas chromatography/mass spectrometry. Attendees will learn about the nature of the components in electrical tape that facilitate differentiation of tapes from different manufacturers from one another.

This presentation will report on the use of Fourier transform infrared (FT-IR) spectroscopy with attenuated total reflectance (ATR) combined with pyrolysis gas chromatography/mass spectrometry for the differentiation of black electrical tape based on the composition of the tape's backing. Principal component analysis (PCA) and canonical variate analysis (CVA), also known as linear discriminant analysis, will be applied to IR and GC/MS data sets to evaluate the discriminating power of the combined information.

The backing of electrical tape usually contains a polymer such as polyvinyl chloride (PVC), carbon black for color, inorganic additives/fillers as well as plasticizers to increase polymer flexibility. For the best of samples, ATR can be used to identify the polymers, fillers, and plasticizers; however, the predominance of the plasticizer in the backing of electrical tape often masks these components. The presence of carbon black in the tape's backing can cause dispersion effects in the spectra, due to an increase in the refractive index. For these reasons, additional analysis is needed to discriminate between tapes with similar components. Pyrolysis GC/MS allows for sensitive analysis of organic components in tape as well as identification of small, distinguishing difference in similar components that ATR may not be able to distinguish.

Tape samples were collected from various stores in the United States. For ATR analysis, a sample of each tape was adhered to a glass microscope slide, allowing for quick analysis of the tape backing. Ten replicate spectra from different locations on the tape sample were obtained. Analysis of the data using principal component analysis discriminated the tape samples with a 88% classification accuracy. To further discriminate between the other samples, pyrolysis GC/MS was employed. For pyrolysis GC/MS, each tape was sampled using a microscope and a surgical blade to remove a small piece of backing from the center of the tape, taking care not to include any adhesive. The sample was affixed to the flat end of a 26 mm long quartz filler rod that acts a platform for quartz sample tubes used in the pyrolysis autosampler (CDS Analytical, Inc, Oxford, PA). Multivariate analysis was performed to visualize differences between the spectra and pyrograms of tapes and to evaluate the ability to classify unknown tape samples.

Black Electrical Tape, ATR, Py-GC/MS

B152 A Forensic Scientist Staffing and Infrastructure Model: A Model for Adequate Forensic Scientist Staffing and Funding of the Nation's Forensic Science Crime Laboratories

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The goals of this presentation are to introduce a versatile, robust, and flexible forensic science staffing and infrastructure model for the nation's forensic science laboratories; and to discuss the development and incorporation of foundational data to support the forensic sciences in the public policy arena.

The presentation will impact the forensic science community by addressing the critical shortages and needs in the nation's forensic science laboratories, while developing the lacking foundational data to further support the forensic sciences in the public policy arena. The incorporation of this foundational data in public policy analysis will justify the expansion of the forensic science role in providing public safety and protecting citizens.

The presentation addresses the critical shortages and needs in the nation's forensic science laboratories (crime laboratories), along with developing the lacking foundational data to further support the forensic sciences in the public policy arena. The presenter creates a dynamic and robust model to address both issues. The model is versatile and flexible, creating data for use by any level of government (federal, state, and local). The model provides *minimum* staffing levels and a variety of costs based on 2005 crime data. Additionally, the model provides the *ideal* staffing levels and costs based on forecasted 2010 crime data.

A major role of government is to provide public safety and protect citizens. Unfortunately, this is not the case for the nation's forensic science laboratories. The nation's forensic science laboratories are understaffed and under budgeted. Forensic science laboratories are under increasing pressures to provide a wide range of services with the

limited resources available. Media stories depict the state of affairs, including high backlogs, cases not being worked timely, and wrongful convictions, while the public has come to expect CSI-like services and results based upon a variety of forensic-based television shows.

How does the forensic community address and defend its needs to the political leadership at national and local levels? The forensic science community must start developing and incorporating the appropriate, supporting data in their funding and staffing requests, using public policy methods.

From a public policy viewpoint, the forensic science community lacks the data necessary for the appropriate support. Several authors have identified the lack of and need for various types of quantitative data. They discussed the need for quantitative data to demonstrate the value of forensic science applied to the criminal justice system, and recommended the development of sophisticated estimates, using agreed upon standards. The developed estimates can provide estimates of values and costs.

The model develops a standard to provide adequate staffing resources for the nation's forensic crime laboratories. The model develops the necessary infrastructure costs to compliment the projected staffing.

An early process in public policy analysis is the identification and development of various costs. More sophisticated policy analyses rely on these costs. The presenter provides the foundational costs in the staffing and infrastructure model, which can be incorporated into further policy analyses. The model calculates annual operational costs. Cost per analyst and cost per case for each operational section are calculated in the model. These various costs can then be used in a variety of public policy calculations.

The model provides the starting point in determining the value of forensic science to the criminal justice community and society as a whole. The model provides some of this quantitative data. The model provides the costs of providing services. These costs provide foundational data for determining the *value* of forensic sciences to the criminal justice system.

From a policy development and evaluation perspective, the costs provide foundational data for further economic and financial evaluations, one of the four main evaluation criterion used by public policy analysts. An example of an economic and financial evaluation is economic efficiency studies. A type of economic efficiency study is a sophisticated cost/benefit analysis, which accomplishes the value objective. The model becomes an integral part of the cost/benefit analysis.

Further economic and financial evaluations are accomplished after the primary data is created. The further evaluations include determining studies on economic effectiveness, benchmarking studies, and marginal analysis.

Staffing and Infrastructure Model, Public Policy Analysis, Values and Costs of Forensic Science

B153 A Comparison Study of Commonly Used Commercial STR Kits on Trace Evidence Samples

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This goal of this comparison study is to assist the forensic scientist in selecting the most appropriate STR amplification system and amplification volume to apply when working with limited known quantities of DNA sample in order to maximize the amount of usable data obtained.

This presentation will benefit the forensic community by serving as a guide when faced with trace amounts of DNA sample and/or with concentrations well below the optimum required as it will demonstrate which commercially available STR kit and amplification volume is more likely to yield the most useful genetic information; thereby, increasing the overall success for solving forensic cases involving trace evidence.

Currently, forensic laboratories employ a wide variety of commercially available STR kits in the genotyping of DNA samples for human identification purposes. These commercial kits are the methods of choice for DNA analysis and have proven to be reliable techniques. However, one of the limitations with these methods is the recommended DNA concentration requirements. This factor alone limits the amplification success, specifically, when trace amounts of DNA samples are handled. The availability of STR kits that amplify up to 16 loci, i.e., ABI's AmpFlSTR® Identifiler and Promega's PowerPlex16 kits has helped improve the situation by requiring a single amplification. More recently, other STR kits, i.e., ABI's AmpFlSTR® Y-Filer™ and MiniFiler™ kits, have been introduced with lower recommended DNA concentration requirements and are expected to improve the sensitivity of the overall DNA genotyping process. The value of a comparison of the efficiency of these commercial kits for use on trace evidence samples is vital information for forensic scientists working case samples with limited biological material.

This study will demonstrate the efficiency of commercial STR kits including ABI's AmpFlSTR® Identifiler™, Y-Filer™, and MiniFiler™; as well as Promega's PowerPlex16™ kits when trace amounts of DNA are used for amplification. Furthermore, data obtained from the amplification of trace amounts of DNA in a full and half PCR reaction volumes will reveal the amplification volume at which each of the kits tested affords the best sensitivity.

This comparison study will assist the forensic scientist in selecting the most appropriate STR amplification system and amplification volume to apply when working with limited known quantities of DNA sample in order to maximize the amount of usable data obtained. The forensic scientist will be made aware of the benefits and limitations of commercially available kits commonly used in casework samples.

This presentation will benefit the forensic community by serving as a guide when faced with trace amounts of DNA sample and/or with concentrations well below the optimum required as it will demonstrate which commercially available STR kit and amplification volume is more likely to yield the most useful genetic information; thereby, increasing the overall success for solving forensic cases involving trace evidence.

Trace, Amplification, STRs

B154 Principles of STR Multiplex Amplification You May Not Know

Christopher A. Cave, MS, Bode Technology, Via del Vignola 12, Int 10, Roma, 00196, ITALY; and Heather M. Cunningham, MS, Kristen Hancock, MS, and James W. Schumm, PhD, The Bode Technology Group, 10430 Furnace Road, Suite 107, Lorton, VA 22079*

The goal of this presentation is to relay the principles that provide quality STR profiling under a variety of amplification conditions.

This presentation will impact the forensic science community by demonstrating how the implementation of these principles can save sample material and reagent expense to produce high quality DNA profiles.

STR multiplex amplification has been studied to understand general principles relating effects of changes in template amount, multiplex primer concentration, amplification cycle number, and amplification volume. The results reveal that, except for stochastic variation with limited template amounts, the same quality, intensity, and

accuracy of DNA profiles can be obtained while varying each of these parameters over a broad range. In fact, often these parameters can be modified, but balanced to produce identical results under very different conditions.

Previous authors (Gaines et al., Leclair et al., Frégeau et al.) have shown that in specific instances with specific multiplexes that amplification volume can be lowered to 12.5µl and even 5µl reaction volumes with no loss in multiplex performance. This workcan be extended to demonstrate that there is a systematic inversely proportional relationship between amplification reaction volume and amplification product intensity for all multiplexes. That is to say with the same amount of template, a 2µl amplification reaction is stronger than a 6µl reaction which in turn is stronger than a 25µl reaction which again in turn is stronger than a 50µl reaction.

A low volume amplification reaction approach not only saves reagent material, it also limits the requirement for sample consumption. Increased intensity is also shown of lower volume amplification reactions can be offset by use of either lower primer concentration or fewer amplification cycles during thermal cycling, or both. Thus, a balanced profile indistinguishable from that using the manufacturer's recommended reagent concentrations and amplification protocol can be generated with the same reliability with lowered cost in both reagent and sample consumption.

It is illustrates that these principles apply universally across all NDIS-approved commercially available multiplex sets including PowerPlex 16, COfiler, Profiler Plus, and Identifiler. This knowledge has important implications that will be discussed regarding evaluation of low copy number samples.

References:
Gaines ML et al. *J Forensic Sci* 2002;47(6):1224-1237.
Leclair B et al. *J Forensic Sci* 2003;48(5):1001-1013.
Frégeau CJ et al. *J Forensic Sci* 2003;48(5):1014-1034.

STR, Low Copy Number, PCR

B155 Comparing Minifiler™, Identifiler™, and Powerplex® 16 Performance With Challenging Samples

Christopher A. Cave, MS, Bode Technology, Via del Vignola 12, Int 10, Roma, 00196, ITALY; and Kristen Hancock, MS, and James W. Schumm, PhD, Bode Technology, 10430 Furnace Road, Suite 107, Lorton, VA 22079*

The goal of this presentation is to illustrate considerations and comparative advantages of use of MiniFiler, Identifiler, and PowerPlex 16 for DNA casework.

This presentation will impact the forensic science community by providing insight in STR kit selection for casework analysis.

In processing remains from the World Trade Center site, Bosnian and Mexican graves, and many other sample sources, our laboratory has become interested and expert in evaluation of challenging remains. In this work, we compared performance of the recently introduced Amp*Fl*STR™ MiniFiler PCR Amplification Kit by Applied Biosystems with other commercial multiplexes for use with challenged samples.

The MiniFiler Users Guide indicates the product "is an assay optimized for genotyping degraded and/or inhibited DNA samples." Recent evaluation of MiniFiler performance confirms it can be used to identify some of the larger missing loci absent in Identifiler amplifications in some particularly challenged samples (Eisenberg). However, Hill et al. recently published that the primers sequences selected display 27 instances of discordant allele calls among 1308 tested individuals when comparing profiles between this system and the Identifiler system.

This 2% discordance in sample matching prompted us to investigate whether there are ways to "optimize" existing Identifiler and/or PowerPlex 16 kits to meet the needs of profiling challenged samples and to avoid this discordance in results versus CODIS-searchable profiles. To investigate this possibility, first the amplification reaction volume was lowered to 6µl with each kit to generate stronger signals. Next, 32 cycle amplification for PowerPlex 16 (at the top end of the Manufacturer's recommended number), 32 cycle amplification for Identifiler (four cycles above the Manufacturer's recommended number), and 30 cycles for MiniFiler (equal to the Manufacturer's recommended number) were selected to provide more even signal.

Multiplex performance was then compared under these modified conditions while challenging the systems with:

1) Small amounts of DNA Template.
2) Degraded DNA templates created by digestion with DNAse
3) UV-treated DNA substrates
4) Inhibition by addition of increasing amount of indigo, humic acid, and hematin to the amplification reactions.

Under these conditions, all three multiplex systems generally performed similarly with small amounts of template, with degraded template, and with UV-treated template. MiniFiler provided the strongest profiles in the presence of indigo and humic acid, but differences were not dramatic. PowerPlex 16 displayed the greatest resistance to hematin, again with no dramatic differences among systems.

In conclusion, with optimized conditions for all systems, Identifiler, PowerPlex 16, and MiniFiler all work well with challenging samples. The greater concordance among Identifiler, PowerPlex 16, and CODIS entries, and the ability to obtain more profiled loci with the megaplex systems suggest that modifying the protocols with use of these systems may be preferred to use of MiniFiler as a first follow up when obtaining a poor profile with a challenged sample. Minifiler would provide a second backup.

References:
Eisenberg AJ, October, 2006. Presentation at 17th International Symposium on Human Identification, abstract published at http://www.promega.com/geneticidproc/ussymp17proc/oralpresentations/Eisenberg.pdf.
Hill C, et al., *J Forensic Sci.* July 2007, 52;4:870-873.

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Inhibitors, Degradation, MiniFiler

B156 Y-Filer and Beyond: Mutation Rates and New Loci for Increased Haplotype Resolution

Amy Decker, MS, and Peter M. Vallone, PhD, National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-8311; Angela D. Gorman, Millsaps College, 1701 North State Street, Jackson, MS 39210; and John M. Butler, PhD, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8311, Gaithersburg, MD 20899-8311*

The audience will become familiar with a set of Y-STR loci that can be used beyond commercially available loci for further haplotype resolution and will also be provided with updated information on mutation rates with the 17 Y-STR loci in the Yfiler kit.

This presentation will impact the forensic community by introducing new multiplex of Y-STR loci that will allow for further resolution of sample haplotypes beyond commerically available kits.

The audience will become familiar with a set of Y-STR loci that can be used beyond commercially available loci for further haplotype

resolution and will also be provided with updated information on mutation rates with the 17 Y-STR loci in the Yfiler kit.

An important part of studies with the Y chromosome is to determine Y-STR loci that are highly discriminatory in order to extract maximum informative value from a sample. The focus of this work was to determine an optimal set of Y-STR loci that can be used for further resolution of male individuals beyond those loci contained in commercially available kits. Close to 100 Y-STR loci were examined with 95 U.S. population samples and those that provided the highest discrimination were combined into a multiplex. These Y-STR loci are being tested with high levels of female DNA to ensure that they have no cross-reactivity with the X chromosome, which would make this multiplex attractive for sexual assault cases.

Another added benefit of these additional Y-STRs is their ability to increase the power of discrimination between closely related male individuals, such as fathers and sons. Currently, we have obtained 400 father:son sample pairs from Caucasians, African Americans, Hispanics, and Asians. Mutation rates using the 17 Y-STR loci in the Yfiler kit with these samples will be discussed as well as a comprehensive summary of mutation rates from literature. Mutations observed with Y-STR loci beyond those in Yfiler will also be investigated.

Methods and Materials: Potential new Y-STR loci were selected from the 166 Y-STR loci described by Kayser et al[1] as well as other various publications. The loci were mapped using PCR primers present in the Genome Database (GDB).[2] Primer pairs were checked for primer-dimer and hairpin structures using the AutoDimer program.[3] The loci were evaluated in singleplex and then combined into multiplexes of 3 or 4 loci and characterized for 95 U.S. population samples. These loci were also tested with 300ng of female DNA to ensure there was no binding on the X chromosome. Gene diversity values for the individual loci in the population samples were examined as well as a collection of haplotype information.

Summary of Results: Additional Y-STR loci have been studied and characterized and a subset of these have been combined into a multiplex that can provide Y chromosome specific results in the presence of a high amount of female DNA.

Conclusions: A multiplex of Y-STR loci that can provide increased discrimination capacity beyond the Y-STR's currently available in commercial kits has been created. Future studies will involve testing these Y-STR loci with father/son pairs.

References:

1 M. Kayser, R. Kittler, A. Ralf, M. Hedman, A.C. Lee, A. Mohyuddin, S.Q. Mehdi, Z. Rosser, M. Stoneking, M.A. Jobling, A. Sajantila, C. Tyler-Smith, A comprehensive survey of human Y-chromosomal microsatellites, Am. J. Hum. Genet. 74 (2004) 1183-1197.

2 GDB; http://www.gdb.org.

3 P.M. Vallone, J.M. Butler, AutoDimer: a screening tool for primer-dimer and hairpin structures, Biotechniques 37 (2004) 226-231.

Y-Chromosome, Short Tandem Repeat, Mutation Rates

B157 Genetic and Population Characterization of the 17 Y STR YFiler Loci in Three Texas Population Groups

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This presentation will present population data and characteristics of the multiplex Y-Filer kit so that the forensic scientist can properly interpret Y-STR data. The approaches for interpretation of forensic Y STR haplotype evidence will be presented.

This presentation will impact the forensic science community by enabling scientists to properly evaluate and assess Y STR DNA evidence.

The Y-chromosome STR genetic markers can be useful for analyzing samples derived from violent crime because these targets are on the male-specific portion of the human genome. Additionally, these genetic markers can assist in resolving paternal lineage issues. The AmpFℓSTR®Yfiler™ Kit (Applied Biosystems) is particularly useful for such analyses, because it contains the reagents necessary for typing 17 Y STR loci in a single multiplex analysis. The loci are: DYS19, DYS389I, DYS389II, DYS390, DYS391, DYS392, DYS393, DYS385 (note that this marker represents two loci), DYS438, DYS439, DYS437, DYS448, DYS456, DYS458, DYS635 and Y GATA H4. In order to place proper significance regarding a 17locus Y STR haplotype obtained from a forensic specimen that matches a profile from a suspect or victim (or cannot be excluded as arising from a biological relative), population data sets are employed. These sample populations allow for: (1) estimating upper bounds on the frequency of an observed Y STR haplotype, (2) assessing the impact of population substructure on estimating the rarity of a haplotype, and (3) identifying any analytical characteristics of the genetic loci and multiplex systems that should be considered when effecting an interpretation. In this study approximately 3000 unrelated males residing in Texas, parsed out over three populations (African American, Caucasian, and Hispanic) were typed. This is the largest United States regional population analysis performed to date. Most of the time only one allele was observed per locus, except for the DYS385 marker where typically one or two alleles were observed. There were a few instances where multiple alleles per locus were observed. The DYS19, DYS439, DYS389I, and DYS385 loci exhibited the majority of multi-allele loci. In a very few samples there appeared to be a null allele at the DYS448 locus which occurred concomitantly with the observance of two alleles or an allele peak with increased height at the DYS437 locus. These samples are being sequenced to determine whether this observation is due to a deletion within the region where the DYS448 locus primers reside. All three population samples were highly polymorphic for the 17 Y-STR haplotypes. The haplotype diversity was greater than 99.9% for each population group. The genetic variance component analysis was conducted using the AMOVA routine of Arlequin 2.0. The Fst value across all three populations is exceedingly small (<0.001), such that given the population size of the databases, accommodating substructure will have little or no affect in estimating an upper bound frequency of Y STR haplotypes when a complete 17 locus profile is obtained. Y-STR mutations have important implications for parentage testing and for

establishing male lineage in forensic applications. The population samples have matching father/son haplotypes confirmed by paternity testing (with high likelihood ratios). The average rate of mutation is consistent with other studies (i.e., the range of 10^{-3}/locus /generation). While DNA profiles based on Y-STRs cannot achieve individualization because they are paternally transmitted and non-recombining, large datasets enable better exploitation of the power of an analysis. These analyses provide guidance for an effective approach for estimating the rarity of a Y STR haplotype, and the approach will be discussed.

Y STRs, Multiplex, Population

B158 Understanding Null Alleles and STR Allele Mobility Issues Through Variant Allele Sequencing

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After attending this presentation, attendees will develop a better understanding of "null" alleles and mobility shift issues after confirming sequence variation.

This presentation will impact the forensic science community by enhancing the knowledge of the forensic community in regards to methodologies used to define the differences found in variant alleles.

Polymorphisms exist in the flanking regions of short tandem repeat (STR) loci that can cause allele dropout when they fall underneath PCR primer binding sites. The resulting "null alleles" are typically detected when concordance studies are performed using sets of PCR primers with different annealing positions[1, 2]. Some interesting mobility shifts due to sequence variation have been elucidated using sequence analysis. Additionally there can be sequence variations found within the STR repeat that do not cause mobility shifts. Some of the STR loci of interest that will be discussed are: D16S539, D8S1179, D7S820, D18S51 and D19S433. These STR typing and sequencing results will be discussed in the context of the growing number of more than 364 variant alleles reported and cataloged as part of the National Institute of Standards and Technology STRBase website: http://www.cstl.nist.gov/biotech/strbase/.

Methods and Materials: DNA sequencing primers lying outside of PCR amplification assay primer binding sites have been designed and tested for all 13 core STR loci used in the Combined DNA Index System (CODIS) as well as four additional loci that are contained in commercial STR kits. A variety of polyacrylamide gel electrophoresis conditions have been developed to separate closely spaced heterozygous alleles so that these alleles can be individually sequenced without the need for cloning. Gel cutouts (individual alleles) are re-amplified prior to sequencing each allele. Variations in the individual alleles are determined by aligning their sequence to a reference sequence from GenBank.

Summary of Results: The novel sequencing primers developed in our laboratory encompass the primer binding regions of all known published primer sequences for loci included in commercial STR kits and thus enable an examination of polymorphisms giving rise to allele dropout upon PCR amplification. With the introduction of "mini" STRs additional variants have been seen.[3]

Conclusions: Methodologies for DNA sequencing of STR alleles can aid in understanding the molecular basis for allele dropout due to point mutations or insertion/deletions in template DNA that disrupt PCR primer annealing. An increasing number of rare variant alleles are being discovered and information is being uncovered through DNA sequencing that can be helpful in assessing natural human variation and developing improved detection assays in the future.

References:

1 Budowle, B., *et al.* (2001) STR primer concordance study. *Forensic Sci. Int* 124: 47-54.

2 Clayton T.M., *et al.* (2004) Primer binding site mutations affecting the typing of STR loci contained within the AMPFlSTR SGM Plus kit. *Forensic Sci.Int.* 139: 255-259.

3 Hill, C.R., Kline, M.C., Mulero, J.J., Lagace, R.E., Chang, C.-W., Hennessy, L.K., Butler, J.M. (2007) Concordance study between the AmpFlSTR MiniFiler PCR Amplification Kit and conventional STR typing kits. J. Forensic Sci. 52(4): 870-873.

Short Tandem Repeat, DNA Sequencing, Variant Alleles

B159 Developing Rapid PCR Multiplex Assays With miniSTR Loci

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The goal of this presentation is to evaluate and discuss the conditions required for developing rapid multiplex PCR assays.

This presentation will impact the forensic science community by demonstrating how the development of rapid multiplex PCR assays will reduce the overall time required for DNA typing. The information provided in this presentation will assist those developing integrated DNA typing devices and provide further understanding of PCR to the forensic community.

Learning Objective and Outcome: Currently DNA typing is conducted in approximately 8 to 10 hours. The process includes DNA extraction, quantitation, PCR amplification, and fragment length detection. With the advent of miniaturization technologies such as microfluidic and micro-capillary devices there is a desire to reduce the overall time it takes to type DNA samples. Such miniature devices could be used for initial screening in the field. An essential component of a rapid DNA test is reducing the time required for amplification of STR loci.

Existing commercial multiplex STR typing kits were not designed for rapid PCR thermal cycling conditions. Currently it takes approximately three hours to amplify a multiplex of up to 15 STR loci. miniSTR loci are promising candidates for a rapid PCR multiplex due to their small amplicon size (<150 base pairs) and flexibility in terms of primer design. Non-CODIS miniSTR loci[1] were used to test conditions for developing a rapid PCR amplification.

Materials and Methods: A useful rapid screening assay should consist of highly variable miniSTR loci. Three miniSTR loci were tested in the multiplex amplification. The forward primer for each locus was labeled with a unique fluorescent dye (FAM, VIC, NED). Amplification was carried out using commercially available polymerases intended for rapid PCR. The temperature ramp rate of a standard thermal cycler was increased from 1°C/sec to 4°C/sec to accomplish the rapid cycling. In addition, temperature dwell times for denaturation, annealing, and elongation were reduced to ten seconds or less. Standard PCR parameters such as Mg^{++}, total reaction volume, annealing temperatures were optimized to produce a balanced multiplex PCR.

Summary of Results: A set of three miniSTR loci (D2S441, D10S1248, D22S1045) were simultaneously amplified in a single PCR. Fast processing polymerases and rapid cycling protocols allowed for the evaluation of a 'rapid' STR multiplex PCR amplification. The total time required to run 28 cycles on a standard thermal cycler employing a heating rate of 4°C/sec was under 40 minutes. Capillary electrophoresis experiments indicated even peak balance and good signal intensity with slight adenlyation artifacts. Genotyping results are concordant with miniSTR amplification utilizing a standard 2 hour (non-rapid) thermal cycling procedure.

Conclusions: A three locus multiplex PCR can be carried out in less than 40 minutes using miniSTR loci. The loci are well balanced and the assay is robust enough to routinely amplify 0.5 ng of template DNA. Understanding conditions and primer design parameters that allow for rapid multiplex amplification can also be applied to researchers focusing on performing rapid multiplex PCR on non-standard thermal cycling devices. Since the miniSTR fragments are less than 150 base pairs the time required for separation on a miniaturized device will also be reduced.

References:

1 Hill, C.R., Coble, M.D., Butler, J.M. (2007) Characterization of 26 miniSTR loci for improved analysis of degraded DNA samples. *J. Forensic Sci., in press*.

MiniSTR, PCR, Rapid PCR

B160 Validation of the BIOMEK 3000 for DNA Extraction, Quantitation, and PCR Set-Up

Mark Powell, MS, Rhonda Clark, PhD, Kevin J. MacMillan, MS, Lisa Gefrides, MS, and Roger Kahn, PhD, Harris County Medical Examiner's Office, 1885 Old Spanish Trail, Houston, TX 77054*

Attendance at this presentation will impart upon attendees a roadmap for validation of automated systems for DNA extraction, quantitation set-up, PCR dilution, and PCR set-up. Attendees will understand the substantial time savings available by simply adopting a novel approach to validation of automation systems. By an initial focus on the validation of post-extraction tasks such as quantitation set-up, PCR dilution and PCR set-up rather than the typical automated extraction validation, users will be able to implement use of their automation tools in casework and also use the robot itself to aid in the complex extraction validation.

This presentation will have an immediate impact on the forensic community by changing the focus of automation away from the complicated and time-consuming task of extraction validation to a more efficient model of validation of post-extraction tasks. Automation users will be able to implement automation for casework in a far more timely fashion and allow their robotic systems to aid in further validation of extraction.

Of interest to attendees and in particular BIOMEK 3000 users, a step by step analysis of the validation procedure will be presented. From initial programming of the instrument to the complicated task of optimizing robot extraction, this presentation will provide attendees an opportunity to learn some valuable time-saving lessons prior to embarking on their own path to automation.

Over the course of validation the Harris County Medical Examiner's (HCME) Office overcame some significant challenges in order to bring the BIOMEK 3000 online for casework. The first challenge was to optimize the robot for microcentrifuge tubes instead of the standard 96 well trays. The solutions to this challenge will be of particular interest to casework operations as tubes tend to be the norm for storage of extract product, as is the case at HCME. This challenge was overcome and tubes are the basis of all the BIOMEK programming.

The validation results of Quantifiler set-up, PCR dilution preparation (normalization) and Profiler Plus and COfiler amplification set-up will be discussed, highlighting the time and money savings afforded compared to the manual equivalent. By focusing on automating these methods, the HCME was able to begin using two Biomek 3000s for casework in as little as three months.

The more labor intensive validation of the Biomek 3000 for automated extraction will also be detailed in this presentation. A comprehensive validation will be outlined as well as comparison of two commercially available extraction kits (Promega DNA IQ and Invitrogen Chargeswitch) to current casework manual methods (Chelex 100 and Phenol/Chloroform).

Along with the challenges presented by validation of robotic systems for casework, this presentation will detail some of the post-validation pitfalls that exist, including maintaining calibration of the systems in manner suitable to pass an ISO audit.

Automation, Extraction, PCR Set-Up

B161 An Automated System for the High-Throughput Processing Of Differential Extraction Samples

Ryan J. Olson, BS, Cristopher A. Cowan, PhD, Melissa R. Schwandt, PhD, Curtis Knox, BS, and Douglas R. Storts, PhD, Promega Corporation, 2800 Woods Hollow Road, Madison, WI 53711*

After attending this presentation, attendees will understand the process by which the Differex™ system allows for the semi-automated separation of sexual assault samples into sperm and epithelial fractions using a liquid-handling robot.

This presentation will impact the forensic community by introducing a process that will allow numerous differential extractions to be performed in a single work day.

Differential extraction is the method by which spermatozoa are separated from epithelial cells present in sexual assault samples in preparation for STR amplification of the respective fractions. The technique in common usage employs a selective proteinase K lysis to liberate DNA from the epithelial cells of the sample while leaving the sperm heads intact. An initial centrifugation, following proteinase K digest, pellets sperm to the bottom of the digest tube. The supernatant is removed from the digest tube and retained for downstream processing as an epithelial fraction. The sperm pellet is subjected to a serial washing process to dilute and remove epithelial DNA-containing supernatant. The sperm pellet then undergoes a second digest step in the presence of dithiothreitol as a reducing agent to liberate sperm DNA for downstream processing as the sperm fraction. The core limitations of this commonly used method are: it is both time and labor intensive, it is low-throughput, and it produces a quality of result that can vary greatly from day-to-day or analyst-to-analyst.

The Automated Differex™ System combines Promega's Differex™ and DNA IQ™ system reagents in a novel pellet-capping process which allows for high-throughput, semi-automated differential extraction of sexual assault samples. Following proteinase-K digest, the starting point for Automated Differex™ separation is a plate of sperm pellets and epithelial digest supernatants resulting from centrifugation in a SlicPrep96® apparatus. Automated Differex™ uses DNA IQ™ Resin paramagnetic particles as part of a pellet-capping process to restrain sperm bodies allowing for supernatant manipulation without pellet disruption. After washing, Differex™ Separation Solution is used to float the majority of residual epithelial DNA-containing wash buffer away from the pellet for removal without disturbing the pellet itself. A dithiothreitol sperm-lysis step liberates sperm DNA from the pellet. Sperm and epithelial fractions of each sample then undergo automated nucleic acid isolation using the DNA IQ™ System.

The Automated Differex technology's pellet-capping process allows for the uniform and high-throughput processing of differential extraction separations. The incorporation of DNA IQ™ technology into Automated Differex™ provides high-quality nucleic acid purification from both sperm and epithelial fractions. Methods for the Automated Differex™ System will be available for the Beckman Coulter™ Biomek®2000 and Biomek®3000 Laboratory Automation Workstations, as well as for the Tecan Freedom EVO® Workstation. The coupling of Automated Differex™ separation and DNA IQ™ nucleic acid

purification methods will allow analysts to go from sexual assault sample to purified fraction eluates in less than 3 hours for 8 samples, and in less than 5 hours for 48 samples. Detailed descriptions of the automated methodologies will be presented. Data will also be presented demonstrating the Automated Differex™ System's sensitivity and quality of separation using mock sexual assault samples comprising sub-microliter equivalents of semen in vaginal epithelial backgrounds.

Forensic Science, Differential Extraction, Automation

B162 Validation of HID Evolution™ System: Automation and Integration of Quantification and STR Analysis for High Throughput Sample Processing

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After attending this presentation, attendees will learn about a validated, automated work flow for DNA quantification, normalization and PCR set-up for STR analysis of forensic type samples. The automated work flow is applicable for low, medium, and high throughput casework laboratories.

This presentation will impact the forensic science community by demonstrating automation and integration of quantification, normalization and PCR set up for STR analysis.

Automation has become an important tool in meeting increasing workload needs and reducing turnaround time in the forensic laboratory while maintaining precise and accurate sample processing and minimizing the opportunity for errors. Optimized protocols have been developed with the HID EVOlution™ System to automate and integrate the quantification set-up and data with STR analysis. The HID EVOlution™ System will track and facilitate sample information and data transfer from the quantification, normalization and PCR set up steps and instrumentation eliminating the need for manual processing and calculations and repetitive data entry. The reagent and instrument configurations for the automated system include a Tecan Freedom EVO® 150 for liquid handling, the 7500 Real Time PCR System for DNA quantification with the Quantifiler® DNA quantification kits, the AmpFℓSTR® PCR Amplification kits with the GeneAmp® PCR System 9700 for STR amplification, and the 3130*xl* Genetic Analyzer for the detection of amplified STR fragments.

This presentation summarizes the work performed to optimize and validate the HID EVOlution™ System for DNA quantification and STR profiling using the Quantifiler® Human and Y DNA Quantification Kits and the AmpFℓSTR® PCR Amplification Kits e.g Identifiler®, Yfiler®, MiniFiler™, SGM Plus®, Profiler Plus®, COfiler®, and SEfiler™ kits. Reproducibility, accuracy and contamination studies were performed on forensic DNA sample extracts and included real-time PCR set up for DNA quantification, DNA extract normalization for sample specific, user defined input amounts, STR amplification reaction set up, and STR amplification products for analysis using capillary electrophoresis to confirm the liquid handling system is fit for purpose. HID EVOlution™ System provides an optimized and comprehensive solution to process forensic samples that will increase throughput, reduce turnaround time, streamline sample information and data transfer and minimize errors while maintaining the integrity of the samples.

Automated DNA Analysis, STR Analysis, DNA Quantification

B163 Integration of Robots, LIMS, and Software to Customize High Volume Sample Handling, Analysis, and Reporting

Kristen Hancock, BS, and Heather M. Cunningham, MS, Bode Technology, 10430 Furnace Road, Suite 107, Lorton, VA 22079; Christopher A. Cave, MS, Bode Technology, Via del Vignola 12 , Int 10, Roma, 00196, ITALY; Stephen Stafford, BS, David Leonard III, BS, Tisha Moss, BS, and James W. Schumm, PhD, The Bode Technology Group, 10430 Furnace Road, Suite 107, Lorton, VA 22079*

After attending this presentation, attendees will better understand DNA analysis process improvement utilizing robotics, LIMS, and expert software.

This presentation will impact the forensic science community by minimizing analyst hands-on time per sample.

Creation and application of the CODIS national database has created an enormous demand for DNA profiling. Several new aspects of automation systems will be discussed that permitted the authors to accomplish analysis of more than 200,000 samples for more than twenty clients employing three primary extraction methods, three different quantification methods, and eight multiplex STR systems each with a diversity of client protocol and interpretation requirements.

The solution employs the following interactive components:

1) Trained analysts. In our environment, the trained analyst still performs numerous critical tasks and provides proper care in handling both sample material and data while interacting with and facilitating flow of the entire automated system.
2) LIMS. Internal LIMS development to support sample accessioning, inventory tracking, chain-of-custody, laboratory methods set up, and data reporting.
3) Robots. The Hamilton and other robotic platforms permit multiple functionalities and constant adaptation to system component upgrades (e.g., new extraction methods or new multiplex system requirements).
4) BodeChecks. This software solution uses information technology to combine key features of GeneMapper, FSS-i^3, our internal LIMS, and our internally developed connective and analytical software to provide a high quality data evaluation and simplified data presentation for analysis.

All of this has been created to provide the highest quality data, the lowest potential for sample mix up or contamination, the most efficient means of sample analysis, simplified organization and generation of data files, minimization of transcription errors, and the greatest confidence in the reported result. Each of the items indicated above, and the interactive nature of the system, will be discussed. This effort is a work in progress, but provides scalability to support evaluation of millions of samples annually and the flexibility to import new methods and procedures as they are developed internally or become available from outside the system.

Automation, Expert System, LIMS

B164 GeneMapper® ID-X Software v1.0: Expert System and Next Generation Forensic Data Analysis Software for Casework Samples

Lisa M. Calandro, MPH, Jaime Handelsman, BHS, Thomas McElroy, BS, Nicola Oldroyd, BS, and Ravi Gupta, MS, Applied Biosystems, 850 Lincoln Centre Drive, Foster City, CA 94404*

After attending this presentation, forensic analysts will gain an understanding of how the GeneMapper® ID-X software can be used to increase the efficiency of data analysis in their laboratory resulting in improvements to overall sample analysis throughput. Attendees will also hear about new tools designed to streamline the analysis of casework evidence samples and tracking of electronic data.

This presentation will impact the forensic science community by outlining a new software workflow and demonstrate how new tools within the GeneMapper® ID-X Software help to alleviate a significant bottleneck in the DNA analysis process thereby increasing overall DNA laboratory throughput.

With the introduction of automation and other new technologies, the bottleneck in the forensic DNA analysis process has shifted to data analysis. GeneMapper® *ID-X* Software v1.0 is designed to allow forensic analysts the ability to analyze and interpret data in less time and with fewer steps. This is accomplished through the implementation of more intuitive data analysis tools, such as an analysis summary, new and enhanced quality values, improved plot displays and label editing options, automated sample-to-sample comparisons and customizable reporting options. In addition, GeneMapper® *ID-X* Software v1.0 incorporates comprehensive security and auditing functionality to maintain electronic data chain of custody. We will demonstrate how this new functionality allows laboratory administrators and/or technical leaders to control the ability to make changes to analysis methods and track any changes made within the software. In addition, access to specific data may also be controlled within the software. Laboratories may choose to use the software as an expert system, a traditional manual data analysis tool or both.

The presentation will demonstrate how the new functionality is incorporated into a logical software workflow that rapidly identifies problematic samples and draws the user's attention to the individual markers and peaks that require further investigation. An analysis summary is automatically displayed allowing users to choose to view only those samples that triggered one or more quality value flags or they may choose to view all samples. The enhanced plot displays and label editing options aid in interpretation of artifacts and enable electronic peer/technical review. The profile comparison tool quickly identifies potential contributors to sample profiles within the project as well as provides a mechanism to run blind quality control sample checks. Having the ability to customize reports allows labs to better integrate exported files with their existing LIMS and/or other downstream applications.

GeneMapper® ID-X Software, DNA Data Analysis, Laboratory Workflow

B165 Combining FSS-I^3 Software With New Analytical Capabilities

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After attending this presentation, participants will understand a new analytical approach that combines the processing strengths of the FSS i-cubed Software in order to increase the efficiency of data analysis and reporting in our laboratory.

This presentation will impact the forensic science community by demonstrating how large and diverse workloads require new reliable and efficient approaches to data analysis and reporting.

The rise in use of STR multiplex systems over the last fifteen years and the growth of the CODIS national database in the last ten has provided a fantastic tool for law enforcement through the use of DNA. At the same time, the number of samples requiring analysis, the diversity of sample sources, and analytical methods available to create and report profiles has increased significantly. This laboratory alone will create approximately 200,000 DNA profiles this year for numerous institutions that provide a diverse sample types, different requirements for extraction, quantification, and STR multiplex systems. This large diverse work load requires new and efficient approaches to analysis and data reporting.

Several computer software systems have provided new tools for forensic data review. The FSS i^3 software offers great advantage in correctly calling DNA profiles without human intervention. However, significant human time and effort results from the necessity to review GeneMapper profiles for samples that the FSS i^3 software puts into an unresolved "to be reviewed" category without definitive calls. It was found that the same criteria were being used repeatedly to call most of these unresolved samples.

To minimize the data analysis required to accomplish our analytical goals, we have combined the most valuable data and processing strengths of FSS i^3 software with our internally developed add-on analytical programming. This combined artificial intelligence works through our LIMS and provides additional characterization of FSS i^3 output more in line with our diverse analytical requirements and adapts output to the terminology used by our analysts. To summarize, the BodeChecks software solution accomplishes the following tasks with almost no human effort.

- Greater than 99.8% correct allele calls.
- Correct allele calls in circumstances that FSS i^3 provides uncertainty.
- Increased concordance (compared with GeneMapper ID or FSS i^3) between analyst and software conclusions.
- More refined description of reasons for failed samples.
- Unification of BodeChecks rejection code language with that of the Analysts.
- Automated determination of reprocessing pathways for failed samples.
- Significantly decreased analysis time.

No review of GeneMapper ID electropherograms or FSS i^3 "spikograms" is required. How this is accomplished will be described, show how it increases quality checks in our work, and compare allele determination performance versus GeneMapper ID and FSS i^3 software.

Expert System, FSS I-Cubed, LIMS

B166 The Discrimination of Colored Acrylic, Cotton, and Wool Fibers Using Raman Spectroscopy

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After having attended this presentation, attendees will understand the advantages and limitations of Raman spectroscopy for the analysis of one of the most common mass produced items of forensic interest—textile fibers.

This presentation will impact the forensic science community by showing the application of one of the analytical methods that in the last years has created a remarkable interest in forensic laboratories. This technique is Raman spectroscopy.

This work concerns the application of one of the analytical methods that in the last years has created a remarkable interest in forensic laboratories. This technique is Raman spectroscopy.

Such a method has been recently revaluated for its application in forensic science for the chemical analysis of several types of materials. The Raman technique allows for the measurement of the inelastic scattering of light due to the vibrational modes of a molecule when irradiated by an intense monochromatic source such as a laser. The Raman technique presents enormous advantages, including its non-destructive nature, its short analysis time, and the possibility of performing microscopic *in situ* analyses. In its forensic application, it is a versatile technique that covers a wide spectrum of samples such as explosives, hazardous materials, drugs of abuse, trace evidence, and inks.

The potential of the Raman technique was demonstrated in the analysis of textile fibers too. Raman spectroscopy allows for the detection of dyes used in the coloration of such samples.

In this project, 180 samples were randomly collected: 60 acrylics (20 blue, 20 red, and 20 black), 60 cotton (20 blue, 20 red, and 20 black), and 60 wool samples (20 blue, 20 red, and 20 black). Four laser excitation sources were tested: argon ion laser at 514 nm, helium-neon at 633 nm, and two near infrared (NIR) diode array lasers at 785 and 830 nm. The advantage of using several laser wavelengths was also emphasized in the forensic Raman analysis of fibers. Several aspects were investigated according to the best analytical conditions for every type/color fiber combination. The results show that NIR lasers provide better results for acrylic fibers (all colors) and for red cottons and wools and blue laser (514 nm) is more adapted for blue and black cotton and wool. It was also observed that some lasers were inefficient for some fiber classes (e.g., He-Ne for acrylics and Argon for red fibers). Interference from the support (due to the fiber type) was not observed for acrylics, and only the information about the dyes was detected. On the other hand, for few cotton and wool samples, Raman bands attributed to cellulose and keratin respectively were observed. They did not hide the information attributed to the fiber dyes. The information about the fiber dye was systematically observed.

In this project, particular attention was placed on the discriminating power of the technique. Based on the results from the Raman analysis, it was possible to obtain different classes of fibers according to the general shape of spectra, but particularly, on the basis of additional bands. Raman spectroscopy was not considered as an isolated technique but rather as a step in the conventional analytical scheme for textile fibers. Thus, in order to optimize the analytical sequence, it was determined at which stage Raman spectroscopy should be integrated and under which conditions. For this purpose, the collected samples were also analyzed by light microscopy (bright field, double polarization, and fluorescence), UV-UV-Vis microspectrophotometry (MSP) and thin layer chromatography (TLC). This research showed that Raman spectroscopy plays an important role in the detection and identification of the main dyes used for the impregnation of fibers. UV-Vis microspectrophotometry showed the best discriminations for every type of analyzed fibers, while in some cases, the Raman technique allowed for further discriminations after MSP. In terms of discriminations, Raman spectroscopy was affected by two main factors. The first was fluorescence, and the second was the fact that some spectra configurations occurred frequently and thus the variation in a given set of 20 samples was low. Given the potential of Raman spectroscopy for identification purposes, the realization of an extended spectral library of reference dyes is an ambitious but useful aim from an operational perspective.

Trace Evidence, Raman Spectroscopy, Fibers

B167 Fabric Frequency in Relation to Child Abduction Cases

Samantha L. Huffman, BS, BA, and Robin T. Bowen, MA, Forensic Science Initiative, Oglebay Hall, PO Box 6217, Morgantown, WV 26506-6217*

The goal of this presentation is to present the forensic community with an example of how fabric frequency distribution among children relates to evidence in child abduction cases.

This research will impact the forensic science community by enabling the forensic science community to observe patterns in fiber type and content frequency among various ages of children.

This paper will describe the collection, comparison, and correlations between studies regarding fabric frequency and child abduction case information. Due to the increased awareness of child abduction cases, the study was conducted to determine if there was a relationship between the evidence found in such cases and the fabric frequency of children's clothing items. The clothing size range focus was from newborn to children's 16. Information was collected based on the Uniform Crime Reports, FBI kidnapping statistics, and Amber Alert statistics to determine the primary targeted age groups. This paper is building off of the processes outlined in the 2005 report *Fabric Frequency* by R. Stoehr and M.M. Houck.

This data was collected to observe the totality of each garment type, fiber type, and percentage. A variety of garment types (*i.e. shirts, sweaters, sleepwear, pants, etc.*) were available to choose from when examining fabric content. Five children's clothing departments/stores were surveyed for item type, fiber content, and percentage of each fiber type. The clothing stores surveyed ranged from specialty boutiques up to large mass produced superstores. A standard form was used to describe each garment by type, season, size, gender, primary color, and fiber composition. In addition, special features such as flame retardant finishes were noted. If unusual fabrics or fiber combinations were found, the item was collected for microscopic examination. Collected items were observed under 40X objective polarized light microscope and images were captured for reference. Information gathered was useful in the comparison of prior studies which involved child abduction cases.

The data collected was compared using information compiled from previous studies as mentioned. Studies were referenced for information regarding garment type frequency among children, fabric frequency, primary evidence found in child abduction cases, and the prevalence/demographics of child abduction cases. The Uniform Crime Report and the National Crime Information Center's Missing Person File, published by the Federal Bureau of Investigation, provide demographics of abduction cases such as juvenile missing persons. This information aided in narrowing the data collected in this study to focus upon the frequency of fabric components in children's clothing.

This research will enable the forensic science community to observe patterns in fiber type and content frequency among various ages

of children. This data will answer questions such as which fibers are more prevalent than others? Which fibers are rare? Are these fibers rare, or just not as common within this particular population? By looking into such population studies, forensic scientists will gain information unique to this age group. Observing the information provided by children's clothing gives researchers a targeted population to study when gathering information regarding child abduction cases.

Child Abduction, Fiber Analysis, Fabric Content

B168 Determination of Entry and Exit Bullet Holes in Garments Using Light Microscopy

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The goal of this presentation is to highlight the different morphology between an entry and an exit bullet hole in a garment.

The presentation will impact the forensic community by providing information to microscopically distinguish between entry and exit bullet holes, allowing more accurate conclusions for shooting scene reconstructions.

The direction from which a bullet originates is often an important factor in crime scene reconstruction. When the muzzle-to-target distance exceeds two to three feet, the deposition of gunshot residue may be difficult to detect. For distances beyond a few feet, lead wipe is often tested for by the use of sodium rhodizonate. Unjacketed lead bullets commonly deposit lead wipe. For jacketed bullets, lead wipe, if present, may only result from primer residues acquired by the bullet's passage down the barrel. Occasional mishandling of the garment, lubricants in the barrel or the use of lead-free ammunition can result in lead wipe not being found.

A careful examination of the garment using light microscopy can reveal differences in the morphology of entry vs. exit bullet holes. This information may assist in the reconstruction of the shooting incident, and lead to a more timely and accurate resolution of the incident.

The experiments were conducted on garments made from synthetic fibers. The polyester garment was cut to fit both sides of the tissue simulation medium, which was approximately six to eight inches thick. This is designed to simulate a human clothed in the garment, and subsequently sustaining a perforating bullet wound through fleshy tissue. The bullet's velocity was determined on both sides of the tissue simulation medium using two identical chronographs, documenting both the initial velocity near the muzzle of the firearm and the velocity loss after traveling through the medium draped with the test garment. A "witness panel", consisting of a taught sheet of brown bench paper supported by a frame, was placed between the test garment and the chronograph on the exit side to determine whether the bullet was in a condition of stabilized or destabilized flight.

After shooting, the garments were examined with a stereomicroscope to determine the different morphologies of the bullet holes. Photomicrographs were taken for comparison purposes.

Entry Bullet Holes, Exit Bullet Holes, Light Microscopy

B169 Gunpowder Particle and Vaporous Lead Deposit Patterns on Fabric From Hand Gun Discharges II

Kay M. Sweeney, BS, KMS Forensics, Inc., PO Box 8580, Kirkland, WA 98034*

After attending this presentation, attendees will learn about the deposit patterns for gunpowder particles and vaporous lead when selected handguns are fired into clothing fabrics using different ammunition and at different distances.

This presentation will impact the forensic community by demonstrating that the collection/manipulation history of clothing exhibiting gunshot defects seized as evidence during shooting scene investigations is extremely important in determining muzzle to target distances.

Clothing items with bullets holes and gunpowder deposits as recovered from shooting homicide victims can be carefully evaluated for their collection/manipulation history, gunpowder particle deposit patterns and vaporous lead deposits and thereby provide a valuable foundation for muzzle to target distance determinations.

Gunpowder particle deposit patterns on clothing fabrics, particularly in the region of a bullet penetration defect, provide interpretive opportunities for forensic scientists interested in establishing an intervening distance measurement between the discharging firearm and the target clothing fabric. The same can be said for vaporous lead deposit patterns. This presentation reports on the results of testing conducted thus far involving a second 9mm semi-automatic pistol with a 5.25 inch barrel and a selected .40 S&W caliber semi-automatic pistol

In order to establish baseline information relating to the source of lead in gunpowder particle deposit patterns on clothing the gunpowder, jacketed bullet and cartridge case of one round representing each of the ten manufacturers were tested using x-ray fluorescence spectrophotometry, (XRF). All gun powders were found to contain lead ranging from 25 ppm to 180 ppm.

Then, one manufacturer's specific cartridge design was used in the 9mm pistol and the .40 S&W caliber pistol to fire into white 100% cotton t-shirt fabric at muzzle to target distances of 4", 6", 8", 10", 12", 14", 16", 20", 24", 30", 36", 42", 48", and 54". A template of concentric circles drawn at one inch, two inches, three inches, and four inches from the center point was prepared on clear Mylar sheet stock and this was used as an overlay on top of the test fire panels with the center point placed dead center on the bullet defect in the panels. The circles were scribed into quarters and during microscopic examination, counts for gunpowder particle deposits were made in one quarter of the circle.

The counts, for purposes of this presentation, are reported in three ways. One unit used is the number of gunpowder particles counted in a particular quarter circle area. The gunpowder particle count for the area ranging from the circle center point out to the quarter arc at one inch from the circle center is recorded as the "First Order Quarter-Circle Gunpowder Particle Count" and the number for the "Second Order Quarter-Circle Gunpowder Particle Count" is the number of gunpowder particles counted in the quarter of circle area ranging from the circle center point out to the quarter arc at two inches from the circle center, and so on. Another unit used is the calculated density of gunpowder particles in a particular designated quarter of a circle area and that figure is recorded using the appropriate quarter-circle reference as "First Order Quarter-Circle Density", "Second Order Quarter-Circle Density" and so on. The third unit is the gunpowder particle count for a particular "Quarter-Arc Band" in which gunpowder particle deposits were found. For instance, the "First Order Quarter-Arc Band" is the same space as that designated by the "First Order Quarter-Circle" area and the "Second Order Quarter-Arc Band" is the area between the quarter circle perimeter at one inch from the bullet penetration center and the quarter circle perimeter at two inches from the bullet penetration center, and so on.

Gunpowder particles were found on the test panels out to a muzzle to target firing distance of 54 inches.

Generally, gun powder particle deposit counts for the second 9mm pistol, with the 5.25 inch barrel, were less than for the previously reported counts for the 9mm pistol, with the 4⅞ inch barrel, in the First Order Quarter Circle Band area with considerably lower values at the shorter shooting ranges. The lower values for the shorter distances may be due to muzzle gas turbulence induced by higher interior barrel pressures for the slightly longer barrel length. Another contributing factor is the longer burn time allowed by the longer barrel length and therefore fewer and/or smaller surviving gun powder particles at the time of muzzle exit by the fired bullet.

Finally, using the .40 S&W caliber pistol, one each of the twenty nine rounds representing varying cartridge configurations of the thirteen brands were fired into white, 100% cotton t-shirt fabric from a consistent muzzle to target distance of 10 inches. Gunpowder particle deposit counts were tabulated for the various orders of "Quarter-Circle" and "Quarter-Arc Band" areas.

Clothing items with bullets holes and gunpowder deposits as recovered from shooting homicide victims can be examined and analyzed for their gunpowder particle deposit patterns and vaporous lead deposits for the purpose of muzzle to target distance determinations, however in doing so one must make every effort to establish gun powder particle counts out to at least the 4th order in short distances, (from 2 to 14 inches in muzzle to target distances) and out to at least the 5th order in the longer distance shots.

Gunpowder Patterns, Vaporous Lead, Primer Smoke

B170 Trace Evidence as Highly Probative Associative Evidence

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The goal of this presentation is to stimulate thinking and discussion about value and universality of trace evidence.

By stimulating thinking and discussion about the value of trace evidence, this presentation will impact the forensic science community by providing a wider appreciation of trace evidence so that it can be used more widely and effectively to assure the use of dispassionate science in the resolution of criminal and civil matters.

The term trace evidence is used to encompass and describe an extraordinarily broad category of physical evidence. An unrivaled breadth of applicability accompanies this extraordinary breadth of evidence types. In fact, no other evidence category can even approach trace evidence in this regard. In spite of its great potential, trace evidence is underappreciated, misunderstood, and grossly underutilized. The reasons for this disparity are varied and manifold. Prominent among these are the complexity of trace evidence casework, the difficulty in understanding it, the perception that trace evidence analyses are not cost-effective, and the difficulty of becoming an accomplished trace evidence scientist. All of this has led to a reduction in the allocation of resources relative to that for more easily understood evidence types.

Trace evidence is often viewed too narrowly as being comprised exclusively of discrete microscopic evidence types, such as hairs and fibers. This is shortsighted. More generally, trace evidence can be anything that is produced as the result of an interaction among physical entities. Material may be transferred or altered, and/or a useful pattern may be produced. The permutations are innumerable. Information concerning details of the interaction(s) is encoded in the process of producing the resulting physical evidence record. Decoding the information by an experienced trace evidence scientist or criminalist can lead to an understanding of the event of concern. In this way trace evidence can provide answers to the interrogatives *what*, *how*, *when*, *where*, and *why* as well as *who* (e.g., what happened? how did it happen? etc.). In many case contexts, this can make it far more valuable and versatile than associative evidence that is viewed as only addressing the question *who*? It is important that this broader application and contribution of trace evidence be understood. However, along with this there should be an increased awareness of the potential of trace evidence as extraordinarily powerful associative evidence. Case examples will be used to illustrate the point.

Trace Evidence, Associative Evidence, Individualization

B171 Human Hair Comparisons: Evaluation Rationale and the Role of Subjective Probability

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The paper discusses the evaluation rationale for microscopy of hairs and the role of subjective probability that may withstand the scrutiny and testing of adversarial process.

Extensive research is required, through modern techniques, to gain a better understanding of the qualitative and quantitative aspect of hair individualization.

Human hair comparisons have been an underrated science in the forensic community for some time. This mode of thinking and trend needs to be changed. In science, truth does not gain acceptance by mere repetition of a set of facts.

Science rather requires patient testing of the facts, the constant re-examination and critical re-appraisal of premises and assumptions, repeating of earlier studies by more modern, better controlled and better standardized methods. This paper discusses these issues and amenability of this subject to empirical testing, the inherent difficulty in studying the phenomenon, and evaluation rationale for microscopy of hairs that may withstand the scrutiny and testing of adversarial process. The role of subjective probability in this context is discussed.

The theories and principles on which microscopic hair comparison is grounded are multi-disciplinary, and draw from such diverse fields as comparative anatomy, physical anthropology, human genetics, human biology, somatometry, somatoscopy, as well as such well established areas as probability theory, pattern recognition, similitude, and lately computer sciences. Although there is an apparent scarcity of scientific studies in forensic hair comparison, the field is a confluence of many discrete, well grounded and previously unrelated disciplines that are expressed in the common language of hair comparison and analysis.

The majority of this multi-disciplinary community has found the principles upon which microscopic hair comparison analysis rests, to be reliable and generally accepted although to some extent subjective in nature. The statements of probability currently offered by hair examiners are qualitative in nature rather than quantitative and are based on a combination of scientific judgment and data analysis. This approach, being void of statistical base, is considered subjective in nature. There is, however, considerable merit in the use of this approach. Arguments has been presented to the effect that it is the mental conclusion of the scientist drawn in the light of experience coupled with the discovered or associated factual distinctions which lead to a conclusion of identification. There is much evidence, relevant, material and admissible, which does not meet the mathematical probability test. There is some physical evidence concerning which the expert will not and should not express an opinion based purely on mathematical probability. Yet, such evidence is logically relevant, and probative. The critics of this approach validly claim that over-reliance on undifferentiated experience does indeed relegate the opinions of testifying experts to "Because I said so" pitfall. Experience is not an adequate substitute for empirical data. Yet, experiences are, to a large extent, essential first steps in the growth of knowledge.

Courts that recently made a distinction between "scientific knowledge" of Fed.R. Evid.702 and turned to "non-scientific" evidence linked to some body of " specialized knowledge" under Rule 702, make a fundamental error in dividing the world into science and specialty categories. Every expert who appears in court has specialized knowledge of one type or another. It could be specialized knowledge based on well established applied sciences, or it may be specialized knowledge based upon years of personal experience, and more often a combination of both. The consequence of this logical view of inference overwhelmingly points to the premise that forensic hair comparison is an effective and harmonious union of "scientific knowledge" and "specialized knowledge" rather than "non-scientific evidence" linked to some body of "specialized knowledge."

Forensic Hair Comparisons, Evaluation Rationale, Subjective Probability

B172 Postmortem Root Banding of Hairs: Their Microscopic Appearance and the Continued Importance of Hair Evidence

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The goal of this presentation is to provide microscopists with reliable information as to what postmortem root banding looks like, when it starts to appear on hairs and under what weather conditions. In addition, this presentation will show that the use of microscopical examination of hairs can provide valuable evidence and investigative leads beyond the comparisons that have come under such scrutiny in recent years and should therefore not be eliminated from a laboratory.

This study will impact the forensic community by providing guidance on what post mortem root banding looks like at various stages. Learning the stages of decomposition in hairs and what can legitimately be stated versus what qualifying factors should be acknowledged will lead to a greater understanding of conclusions of degradation versus decomposition.

Microscopic examinations of hair have shown that not only are well trained microscopists able to differentiate hairs between individuals, but they are able to provide lead value to investigators as well as substantive information as to whether or not a hair is consistent with the hairs in a known sample collected from a victim or suspect. Whether a hair has been forcibly removed or naturally shed, if the hair is artificially treated and if there are any indications that a hair could have come from a decomposing body through the presence of the postmortem root band is all valuable information that may add value to evidence or corroborate other evidence in court. This study was an attempt to provide information to hair microscopists as to when the post mortem root banding starts to appear on human hairs. The microscopical examinations were done in the FBI Laboratory from samples collected by graduate students in the Anthropology Department at the University of Tennessee. Hairs were collected daily from bodies donated to the Forensic Anthropology Facility from five different areas of the head over a period of several months. Information such as the temperature, cloud cover, precipitation, and wind were recorded daily along with the basic information as to age, sex and ancestry.

Attendees will learn what the stages of the postmortem root banding look like, when it starts appearing, when a majority of the hair samples have the banding pattern and what impact factors such as weather and body placement may have on development of the postmortem root banding.

Hairs, Postmortem, Root Banding

B173 Forensic Use of Hair Pigmentation Gene SNPs to Predict an Individual's Hair Color

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After attending this presentation, attendees will become familiar with genetic methods that may be useful for predicting hair pigmentation. Attendees will receive a basic overview of the genetics of hair pigmentation, and how this knowledge is useful in forensics. The effectiveness of SNP analysis in predicting human hair pigmentation will be discussed.

This presentation will impact the forensic community by increasing the understanding of pigmentation genes, and detailing a forensic assay for inferring an individual's hair coloration. Such data could be quite useful in a legal investigation.

In the absence of video or witness identification, DNA-predicted hair pigmentation may be used to help create a physical profile of an offender and aid in police investigations. Additionally, it could be useful in developing a physical profile of remains that cannot be identified through conventional means. As of May 2007, DNA profiles generated from crime scene evidence reached a total of 177,870 in the National DNA Index System Forensic Index,[1] and CODIS had over 49,400 hits.[2] According to The 2004 Bureau of Justice Statistics' Census of Medical Examiner and Coroners' Offices, approximately 4,400 unidentified human decedents are discovered every year, about 1,000 of which remain unidentified.[3] In both instances a lack of reference DNA poses a limitation to successful identification. To circumvent this, DNA analyses that do not require reference samples may be extremely useful. The analysis of genetic loci that produce obvious phenotypic differences among individuals has the potential to directly aid in identification. Among these, single nucleotide polymorphisms, or SNPs, in conjunction with population allele frequencies, can allow for inferences of physical characteristics of an individual. These can be summarized to produce a physical profile or "fuzzy photo" of an unidentified individual. Furthermore, SNP analysis can be carried out using short amplicons to aid in the genotyping of degraded DNA, and can be conducted using high throughput techniques, making it well suited for automation and databasing.[4]

This presentation will discuss the forensic use of SNPs to predict hair color based on several genes that contribute to pigmentation. The pigment melanin determines the natural color of skin, irises and hair in humans. Melanin is synthesized and packaged into granules called melanosomes. The degree of pigmentation depends on the type of melanin and the size, shape and density of melanosomes.[5] Many genes influence the melanin synthesis pathway, and thus human pigmentation. There has been recent research into the genetics of hair pigmentation, but little on the predictive value of a genotype in deducing an individual's hair color. Strong correlations between skin, eye, and/or hair color and the SNPs examined are known to exist; therefore genotypes of each SNP are expected to correlate with hair pigmentation.

Eight SNPs located in three different pigmentation genes (*SLC24A5, SLC45A2* and *MATP*) were selected for study. DNA samples were collected, along with data on background characteristics (including hair pigmentation measurements) and ancestry informative markers. A multiplex SNP primer extension assay was developed and optimized to carry out the genotyping, and the samples were analyzed for the SNPs of interest. Using an admixture mapping approach, the genotypes were tested for linkage to hair pigmentation. A model for predicting hair pigmentation from the eight SNPs studied was designed.

The proposed model was then used to predict hair pigmentation for an additional set of samples, which were assayed blind. The results were compared to the individuals' original hair color descriptions and pigmentation measurements and the accuracy of the eight SNPs in predicting hair pigmentation was determined. The effectiveness of the SNPs individually and collectively in predicting hair pigmentation will be discussed.

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Hair Pigmentation, SNP, DNA

B174 Compilation of Human Hair Characteristics

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The goal of this presentation is to present the forensic community with an example of obtaining and compiling microscopical human hair characteristics.

This research will impact the forensic science community by providing a new methodology to referencing human hair characteristics.

This paper will present the work done by the author of the Australian Federal Police, in conjunction with the Scientific Working Group on Materials Analysis (SWGMAT) Expert Hair Panel. The panel was organized to provide resources and research in forensic hair examination leading to best laboratory and interpretive practices.

It was determined that a common reference database would be useful for examiners to use when microscopically examining human hairs. Currently, a similar animal hair database was deemed as less useful. The focus of the database surrounds pattern classification, matching, and color analysis. Forensic scientists should make use of a limited palette when describing the color of an item of evidence. Color may be attributed to an object in both subjective and objective manners using the Munsell or CIE Lab color coordinates. Common hair features, as described by SWGMAT and the Expert Hair Panel, are used as the descriptive search tools. Hairs will not be linked to individuals and the information provided omits descriptors of race, sex, and ethnicity.

In preparation for creating such a database, many techniques were tested in order to provide the highest quality image possible. Digital imaging and traditional microscopy techniques were tested with relation to developing numerical features for forensic hair examination. A combination of comparison microscopes, digital cameras, and software packages were utilized during this process. Once the optimal setup was achieved, image manipulation software was chosen based on the extraction techniques and results as opposed to the ability to actually *change* an image.

An important aspect of the methods used was consistency. Some constant factors include automatic exposure, white balance, optimizing by precision as opposed to speed, and use of oil immersion lenses. Another important feature is the use of image analysis as opposed to image *enhancement.* Photo montaging was the process used to achieve quality layered images. This process helps to eliminate background noise from the images. Eliminating the background allows the focus to be on the hair, color, and the specific characteristics.

This research provides the forensic science community with a new methodology to referencing human hair characteristics. The databases of common hair features and specific human hair characteristics will serve examiners in practice by providing a visual reference. As the database develops, it will allow practitioners to add images using a specific protocol that serve as useful visual references. Such a database will provide a visual standard of what we are looking for in terms of hair examinations and specific characteristics.

Microscopy, Human Hair, Reference Databases

B175 Hydrogen and Oxygen Isotope Ratios in Human Hair are Related to Geography

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The goal of this presentation is to introduce a new technology to law enforcement that can assist in tracing origins of murder victims.

This presentation will impact the forensic science community by demonstrating how applications are extensive and include reconstructing historic movements of individuals and providing region-of-origin information for unidentified human remains.

Here a model to predict the geographic region-of-origin of humans based on the stable isotope composition of their scalp hair is presentede. This model incorporates hydrogen and oxygen atoms in amino acids to predict the hydrogen and oxygen isotope ratio values of scalp hair. Model predictions with stable isotope analyses of human hair from a range of cities across the U.S.A were evaluated. The model explained more than 85% of the observed variation. Based on the geographical distributions of the isotope ratios of tap waters, maps were constructed of the expected average hydrogen and oxygen isotope ratios in human hair across the contiguous 48 states of the U.S.A. These maps revealed discernable regions across which stable isotope values of human hair were isotopically distinct. Possible applications are extensive and include reconstructing historic movements of individuals and providing region-of-origin information for unidentified human remains.

Stable Isotope, Human, Geography

B176 A Comparison of the Multivariate Likelihood Ratio (LR) Method and the Confidence Interval Method in Practice: Forensic Glass Analysis Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS)

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After attending this presentation, attendees will learn about the application of likelihood ratios in multivariate comparisons.

This presentation will impact the forensic science community by determining the evidential value by a Bayesian approach.

For the forensic analysis of float-glass a method using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is in use at the NFI. The concentrations of ten elements in small glass fragments are measured with this method. Previously the method was validated[1, 2] and accredited by the Dutch accreditation council. An important question is how to evaluate the results as evidence that glass samples originate from the same or from different sources.

Currently the comparison of glass particles is done by using confidence intervals. Overlaps in confidence intervals for each of the ten elements are evaluated. The number of overlaps is used as a measure of similarity or difference between the samples. Based on a validation with known float-glass samples matching criteria have been defined to conclude whether glass fragments originate from the same source. However, this method has some disadvantages. First of all, the comparisons are univariate and therefore possible correlations between the concentrations of some elements are not taken into account. Secondly, small differences in the confidence intervals can result in a match or non-match, the well-known 'fall-off-the-cliff' effect. Finally, population data i.e., the relative frequency of occurrence of the glass composition could not be incorporated.

An alternative method which does not have these disadvantages is based on a Bayesian approach. In this study the use of multivariate Likelihood Ratio's (LR) as proposed by Aitken & Lucy[3] is evaluated. For the calculations a program written in R, based on Lucy's work, was applied. The underlying database consisted of 203 known float glass samples measured by LA-ICP-MS (10 elements). A multivariate kernel density estimate was used for the between-source variability and a multivariate normal distribution for the within-source variability.

To investigate the Likelihood Ratio method a series of simulations and validations have been undertaken. The results of the multivariate LR calculations are compared with the conclusions obtained from the confidence interval method. It appears that both type I errors (false negatives) as well as type II errors (false positives) are lower for the LR method. For glass fragments originating from a single source often very large likelihood ratio's are calculated . This reflects the high evidential value that potentially can be obtained from LA-ICP-MS measurements on glass.

For the time being both the Bayesian approach as well as the confidence interval method will be run in parallel to gain more experience. Also the glass database will be expanded to improve the accuracy of the calculations.

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Likelihood Ratio, Glass, LA-ICP-MS

C1 480 Volt Downed Electrical Power Line Causes Multiple Human Electrocutions (Including a Dog) in a Puddle – A Tropical Storm in Florida, Vegetation Management, and the Electrical Power Circuit Configuration and Characteristics Were All Factors in the Incident

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The goals of this presentation are to study the effects of poor vegetation management on overhead electrical power lines, and phenomena associated with power lines breaking. Also included is a technical study of the electrical power system configuration impact on hazardous ground fault currents. Methodology for investigation of a downed power line incident scene and examination of the evidence will also be discussed.

This presentation will impact the forensic science community by studying the cause of downed power lines allows electrical power utilities to better manage and allocate resources to prevent future occurrences. The methodology is also important to assist the forensic investigator. Proper electrical circuit configurations and protection may prevent lines from remaining energized once on the ground.

A tropical storm blanketed Florida with severe winds and rain in the fall of 1999. The storm carried winds of approximately 70 mph.

An incident occurred at a residential "T" intersection. A mother, her two boys, a friend, and a dog were out taking a walk after the storm had passed. Everyone except the mother was in bare feet since the weather was warm. The boys and the dog walked through a large puddle of water approximately 3 inches deep at the intersection. The three were electrocuted, including the dog. An overhead 480 volt street lighting power line had fallen into the puddle. The mother tried to go into the puddle to save the boys and also succumbed to electrocution.

The overhead power line was used exclusively for the 480 Volt street lighting system. The 480 Volt circuit originated from a 7200 volt, 25 kVA transformer. The transformer was allegedly protected with a 15K fuse. The energized conductor was #4 AWG AAAC[1], located 1 foot above the 3/0 ACSR neutral conductor. There were a total of 43 or 52 street lights connected to this lateral circuit. The lights drew a load current of 1.16 amps each, and power of 400 watts at 480 Volts. The ampacity of the energized #4 AAAC conductor is 148 amps.

The line was suspended at either side of the intersection to concrete hydro poles with an assumed 1 foot of initial sag according to utility design. The high growing vegetation in the area below the line consisted of ficus trees. The ficus tree is considered a fast growing deciduous tree, which can grow at an average rate of 1.5-2 feet per year. Upon first examination of the scene, two ficus trees were noted to have been cut down to small hedges. There were reports that the two subject ficus trees were much larger and may have been growing into the power line prior to the accident.

The first inspection of the subject line was carried out in a long ballroom at a local hotel. This allowed easier manipulation of the 260 foot conductor. A special proprietary conductor inspection jig was used for this inspection. The jig facilitated inspection of every inch of the conductor with a zoom stereo microscope. The inspection revealed the following anomalies and insults:

- Corrosion
- Contamination
- Presence of Tree Bark
- Wear
- Significant Electrical Arcing Damage

The type of corrosion found was typical crevice and pitting corrosion. The contamination consisted of ficus matter on the conductor at various locations. Wearing had also occurred along strands at certain locations. The electrical arcing damage was extensive and occurred at many locations beyond those where the conductor was lying in the puddle; it had also caused strands of the line to sever in various locations. Each insult was recorded by means of a description, photograph, and measured location from the end of the line. After the inspection was completed, the insult locations were transferred to a rope model copy. The 3/0 ACSR neutral conductor was later examined using the same methodology when it became available.

The scene was then examined using the rope model which was laid between the two subject poles on the ground. This allowed one to determine the location of the various insults with respect to the scene and ficus trees. Most interesting was the location of contamination and electrical arcing damage at locations where the east ficus tree had been cut down to a hedge, and at locations where the subject west ficus tree existed at the wire fracture.

Electrical tests were carried out in our high voltage laboratory to gain an understanding of the conductivity of ficus branches at 480 Volts. The tests indicated (as expected) that insignificant currents conduct at 480 Volts along a ficus tree. There is also additional ground resistance through the ground and back to the source. The electrical arcing damage on the conductors could not have been caused from the line contacting the ficus tree.

After inspecting the 3/0 ACSR neutral conductor, an interesting discovery was made. The neutral conductor was found to have electrical arcing damage as well. The locations of the damage were matched to the locations on the energized #4 AAAC phase conductor. It was then determined that the neutral conductor must have contacted the phase conductor at some point. It was determined that this contact was likely from the ficus tree growing and pushing the neutral conductor into contact with the phase conductor at various locations during moments of high winds. Eventually the #4 AAAC energized conductor severed and fell to the ground. Unfortunately, it severed at a location which left the upstream section energized and lying in the large puddle. Further tests were conducted to obtain an understanding of the conductivity of the energized conductor in various solutions of storm water and other mixtures which included grass fertilizer. The ground fault current from the live conductor in the puddle was eventually estimated by means of tests and calculations.

The ground fault current in water created a condition of dangerous step potential close to the conductor. Unfortunately the boys probably did not see the conductor under the water at night, and as they approached lost control of their leg muscles causing them to fall forward facedown into the water. After falling, the voltage potential between head and foot led to electrocution.

In summary, this accident could have been avoided if the trees had been properly trimmed and maintained. In addition, the fuse used was 15K which was considerably higher than the 4K prescribed for this circuit. After careful analysis of the time-current curves of various fuses, and ground fault current calculations, it was determined that a 4 or 6 amp fuse may have been cleared the circuit prior to the family entering the puddle and the electrocutions may not have taken place. The utility and the estate have since settled this case.

Reference:

[1] All Aluminum Alloy Conductor.

Electrocution, Power Line, Storm

C2 Wild Fires of Electrical Origin

Helmut G. Brosz, PE, Brosz & Associates, 64 Bullock Drive, Markham, ON L3P 3P2, CANADA*

Upon completion of this presentation, participants will better understand the cause of a wild fire of electrical origin. Examples of replication will be shown.

This presentation will impact the forensic science community by showing the importance of forensic electrical engineering in the study of wild fires of electrical origin is essential in the litigation which invariably ensues.

Trees coming into contact with high voltage power lines can lead to power outages and pose a risk of ensuing wild fires. Vegetation contacting transmission lines was the contributing factor in a major power interruption resulting in the North-East blackout of 2003. In instances where tree contact causes fire in residential areas, the risk of property damage and potential fatalities is significantly increased. Vegetation management is an essential activity in order to reduce the risks.

This presentation will focus on the Cavedale fire of Glen Ellen, California, where a vegetation management company hired by a major utility neglected to trim certain trees in a timely manner which subsequently grew into power lines. The result was a fire that destroyed thousands of vineyard acres in wine country as well as some homes. Various experts often have opposing theories as to the cause & origin of wild fires.

Wild Fire, Electrical, Power Lines

C3 Development of Early Detection Approach of Dangerous Driver of Advanced Age and Dementia

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The goal of this presentation is to describe the re-education of a senior driver.

This presentation will impact the forensic science community by providing research that will be useful for establishment of the driving ability recovery approach for advanced age and dementia drivers.

In Japan, the rise in traffic accidents by advanced age and dementia drivers is a social problem, and relevant governmental agencies are seeking solutions to the crisis. Since the early detection of dementia is an advanced subject medically, it is also researched eagerly in medical institutions.

On the other hand, elderly people with a high dependence to a private car are increasing in number by the decrease of the public traffic by local decrease in population. When they are uniformly deprived of a driver's license, there is a danger of diminishing definite goals in life, resulting in decreasing quality of life and increasing the number of bedridden elderly people.

So, it is the object of this research to develop the approach of carrying out early detection of the high advanced age and dementia driver of possibility of causing a traffic accident, by the test which uses a driving simulator (DS) and a driving recorder. As a result, it will become possible to determine a superior senior driver and allow them to continue driving. Additionally, the development of assistant apparatus and establishment of training approaches for driving ability recovery will be attained for the advanced age or dementia driver on which driving ability has fallen.

As a result of conducting the run experiments by test subjects using simplified mould DS developed by this research, it was confirmed by the easy apparatus which can be used at a hospital or a home by devising a scenario (soft ware) that evaluation of driving ability is possible to some extent. The expression of the test subject under experiment and the relationship of an operation condition are under analyses now with the member who added the researchers of medicine and psychology.

Driving Simulator, Driving Recorder, Dementia Driver

C4 Comparison of Vehicle and Occupant Kinematics in Bumper to Barrier vs. Hitch to Barrier Collisions

Robert D. Anderson, MS, Biomechanics Analysis, PO Box 7669, Tempe, AZ 85281-0023*

After attending this presentation, attendees will have a greater understanding of the effect a towing hitch has on the vehicle and occupant accelerations as demonstrated in full scale barrier impacts.

Commonly it is believed that the additional structure of a trailer hitch will stiffen a vehicle's structure, thereby reducing the amount of vehicle property damage, while increasing the acceleration, Delta V and occupant loading within the vehicle. However, this is not generally the case. This presentation will show, through a specific physical example, a demonstration on how the presence of a hitch has the potential to increase the damage susceptibility of the struck vehicle's frame, to lengthen the collision duration, and effectively cushion the impact for the vehicle occupants.

There has long been discussion regarding the effect on the struck vehicle and occupant accelerations in motor vehicle accidents that involve the struck vehicles' trailer hitch versus the bumper system. It has been theorized that the additional structure associated with the hitch strengthens and stiffens the vehicle structure, thereby shortening the collision duration, and increasing the accelerations experienced by the vehicle and occupant for a given amount of vehicle damage.

In a recent study researchers reported the results of two car-to-car rear-end impacts. While both struck vehicle acceleration durations were on the order of 140 msec and both average accelerations were 3 g's, the hitch equipped vehicle experienced a higher peak acceleration, 9.6 g's vs. 8.0 g's, a higher Delta V, 15.1 kph vs. 14.1 kph, and its driver dummy experienced higher peak lower neck acceleration, 8.9 g's vs. 6.7 g's, as compared to the control car without a hitch. In part, based upon these crash demonstrations, it was concluded that the addition of a tow bar *may* significantly increase the acceleration experienced by the struck vehicle and occupant.[1]

Conversely, it can be argued that the addition of a hitch increases the struck vehicle's frame damage susceptibility by structurally bypassing the bumper and by introducing an additional downward moment on the frame due to the eccentric loading that is not present without the trailer hitch. While the hitch may add structure to the vehicle, the increased damage susceptibility of the hitch-frame combination can actually be more compliant and provide a more effective cushion than the rear bumper.

It stands to reason that penetration of the hitch into the striking vehicle's front structures would effectively increase the cushion in a car-to-car impact by rendering the striking vehicle more compliant. In this demonstration, the effect of the increased compliance of a striking vehicle was eliminated by conducting barrier impacts. The effect of loading through the hitch was isolated by conducting 5 mph rear bumper to barrier and rear hitch to barrier impacts with a 1993 Dodge Grand Caravan equipped with a frame attached hitch receiver assembly.

Following the bumper to barrier impact, there was not any frame damage, but the Dodge sustained rear bumper reinforcement bar, bumper brackets and rear body panel damage, which is consistent with previous test results.[2] In the rear hitch to barrier impact, the Dodge sustained primarily frame damage at the forward portion of the hitch receiver assembly attachment to the frame.

Figure 1: bracket damage in 5 mph rear bumper to barrier

Figure 2: frame damage in 4.7 mph rear hitch to barrier

In addition to the barrier impact speeds and resultant damage patterns, vehicle and live human occupant accelerations, seat belt forces and seat back displacement data were recorded.

As seen in figures 2 and 4, as compared to the bumper impact, the hitch strike produced a significantly longer pulse, 225 msec vs. 90 msec. The restitution dropped from 0.3 in the bumper impact to 0.2 in the hitch strike, thereby producing a reduction in Delta V from 6.5 to 6 mph, respectively.

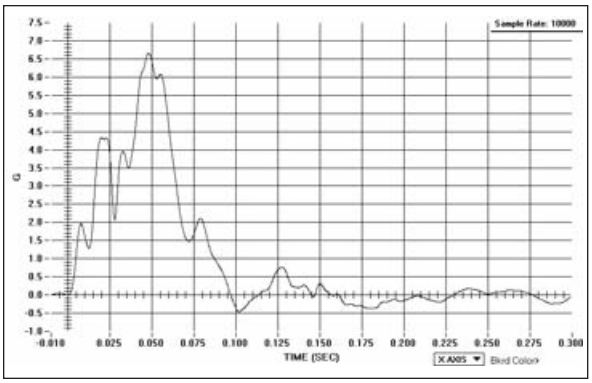

Figure 3: Dodge 5 mph rear bumper to barrier

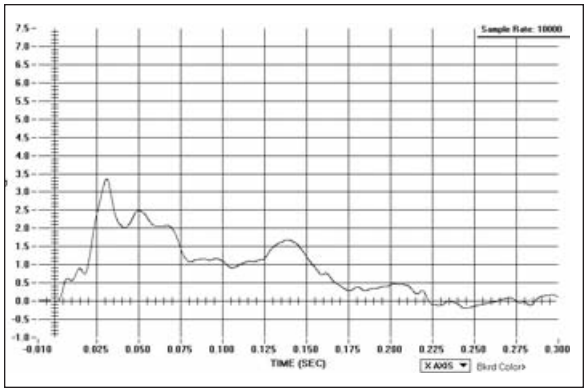

Figure 4: Dodge 5 mph rear hitch to barrier

The hitch strike produced occupant head, lower cervical, and lower lumbar accelerations that were approximately two-thirds that produced in the bumper impact. The dynamic seat back deflection was reduced from 5 to 4 inches, and the seat belt loading during rebound dropped from about 5 pounds to about 3 pounds. Commensurate with the above, the occupant described feeling the lower seat bar and being aware of a head to seat strike in the bumper impact, but described the hitch strike as much more "benign" without any awareness of any head to seat contact or any detection of the internal seat structure.

The performance of the vehicle in a hitch strike versus a bumper impact is dependent on the offset or eccentricity of the hitch relative to the frame, the amount of cushion provided by the bumper, the structural nature of the frames themselves etc. Certainly, there are circumstances where the addition of a hitch would decrease vehicle damage while increasing the vehicle acceleration, Delta V and occupant loading. However as demonstrated, the addition of a hitch can also significantly increase the vehicle damage susceptibility while decreasing the vehicle acceleration, Delta V and occupant loading. As such, this demonstration emphasizes the danger in over generalization and the importance of the application of sound engineering and mechanical principles in analyzing the role the hitch plays in a particular motor vehicle accident.

This author wishes to acknowledge Russell Anderson and Eric Miller whose hard work and perseverance have proved invaluable during vehicle collision testing.

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Hitch, Barrier, Testing

C5 Comparison of Acceleration Data and Human Subject Kinematics in Bumper-to-Bumper vs. Bumper-to-Hitch Low-Speed Collisions

Billy S. Cox, Jr., EFI Global, Inc., 2218 Northpark, Kingwood, TX 77339*

After attending the presentation, participants will have a greater appreciation of the biomechanical implications in low speed bumper-to-bumper vs. bumper-to-hitch collisions. Participants will also understand that the crash pulse is significantly longer and the absorbed energy, vehicle and occupant accelerations may be significantly lower in bumper-to hitch collisions.

There is a popular notion that striking the hitch of a so-called, rigid bumper vehicle, may result in higher accelerations, shorter crash pulses, and more severe kinematic responses of occupants in rear collisions. This study impacts the forensic and scientific community by revealing crash test results that seem to indicate that bumper-to-hitch impacts are less severe than identical bumper-to-bumper collisions. Participants will learn that crash pulses are significantly longer and crash accelerations are significantly lower when the bumper of a bullet vehicle engages only the hitch of a target vehicle and bumper deformation occurs.

The author will present data from at least twelve crash tests in which half of the impacts were bumper-to-bumper and half were bumper-to-hitch impacts.

Biomechanics, Low-Speed, Crash

C6 Limit Performance and Controllability Testing of Vehicles Towing Loaded Tow Dollies

Robert L. Anderson, BSME, Applied Research and Investigations, 3049 East Campbell Avenue, Phoenix, AZ 85016*

After attending this presentation, attendees will gain an understanding of combination vehicle dynamics.

This presentation will impact the forensic science community by addressing tow vehicle dynamics related to weight ratios.

There are not many standardized tests that have been developed for vehicle limit handling. There are of course braking tests and some limit performance turning testing for single unit vehicles. For trailers or vehicles towing another, there is even less. For trailer towing there are tests that evaluate the damping. In the damping test, a very small short steering disturbance is introduced and the sway is observed. The growth or decay of the amplitude is measured. There is no standard test to evaluate the controllability of a combination once the sway starts. There are a class of towed vehicles that have no brakes and are designed allow a vehicle to be towed behind a tow vehicle. There are no standardized tests for this combination.

Over the last ten years a series of tests have been performed to investigate the controllability of combination vehicles that consist of a vehicle towing another vehicle on a tow dolly.

Tow dollies were originally designed to be used behind vehicles like large moving trucks and motor homes. The weight ratio between the tow vehicle and what was being towed was relatively large and usually at least two to one. Some rental companies have allowed rental of dollies to small vehicles where the resultant weight ratio is closer to one to one or even worse. Since the tow dolly is frequently un-braked, this can create potential controllability problems. The following issues were investigated:

1. Stopping distance increases, since the towed portion of the combination is un-braked.
2. Braking can cause jackknifing, due to the saturation of the rear tires on the tow vehicle
3. Loss of directional control due to sway can occur due to the saturation of the rear tires during trailer oscillations.

Since the tow vehicle is the only one with brakes, the retarding force on the combination is limited. For a 2:1 ratio compared to a 1:1 ratio the stopping distance is 67% compared to 50% of the stopping distance of the tow vehicle alone.

If the vehicle combination is in a turn, the braking forces transmitted through the trailer hitch have a lateral component. This lateral component can and does easily cause jackknifing.

Sometimes the combination with the un-braked tow dolly will jackknife under straight line braking.

If the vehicle is placed into a small turn the lateral forces will be generated on the tow vehicle.

Trailers sway for a number of reasons including wind gusts, road disturbances, driver input, etc. Once the sway starts, the ability of the combination to resist the sway depends on the reserve friction available on the tow vehicle, particularly in the rear. The saturation of the tires in the rear of the tow vehicle can result in either jackknifing or the entire combination may yaw out of control.

Jackknifing or out of control combinations can lead to rollovers and other types of accidents.

Testing of various vehicle combinations have been conducted dating back ten years. Combinations included:

- Small SUV towing small passenger car
- Pickup towing sedan
- Station Wagon towing sedan
- Medium sized SUV towing sedan
- Small Pickup towing sedan

Instrumented tests were performed for each of the combinations. The control inputs and the dynamic output were measured. Typical continuous measurements were made of:

- Steering wheel angle
- Brake pedal force
- Speed
- Throttle position
- Accelerations of tow vehicle and towed vehicle
- Rotation rates of tow vehicle and towed vehicle
- Video cameras documented each maneuver

The vehicle was tested in the following ways:

- Straight line braking
- Braking in a turn
- Reverse steer

The tow vehicle was also tested without the tow dolly attached.

In each case, the testing was also performed with a van type truck both with and without the towed vehicle on the tow dolly. The comparison of weight ratios between the tow vehicles and the van type truck increased the ratio of the tow vehicle to towed vehicle from close to 1:1 to closer to 2:1.

As might be expected, there was no control problems with the higher weight ratio combinations, even with higher control inputs.

Straight Line Braking: Straight line braking consisted simply of driving the combination to test speed and applying the brakes at maximum. The stopping distance or the deceleration was observed.

As predicted, the stopping distance increased and the deceleration rate decreased with a lower weight ratio. In other words a small vehicle cannot stop as readily, while towing a vehicle on an un-braked tow dolly, as a larger vehicle. While this result may not be surprising, sometimes the combination would jackknife without any turning input from the tow vehicle. In the jackknifing cases the instability of the combination manifested itself that was further confirmed in the braking in a turn test.

Braking in a Turn: The Braking in a Turn test involved steering a slight amount, 90 to 180 degrees on the tow vehicle steering wheel, and then braking.

The tow vehicle with the towed vehicle attached experienced severe loss of control as demonstrated by extreme jackknifing in the braking in a turn test at speeds as low as 15 to 20 mph.

The tire friction forces of the tow vehicle, particularly for the rear axle, were almost saturated from braking alone. When the additional lateral forces were applied to turn and stop the towed vehicle, the friction limit at the tire road interface was exceeded and jackknifing occurred.

Reverse steer: The reverse steer is designed to start the towed portion of the vehicle to sway. The sway was intentionally induced in order to evaluate the ability of the combination to be controlled. The vehicle is steered one way, the steering wheel brought back to zero, steered the other way, and then brought back to zero. This turning sequence could result in an approximate lane change under some circumstances. There will be swaying of the towed portion of the combination.

The combination with a weight ratio of tow vehicle to towed vehicle of 1:1 loses control at much lower input levels than the combination with weight ratios of closer to 2:1.

The loss of control occurs in one of two ways. Both limit performance configurations result from the exceeding the friction force capacity of the rear tires of the tow vehicle. In the limit, the vehicle combination can jackknife or swing out of control in a sweeping yawing motion with the vehicles almost aligned.

These series of three tests have been successful in quantifying the controllability and limit performance levels for tow vehicles towing other vehicles with a tow dolly. One obvious conclusion is that the weight ratio needs to be closer to 2:1 than 1:1.

Tow Dolly Testing, Limit Handling Performance, Controllability

C7 Occupant Kinematics in Low Speed Motor Vehicle Accidents and Evaluation of Common Analogies

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After attending this presentation, attendees will gain an appreciation for a method of physically evaluating the appropriateness of common analogies used to describe the magnitude or effect of low speed collisions on the vehicle and its occupants.

The presentation will impact the forensic science community by demonstrating how vehicle and occupant accelerations can be compared, in addition to presenting a number of common analogies will be shown to be appropriate and reasonable, or inappropriate and unreasonable.

Biomechanical engineers commonly use analogies to illustrate the nature or magnitude of low speed collisions and the effect on vehicle occupants. For example, hard braking, backing into a curb, plopping into a seat, and dropping a seat are common analogies for low speed rear-end impacts; rapid side-to-side steering and driving over a rough road are common analogies for side-swipe collisions; and amusement park bumper car collisions are common analogies for rear-end, broadside, and frontal collisions. However, the applicability or fairness of some analogies has been called into question and warrants evaluation.

By using specific examples, a method of objectively evaluating analogies by directly comparing the vehicle and/or occupant accelerations measured during low speed collisions to those measured during the corresponding potential analogous events will be demonstrate. The appropriateness or fairness of each analogy will be discussed.

Rear-end Collisions: Events that result in the same contact speed between the occupant and seat back should produce similar bodily accelerations and forces.

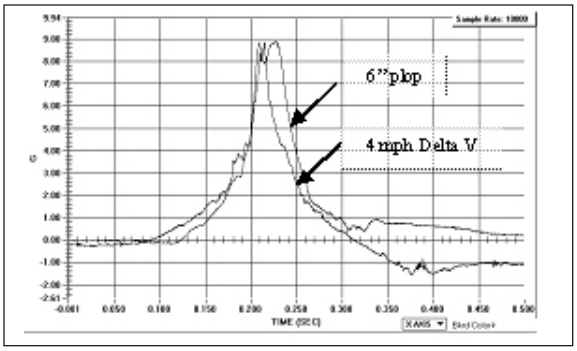

Figure 1: Head accelerations

Indeed, plopping rearward into an automotive seat from a height of 6 inches and 8 inches produced occupant head and upper torso accelerations that compared favorably with those measured in car-to-car impacts producing Delta V's of 4 and 5 mph, respectively. Figure 1 shows the head accelerations measured in a 4 mph Delta V impact and a 6 inch plop into the same automotive seat. With comparable occupant accelerations, plopping rearward 6 to 8 inches into an automotive seat can be considered a fair analogy for 4 and 5 mph Delta V rear end impacts.

It has been postulated that dropping an occupant seated in an automotive seat with the seat back suspended horizontally 10 inches above the ground would produce a 5 mph contact speed and Delta V and therefore produce occupant forces to a 5 mph Delta V rear-end impact. However, a 10 inch seat drop resulted in two to three times higher thoracic and lumbar accelerations and less than half the head accelerations that those produced in the same seat in a 5 mph Delta V rear-end car-to-car impact. In addition, the occupant rebound characteristic of rear-end impact was absent. Clearly, this analogy can not be considered fair or appropriate.

Previous authors have compared hard braking while backing to Delta V's up to 1.9 mph, when comparing vehicle accelerations, and up to 3.3 mph when comparing occupant accelerations.[1,2] In replicating these tests, head and upper torso accelerations during hard braking while backing at 5 mph were found to be comparable to those produced in a 3.6 mph Delta V car-to-car rear-end impact. Thus, hard braking while backing at low speed would be judged to be analogous to rear-end Delta V's up to 3.6 mph.

It has been theorized that backing a vehicle into a curb at 3 to 5 mph would produce comparable vehicle accelerations and occupant motions in car-to-car impacts with the Delta V. However, vehicles backed into typical curb or parking blocks consistently resulted in the vehicle mounting the curbing with markedly dissimilar vehicle and occupant accelerations when compared to car-to-car impacts. Thus, backing a vehicle into a curb is neither a fair nor appropriate analogy for rear-end impacts in this range.

Previous authors have reported that amusement park bumper car collisions not only produce similar body motions to rear-end impacts, but the Delta V's and collision durations compare favorably to rear-end impacts with Delta V's as high as 5 to 6.6 mph.[1,3,4,5] As such, amusement park bumper car impacts are judged to be a fair analogy for rear-end impacts with Delta V's up to about 5 to 7 mph.

Similar to the dropping analogy, hopping off a 10 inch step has been equated to a 5 mph Delta V impact. Although similar accelerations are produced, the fact that they are in a different direction coupled with the inherent anisotropic nature of the human body, this analogy can neither be considered fair nor appropriate.

Side-swipe Impacts: The lateral head accelerations of 0.7 g's were measured in side-swipe impacts producing scraping door dents as deep as an inch and fender denting as deep as 3 inches. The amplitude of the lateral shoulder displacement was measured to be an inch. Not surprisingly, side-to-side steering while driving also produced lateral head accelerations of 0.7 g's and lateral shoulder displacements of about an inch. Thus, side-to-side steering is judged to be an appropriate and fair analogy for such side-swipe contact.

Frontal and broadside collisions: Similar to rear-end impacts, pulling forward into curb has been postulated to be comparable to frontal impacts. However, in the highest speed tire to curb contact to date without mounting the curb, a 3.3 mph velocity change was produced. However, the average acceleration was less than 0.23 g's over a 443 msec duration. Clearly, tire-to-curb strikes are neither fair nor appropriate analogies for frontal impacts.

In angled broadsides producing 1.5 to 3 mph Delta V's and door indenting from 2 to 2¾ inches, the lateral head, upper and lower torso accelerations ranged from 0.7 to 1 g. The lateral head, upper and lower torso accelerations measured driving over a rough road was measured to be 1.4, 2.1, and 0.9 g's respectively. Thus, traversing a rough road is a fair analogy for such low speed broadside impacts.

As discussed above, lateral Delta V's as high as 6.6 mph and frontal Delta V's of almost 10 mph can be expected in an amusement park bumper car collisions. With comparable Delta V's and impact duration, frontal and broadside impacts are judged to be comparable to low speed car-to-car impacts with a similar Delta V range.

Head Injury Potential: Head injury criteria or HIC is commonly used to gauge the potential for head injury. Below 50 there is effectively no chance of even the most minor (AIS 1 or 2) head injury.[6] In fact, volunteer studies are routinely conducted in a range that produce HICs below 50 without consequence.

HICs of 1 to 2 have been measured during sneezing and 10 inch hops. HICs of 1 to 22 have been measured in 5 to 14 mph frontal barrier impacts, and HICs as high as 34 were measured in 5 mph rear to barrier impacts, while a pillow blow to the back of the head produced a HIC of 41.

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Low-Speed, Analogies, Biomechanics

C8 Appearances Are Deceiving: Physical Handicaps? Diminished Braking Capabilities

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The goal of this presentation is to show how impressions based upon physical appearance can convey messages regarding potential specific human performance or the lack thereof, but such appearances can be deceiving. This prospective laboratory study quantitatively exemplified this point and showed that the braking abilities of a one-legged driver are indistinct from normal two-legged drivers. Objective testing, not appearances, are needed to quantify the extent (if any) of altered human performance accompanying a physical handicap.

This presentation will impact the forensic science community by presenting results which will clearly show that: 1) certain physical handicaps are not necessarily the cause of vehicular accidents; 2) individuals can overcome certain physical handicaps to the extent that the resulting human performance is indistinguishable to those without handicaps; 3) objective biodynamic testing is useful to quantify the extent (if any) in which a physical handicap affects performance of a specific task; and 4) visual appearances are poor indicators of human biodynamic performance.

A one-legged truck driver was involved in a fatal vehicular accident. Questions arose regarding his physical ability to adequately brake a commercial tractor-trailer. The specific aim of this study was to test the null hypotheses that there were no differences in the reaction time or the braking time of this driver as compared to other one- and two-legged drivers.

Four truck drivers (two normals and two amputees – including the subject) volunteered for this prospective study. A commercial 18-wheel tractor-trailer was parked in the right lane of an actively used 4 lane commercial track. Accelerometers were fixed to the pedals. A red/green lighting system, similar to a traffic light, was positioned 100' ahead of the driver. Subjects seated themselves and prepared for normal driving. The tractor engine was running, but the vehicle remained stationary at all times. The green light meant "all clear, proceed with normal driving", but the red light meant an emergency stop (no evasive maneuvers allowed). Written instructions were read aloud to each subject before testing, but details of objectives, measurements, analyses, etc. were not revealed. Each subject was asked to "drive" for a period, then within a randomly chosen 5 – 30 second window, an "emergency" (signaled by the red light) would occur requiring braking. Five "practice" braking sessions preceded a set of ten "actual" test measurements. Reaction time (red light to accelerator release) and brake time (accelerator release to brake application) were measured. Subjects did not discuss the experiment. One person converted all voltage-time data and quantified the parameters. Data were analyzed with power analyses and repeated measures ANOVA.

Mean reaction time and total times of the subject were 17.2% ($p=0.006$) and 15.5% ($p<0.001$), respectively, better than the other one-legged driver, but were within ± 4.2% (typically ~1%) of the mean time values observed for either control driver. These results showed that the subject's braking ability was superior to the one-legged driver and indistinguishable from the control drivers.

These data clearly show that a priori assumptions regarding diminished braking performance due to the absence of a lower extremity are gratuitous. Individuals can compensate for physical handicaps in a manner resulting in specific task performance that is indistinguishable from that of the normal population.

Biomechanics, Human Performance, Braking Abilities

C9 Motor Vehicle Pitch Associated With Hard Brake Application

Russell L. Anderson, MS, Collision Analysis & Research, LLC., PO Box 7185, Tempe, AZ 85281; and Robert D. Anderson, MS, Biomechanics Analysis, PO Box 7669, Tempe, AZ 85281-0023*

Attendees will be provided with data collected from hard brake testing including change in bumper heights and vehicle pitch.

The change in bumper height associated with hard braking is important in addressing vehicle compatibility issues and reconstruction. To these authors' knowledge, this type of objective data has not been previously published.

Collision forces are best managed when there is full engagement of the involved vehicles' bumpers. This allows the collision forces to be best managed by the structural portions of each vehicle, such as the bumper structures and the frame. Static geometrical incompatibility may exist as a result in the difference in bumper heights, as illustrated in Figure 1 below.

However, because forward vehicle pitch during hard braking effectively lowers a vehicle's front bumper height, while raising its rear bumper height, a dynamic mismatch in bumper height leading to an under-ride can be produced by hard braking by either one or both involved vehicles.

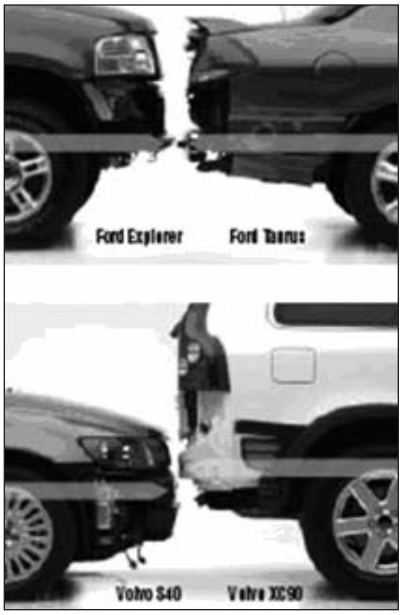

Figure 1: Geometrical Compatibility and Incompatibility[1]

Since the structural portions of the striking vehicle's bumper are effectively bypassed, the striking vehicle typically sustains substantial crush to the relatively easily damaged structures above and behind its front bumper, while the struck vehicle sustains relatively minor, if any, structural damage.

In understanding this acquired or dynamic structural incompatibility, it would be helpful to be able to quantify the amount of bumper height change associated with hard braking. Such data may also be helpful in resolving some reconstruction issues. However, prior to this study, there is not any known published data regarding the change in bumper height associated with hard braking.

The purpose of this study is to provide empirical data regarding vehicle pitch and the resultant change in bumper height during hard braking. Seven vehicles representing most passenger vehicle types were selected for this study.

Data was collected while each vehicle underwent hard acceleration to at least 40 mph, maintaining that speed for a few seconds, and then hard braking to a stop. A Racelogic VBOX III, a GPS based system, was used to collect longitudinal acceleration data. In addition, the VBOX III was used to collect data from external sensors for brake pedal force, vehicle pitch rate and bumper height.

Each vehicle was subjected to a series of hard braking events. The maximum changes in bumper heights were averaged for each vehicle and are presented in Figure 2 below. Front bumper heights are shown to decrease or dip down as a negative change in bumper height, while rear bumper heights were raised or experienced a positive change in bumper height.

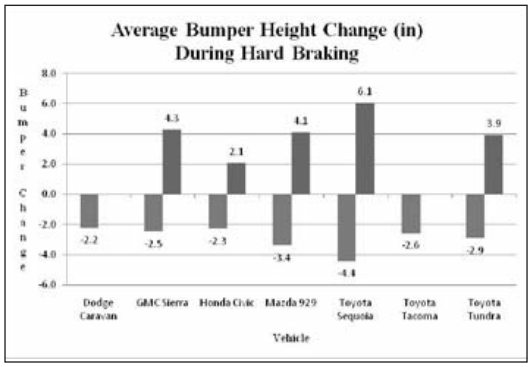

Figure 2: Change in Bumper Height During Hard Braking

The front bumper dip ranged between 2.2 and 3.9 inches for all the vehicles, with the exception of the Toyota Sequoia whose front bumper dipped down 4.4 inches.

The rise in rear bumper height for most vehicles ranged between 3.9 and 4.3 inches. However, the Toyota Sequoia, a large SUV, exhibited a rise in rear bumper height of 6.1 inches, and the Honda Civic, a small passenger vehicle, exhibited a rise in rear bumper height of only 2.1 inches. Data loss precluded collection of rear bumper height data during testing of the Dodge Caravan and the Toyota Tacoma.

Bonus Information: During the hard braking tests, the average deceleration for these vehicles ranged from 0.69 and 0.86 g's, as depicted in Figure 3.

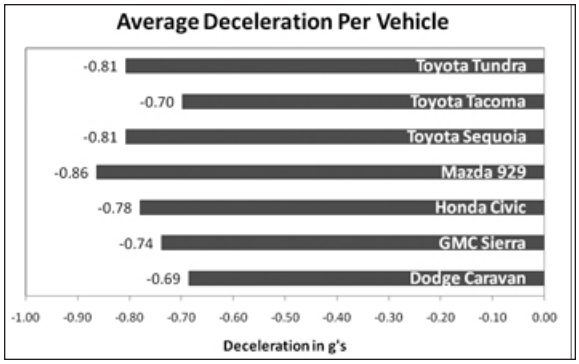

Figure 3: Test Vehicle Decelerations

The changes in the front and rear bumper heights were also measured during hard acceleration for these same vehicles. The average rise in front bumper height for each vehicle ranged between 1.5 to 2.2 inches, with the exception of the Toyota Sequoia whose front bumper raised an average of 2.7 inches. The average rear bumper dip ranged from 0.7 to 1.7 inches for all the vehicles with the exception of the Dodge Caravan's rear bumper height which dipped 2.4 inches.

Intuitively, when occupants enter the vehicle, the suspension is loaded causing the vehicle's bumper heights to be lowered. With different numbers of occupants and weights added to the same vehicles listed above, the average change in front and rear bumper heights ranged between 0.5 and 1.2 inches.

Conclusion: It should be noted that this study involves a relatively small number of vehicles, it is not all inclusive, and clearer trends may emerge with the addition of more vehicles.

While preliminary, it is believed that this is the first presentation of vehicle pitch and bumper height change associated with hard braking.

These authors wish to acknowledge Eric Miller for his assistance in conducting this study.

Reference:

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Pitch, Bumper, Under-ride

C10 Repeatable Rollover Testing for Injury Analysis

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The goal of this presentation is to help the audience better understand relationships between roof crush and cervical spine injury in vehicle rollovers, and to learn about a unique new dynamic rollover test device.

The presentation will impact the forensic science community by demonstrating how the Jordan Rollover System (JRS) is a valuable research tool for analyzing the effect of roof crush shape and magnitude on occupant head and neck injury.

The device is known as the Jordan Rollover System (JRS), developed by Acen Jordan and operated by the non-profit Center for Injury Research. Additionally, a case study will be presented for which the JRS was used – producing both comparable damage and dummy body motion to the real world crash.

Over 10,000 occupants of motor vehicles are killed each year in rollovers and more than that are paralyzed. Rather than the number of fatal injuries going down every year, as is the trend in other crash modes, fatalities are increasing in rollovers. Part of the problem is the popularity of less stable vehicles such as SUV's and light weight trucks. However, the situation is exacerbated by the lack of adequate standards for roof strength. In the last 30 years, no new standards for roof strength have been instituted. No dynamic strength tests are required by the National Highway Traffic Safety Administration for vehicle certification. One of the reasons given for the lack of dynamic testing is that rollovers are not repeatable, that is, roof impacts in a rollover are unpredictable and random. This reason is no longer valid. Impacts to the roof using the JRS are repeatable and can replicate the first two roof impacts in a rollover.

In the JRS, the vehicle is elevated above a track and rotated about its longitudinal axis to a specified rpm. A platform representing the roadway is accelerated down the track. The rotating vehicle is then dropped onto the moving platform such that the roof of the vehicle impacts the platform. Once the vehicle clears the platform, it is caught so that no other impacts can occur. The system is designed such that vehicle drop height, yaw, roll rate, pitch, and contact angle can be specified. In effect, the system has the rolling vehicle striking a horizontally moving roadway that approximates a rollover crash in which the vehicle roof impacts as the vehicle rolls over a stationary surface. The laws of motion related to impact force allow such a comparison,

and are commonly analogized by an impact of a ball thrown against the wall. The impact is the same whether the wall is moving into the ball or the ball is moving into the wall, provided the closing velocity is the same. Impact forces are the same, only the reference frames used in the equations that govern the impact are different.

Using the JRS, instrumented anthropomorphic dummies are placed in the vehicles to measure head acceleration and neck loads. The vehicle accelerations and roof displacement are measured and the platform is instrumented. High-speed video cameras record the interior and exterior impact dynamics. When the JRS is used to study an actual injury event, the roof crush produced is compared to the actual crush. When produced damage correlates with actual damage, the dummy response measures are compared to injuries sustained.

In a case study rollover injury event, the driver sustained a C5 dislocation resulting in quadriplegia. A left forward roof rail ground contact produced a longitudinal roof buckle above the driver's head. Marks on the headliner showed the driver's head contacted the roof just to the left of maximum buckle intrusion. The same shape buckle and dummy head impact was produced on the JRS. The measured dummy neck compression of 9,960 N exceeded human neck injury thresholds and correlated with the actual cervical injury sustained. Although a one-to-one relationship between dummy neck forces and human neck forces cannot be made due to the dummy neck's lack of biofidelity, conversion relationships exist. This approximation of a rollover injury event using the JRS revealed valuable new information about the impact that produced the driver's paralyzing injury and also how the injury could have been prevented by lessoning the roof intrusion. The system provided a valuable research tool for analyzing the effect of roof crush shape and magnitude on occupant head and neck injury.

Rollover, Cervical Injury, Jordan Rollover System (JRS)

C11 3-D Digitization for Traffic Accident Reconstruction, Simulations, and Animations

Russell L. Anderson, MS, Collision Analysis & Research, LLC, PO Box 7185, Tempe, AZ 85281*

After attending this presentation, attendees of this presentation will be exposed to the use of 3-D digitization of vehicle and scene to aide in the determination of the orientation and sequence of events.

This presentation will impact the forensic science community by showing how this technique can prove to be extremely useful in aiding the investigator or reconstructionist in the sometimes difficult task of depicting the accident scenario for demonstrative purposes. This can be accomplished without the risks to safety, evidence alteration, etc. that would be associated with attempts to directly match the scene and vehicle evidence by bringing the vehicle back to the scene. Indeed, this technique can be employed even after subsequent alterations to the scene.

In order to reconstruct a traffic accident, investigators and accident reconstructionists often rely on the physical evidence left behind at the scene and on the vehicles to piece the puzzle together. One of the many ways to document the evidence is to digitize the scene and vehicle with a three dimensional measurement system.

Once 3-D data is acquired, scaled 3-D models of the vehicle and scene are created. The digitized features and/or damage of the vehicle and scene can then be physically matched in a scaled 3-D virtual space. This can be accomplished without the risks to safety, evidence alteration, etc. that would be associated with attempts to directly match the scene and vehicle evidence by bringing the vehicle back to the scene. Indeed, this technique can be employed even after subsequent alterations to the scene.

This can prove to be extremely useful in aiding the investigator or reconstructionist in the sometimes difficult task of depicting the accident scenario for demonstrative purposes as illustrated in the following case studies.

Case study #1 involves a single vehicle rollover that occurred when the passenger side tires left the roadway and the driver tried to recover and rolled the vehicle. The restrained driver sustained fatal injuries as her head was partially ejected during one of the rolls. By matching the rim strikes in the roadway to the vehicle wheels, the 3-D data collected at the site and the vehicle helped to determine the number of rolls the vehicle underwent. Figure 1 shows a diagram depicting the roll sequence.

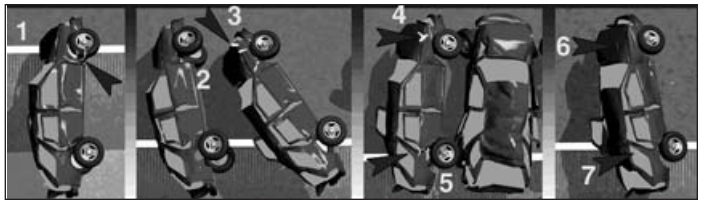


Figure 1: Matching Roadway Damage to Vehicle Features

Case study #2 involves a single vehicle accident that occurred on a steep incline in a curve during a heavy rain storm. The vehicle lost control, left the roadway to the inside of the curve, and mounted an embankment where it struck a large boulder. As a result, the rear of the vehicle quickly rotated ejecting the driver rendering him paraplegic. At issue was the vehicle's orientation at impact, and the specific boulder that was struck.

Both the boulders on the embankment and the vehicle's 3-D crush pattern were digitized. The actual involved boulder was identified as the vehicle's crush pattern matched the boulder's 3-D geometry similar to a lock and key. A 2-D rendering of this matching is shown in Figure 2.

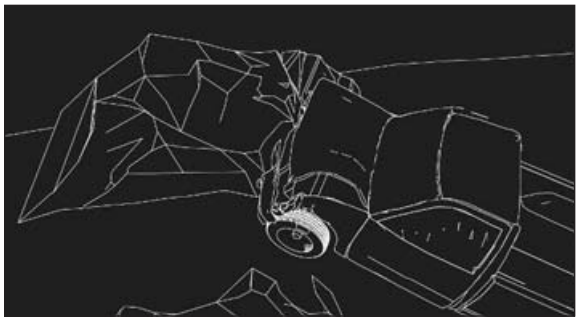


Figure 2: Matching Vehicle Damage to Scene Features

Case study #3 involves a single vehicle rollover of a vehicle that was towing a trailer. The trailer initiated a weave, causing the vehicle to jackknife and lose control. The rollover occurred on top of a guardrail slicing into the body of the vehicle. The right rear passenger was rendered paraplegic. Once the vehicle and scene were digitized, the vehicle damage was matched up with the scene showing the orientation of the vehicle and the progression of damage throughout the rollover, as shown in Figure 3.

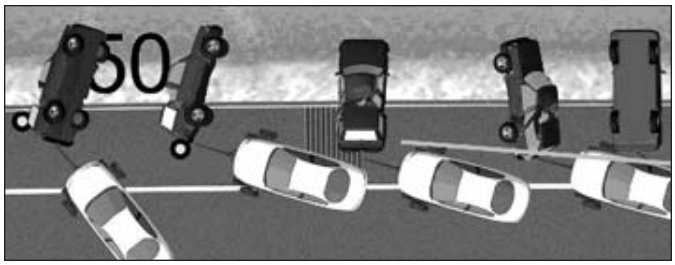


Figure 3: Vehicle Dynamics During Rollover Involving Damage from a Guardrail

Conclusion: As demonstrated in these case studies, having 3-D models of the vehicles and scene can prove invaluable in physically matching the evidence thereby defining the relative orientation of the vehicle and scene throughout the collision event.

Once defined, the 3-D models lend themselves to generating story boards and animations for demonstrative purposes.

Digitization, Reconstruction, Animation

C12 Was That Fender Dent Really Caused by a Closed Fist Punch?

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

After attending this presentation, participants will learn how engineering fundamentals can be applied with inexpensive test apparatus to quantify biodynamic phenomena in a felony case. Intuition may yield a similar conclusion, but would not ordinarily be admissible as evidence.

This presentation will impact the forensic science community by demonstrating an application of engineering fundamentals and inexpensive test fixtures to quantify dynamic phenomena and supplement intuition in a case with felony charges.

Background: Defendant was giving his teen aged daughter a ride to school in his Hummer. He was angered by the driving behavior of a male student in a imported luxury sports sedan in the school parking lot. He stopped the student, exited his large luxury SUV, walked over to the sedan shouting obscenities, and opened the driver's door. He attempted unsuccessfully to pull the student out of the sedan, because the seat belt was fastened. Defendant struck the left front of the sedan with his bare hand making a loud noise. Defendant claims he slapped the car with an open hand on a down-stroke on the outer edge of the hood. The student claims the blow was a closed fist horizontal punch to the top of the left fender. The defendant had no hand injuries.

After the altercation, a sharp dent was noted in the top corner of the fender above the left front wheel. Repair cost estimates obtained by the prosecutor were over $750, while a 3rd estimate made obtained by the defense attorney was $490. Minnesota law states that all the assault actions in this incident are misdemeanors unless property damages exceed $500, in which case it may be classed as a felony.

At the request of the defense attorney, the author inspected the sedan noting the location and dimensions of the fender dent in question. The dent was located along the stamped crease near the top of the fender which is a structurally strong part of the fender. The possibility of the cause being an open hand slap on a down-stroke was ruled out by the shape and location of the dent. The possibility of the cause being a closed fist horizontal punch was contrary to the intuition of the author and of several engineer colleagues. Intuition, at least in the engineering sciences, is usually not a sufficient basis for an expert opinion to be admissible.

The defense attorney retained an investigator who located and purchased a similar model sedan with no front end damages. The exemplar was made available for limited destructive testing of the front fenders.

An inexpensive pendulum fixture for delivering impact blows which could be quantified in terms of kinetic energy at impact was designed and constructed. Lumber and hardware were purchased from local retail stores. The pendulum pivot is a loose bolt connection to an overhead wood frame with adjustment features that is supported by the ceiling joists in the author's garage. The impacting surface is pine wood cut in a shape that approximates a closed fist. A physical therapy ankle weight consisting of a partitioned vinyl bag filled with fine grain sand utilizing a Velcro® strap was attached to the wood pendulum arm. The weights were measured with a spring scale and the center of mass was determined by a simple balance test.

Pivot fiction loss characteristics were determined by measuring amplitudes of pendulum cycles.

To determine data for punching energy of adult males, volunteers known to be stronger than the general population punched the ankle weight from the bottom pendulum position and the author measured the height to which the pendulum swung. These data were used to select release heights for impact tests of the pendulum against the exemplar fenders. Results showed that impact energies of 1.5 times the maximum demonstrated by the volunteers caused dents which were less severe in the exemplar than the dent in the subject sedan. The dent from a maximum energy single impact was similar to the dent from the same energy 3rd impact in a sequence of increasing energy impacts. Results confirmed that a closed fist punch was *not* a probable cause of the subject dent.

Pendulum Impact Tests, Engineering Fundamentals, Biodynamic Applications

C13 Case Study: Throttle Malfunction in a 2004 Ford Escape

Eric R. Miller, BSE, PO Box 7337, Tempe, AZ 85281*

After attending this presentation, attendees will understand a mechanism for throttle pedal "sticking" that may occur in a 2004 Ford Escape equipped with a 3.0L V6 engine and subjected to Ford Recall No. 04S25.

The presentation will impact the forensic community by providing an example of how a malfunction that is undescribed in the available literature can lead to the same symptoms produced by another malfunctioning part.

In December of 2004, the Ford Motor Company issued Ford Recall No. 04S25. The recall covered certain 2002 through 2004 model years Ford Escapes originally equipped with 3.0L V6 engines manufactured from May 30, 2001 through January 23, 2004. The item affected by the recall was the accelerator cable.[1]

According to the recall documentation, the inner liner of the accelerator cable could migrate out of the outer casing at the dash panel fitting, possibly coming into contact with the accelerator pedal to a degree that would prevent the pedal from returning to the fully released position.

Utilizing the National Highway and Traffic Safety Administration's (NHTSA) consumer complaints database for the date range covered by the above recall revealed 36 complaints regarding the accelerator pedal sticking. Of these complaints, 22 were most likely related to the recalled accelerator cable while the remaining 14 were either unexplained or due to reasons not directly related to an accelerator cable failure.[2] One of the failure modes described is demonstrated in the following case study.

A 2004 Ford Escape was traveling on a highway when the driver decided to exit the freeway. Upon exiting, the driver attempted to bring the vehicle to a stop and was unable, resulting in a crash. Statements from the driver, tow truck driver and other witnesses indicated that the engine sounded as though it was "revving" after the crash, even though the transmission was in neutral.

Inspection of the subject vehicle confirmed that the accelerator pedal was stuck in an applied position. The recall dealt with migration of the inner lining at the dash panel fitting however, as shown in Figure 1, the cable appeared to be intact. The cable was inspected from its insertion point in the firewall to the termination point on the throttle body and was found to be free of bends, twists or kinks that may have prevented the accelerator pedal from returning to its fully released position.

Figure 1: Accelerator cable at firewall and accelerator pedal installation point.

However, Figure 2, it appears that the throttle position sensor became caught on the underside of the plastic engine cover, thereby preventing the throttle body pulley/spring combination from rotating which prevented the taking up of slack in the accelerator cable. This not only prevented the accelerator pedal from returning to its fully released position, but also kept the throttle plate (located inside the throttle body) open.

Figure 2: Throttle position sensor entrapment at plastic engine cover.

Since the subject vehicle had been serviced under the above mentioned recall, it is not known if the pulley was able to rotate to the position shown in Figure 2 due to an error during the installation of replacement cable, a difference in the length of the pre- and post-recall accelerator cables, or some other factor. The accelerator cable was not released from this position, and therefore an attempt to replicate the circumstances that led to the throttle position sensor becoming trapped on the plastic cover was not conducted.

The above case study demonstrates a possible cause of accelerator pedal "sticking" in a 2004 Ford Escape affected by Ford Recall No. 04S25 that is unrelated to the safety issue addressed by said recall.

References:

1 Ford Motor Company, "49 CFR Part 573 – Defect Information Report 04S25 – Certain 2002 Through 2004 Model Year Ford Escape Vehicles," Dearborn, MI, December 2004.

2 National Highway Traffic Safety Administration – Office of Defects Investigation, http://www-odi.nhtsa.dot.gov/cars/problems/complain

Ford Escape, Accelerator Cable, Throttle

C14 Laboratory Impact Evaluation of Fuel Tank Filler Anti-Spill Valves

Jerry G. Wallingford, PE, and Clarence R. Hitchings, PE, Verifact Corporation, 11220 West Loop 1604 North, San Antonio, TX 78254*

After attending this presentation, attendees will understand how fuel can escape from a vehicle fuel tank if the fuel filler assembly is compromised and how the installation of anti-spill valves (check valves) on the fuel tank filler inlet will substantially mitigate the loss of fuel under the conditions evaluated.

This presentation will impact the forensic community/or humanity by demonstrating through laboratory testing that the loss of liquid such as gasoline and it's vapors from a compromised fuel filler assembly is substantially mitigated by the installation of anti-spill valves on fuel tank filler inlets. As a result the probability of post-collision fuel fed fires is reduced.

A severe fire can result from the escape of gasoline and gasoline vapors during and after a collision and/or rollover due to a compromise in the fuel tank filler assembly. The fuel tank filler inlet (spud) is the opening in the fuel tank where the fuel filler pipe/hose assembly attaches and fuel enters the fuel tank. The fuel filler assembly is the hose, pipe, or hose/pipe combination which attaches to the fuel tank filler inlet (spud) on one end and to the body of the vehicle on the other end. The fuel cap closes the fuel filler opening to prevent fuel from escaping.

History has shown the fuel filler assembly may be compromised during a collision. The fuel filler hose and/or tube can be cut, the fuel filler pipe or hose may separate from the fuel filler inlet, or the fuel filler cap may be loose, not installed or improperly installed. If one of these failures occurs, gasoline and gasoline vapors can escape from the fuel tank.

The use of fuel filler anti-spill valves to prevent the loss of fuel from the fuel tank filler should the filler system be compromised was discussed and recommended as early as the mid-1960s. These valves function as "one-way" type valves. They open under the force of the fuel during refueling and close when refueling stops. Automobile manufacturers use some of these anti-spill valves as part of their emission system to prevent the escape or "spit-back" of fuel and fuel vapors.

Six different anti-spill valves were installed on the fuel tank filler inlet (spud) in OEM (original equipment manufacturer) polymer fuel tanks which were not originally equipped with anti-spill valves. The fuel tanks were filled to 90% of their capacity with colored water. The fuel filler assembly was compromised or removed from the fuel tank filler inlet. Using a pendulum, laboratory impact testing was performed to evaluate the effectiveness of these valves in preventing the loss of liquid when the fuel tank is exposed to impact loading. The anti-spill valves were not directly impacted. Following the impact, the fuel tanks were placed on a tilt table to evaluate the effectiveness of the valves while the tank was rotated 360 degrees. Additionally three different polymer fuel tanks equipped with OEM installed fuel filler anti-spill valves were tested.

The results of the testing reveal that for the circumstances evaluated, anti-spill valves installed on the fuel tank filler inlet are effective in substantially mitigating the loss of fluid from the fuel filler inlet spud when the fuel tank is subjected to impact loading. The results also indicated that some anti-spill designs are more effective in preventing the loss of fluid when the fuel tank is rotated.

Fuel, Filler, Valve

C15 Fuel Tank and Filler Neck Modifications to Improve Vehicle Crashworthiness

Mark C. Pozzi, MS, Sandia Safety Sciences, 2 Marietta Court, Suite A, Edgewood, NM 87015*

The goal of this presentation is to present an objective, scientific demonstration of how a real-world collision was evaluated, defects were identified, alternative designs were developed, and dynamic testing was conducted to validate those designs.

This study impacts anyone who rides in a vehicle equipped with an internal combustion engine using volatile fuels like gasoline. This study will impact the forensic science community by showing the hazards of fuel system failure and its effect on vehicle occupants. This research should be of interest to crash investigators, safety officials, and vehicle designers.

The goal of this paper is to present dynamic crash testing depicting a modification of a production fuel tank and filler neck. OEM and modified fuel systems were tested in vehicle-to-vehicle collisions under identical test conditions. This test series proves conclusively that technically and economically feasible, significantly safer design alternatives exist for vehicle fuel systems, even those found in subcompact cars. This has significant safety implications for the public, as well as vehicle designers, safety officials, and crash investigators.

A subcompact passenger car was struck in the rear quarter panel by the front of a utility vehicle at approximately 60 mph. The filler neck separated from the fuel tank, allowing massive fuel leakage to occur. Several restrained occupants of the struck vehicle, including children in the rear seat, incurred severe burns due to a fire caused by fuel leaking from the failed fuel tank and filler neck. There were no impact-related injuries due to the offset nature of the collision. Since the failure of the filler neck was obvious from the real-world collision evidence, it was desired to determine if there were reasonable alternative designs. Two vehicle-to-vehicle crash tests were conducted by a certified test laboratory that regularly performs similar crash testing for government safety agencies and auto manufacturers. The crash tests were designed to be at least as severe as the upper end of the calculated accident reconstruction velocities of the subject collision. An identical exemplar bullet vehicle traveling approximately 60 mph struck a stationary exemplar vehicle in the right rear quarter panel. The filler neck of the target vehicle was di-

rectly in line with the front bumper of the bullet vehicle. The OEM filler neck on the subject vehicle passed through the open wheel well of the vehicle.

One crash test involved an unmodified, completely "stock" exemplar of a later model year of the subject vehicle, which had shown changes to the filler neck and fuel system by the manufacturer. In that crash test, there was no fuel system failure, and the filler neck remained attached to the exemplar fuel tank. The second crash test involved an identical exemplar vehicle from the same production year. The OEM fuel tank was retained in its original location. The fuel tank and filler neck were modified to allow re-location of the filler neck. The tank and filler neck were modified to prevent separation of the filler neck from the fuel tank, as well as to prevent cutting or other breach of the filler neck. A filler cap outlet from the same manufacturer was installed in a slightly different position, yet remaining within the rear quarter panel of the vehicle. An OEM filler cap and distal part of the filler neck were utilized, with off-the-shelf additional parts utilized to connect to the fuel tank. Minor reinforcements were made to the vehicle structures to improve shielding of the filler neck.

With the modified fuel system, there was no fuel leakage. The crush damage to the vehicle was more severe than was seen in the subject collision.

This test series proved that with off-the-shelf parts and common fabrication equipment found in most automotive repair shops, it was economically and technically feasible to design and build a significantly safer vehicle fuel tank and filler neck. The hazards of an exposed, un-tethered filler neck were avoided; despite dynamic crash testing that was in all probability more severe than the subject crash.

This test series proved that vehicle can be subjected to increased injury risk due to massive fuel leakage and resulting fire due to fuel system failure in readily survivable collisions, even with fuel systems that apparently meet applicable U.S. Federal Motor Vehicle Safety Standards.

Reasonably similar failures have been seen in a wide variety of fuel systems found in other vehicles from various manufacturers. The defects in this fuel system are not apparent to the average consumer.

Fuel System Integrity, Vehicle Fire, Crash Testing

C16 Explosion Investigation and Reconstruction Using Multidisciplinary Methods

Stephen J. Selk, BASc, PE, U.S. Chemical Safety & Hazard Investigation Board, 2175 K Street, Suite 400, Washington, DC 20037-1809*

The goal of this presentation is to familiarize investigators with multidisciplinary methods including witness interviews, as found conditions, debris analyses, blast marker identification, engineering analyses of the response of structures to explosions, combustion energy, pressure and impulse calculations, engineered system fault analyses, and medical evaluation of injuries.

This presentation will impact the forensic science community by increasing appreciation of the value of gestalt. Reconstruction is developed using a multidisciplinary team approach. The totality of the evidence from different methods yields a robust reconstruction on which public policy recommendations can be based.

On January 25th 2005, an explosion at an acetylene production and bottling facility killed three people and gravely injured a fourth. A primary issue was whether the fuel for the explosion was leaked acetylene or propane gas from a heating appliance. Using the actual incident as a case study, attendees will learn how multidisciplinary techniques were applied to reconstruct the explosion identifying acetylene as the fuel.

Acetylene and a handful of other gases burn very rapidly compared to hydrocarbons like propane. One consequence of rapid combustion is the creation of shock-like impulsive forces. Such forces can shatter certain construction materials while leaving other structural materials unaffected. In the instance at hand this manifested itself in a particular debris pattern. Similarly, damage to structural components may serve as blast markers allowing conclusions to be reached about overpressure and impulse. These techniques suggested acetylene was the fuel rather than propane.

Yet, the methods above were insufficient to build a conclusive case. Consequently, investigators obtained an exemplar propane appliance and conducted a failure modes analyses to demonstrate the improbability of failure of the appliance as a source of the leaked propane. They also considered the nature of injuries that resulted from the explosion. Medical opinion supported the theory that the injuries were consistent with what would be expected from a rapidly burning fuel. These additional considerations and others were sufficient to conclude acetylene was the fuel for the explosion.

Investigators then completed an engineering analysis of the acetylene production process to develop a plausible theory for how acetylene leaked to form an explosive vapor cloud. The Safety Board consequently published a safety bulletin directed at the acetylene industry and made safety recommendations including one for regulatory change.

Accident, Reconstruction, Explosion

C17 Appearances Are Deceiving: Observation is an Unreliable Gauge of Object Mass and Behavior

David Pienkowski, PhD, University of Kentucky, Department of Orthopaedic Surgery, 740 South Limestone, Suite K401, Lexington, KY 40536-0284*

The goal of this presentation is to show how observation-based perception can be dangerously misleading and can lead to personal harm. While quantitative mechanical analyses are not universally used for directing human behavior (and thereby preventing accidents); such analyses are useful for explaining subsequent events that have caused human injury. Visual observation is an unreliable gauge of object mass and dynamic mechanical behavior.

Objects of everyday living, e.g., sheets of diamond-patterned steel flooring, may appear manageable due their commonplace size and diminutive thickness, but the weight of these objects in certain positions or when placed in motion can be dangerously deceptive. This presentation will impact the forensic science community by demonstrating injuries resulting from vision based misperceptions of objects such as these and others do occur; questions regarding causation and injury mechanism often accompany such accidents. This study clearly demonstrates the usefulness of an integrated set of analytical methods, based on engineering principles coupled with biomechanical analyses, to explain the cause and extent of human injury in this particular set of circumstances. While such analytical techniques are commonly applied to vehicular accidents, this presentation demonstrates the value of the same techniques when applied to accidents in the workplace. This statement is also valid for other environments (home, office, recreational settings, etc.) where injuries occur when humans interact with structural, vocational, or recreational objects.

A "mining" accident occurred in a coal loading tower. Contract workers previously stacked four steel 4'X8' diamond-patterned sheets (0.125") against a steel frame. These sheets leaned against the frame at about an 11° angle. The next day an employee was found prone on the floor underneath these sheets. The edge of a nearby piece of machinery kept the full weight of these sheets from bearing on the lower extremities of this employee. He had fractures of the left proximal femur, right proximal tibia, and right proximal fibula. The objective of this study was to determine whether the sheets fell, or were pulled, onto this employee.

Sheet weights were obtained from specifications. The post-accident scene was photographed and inspected. Dimensions of all relevant structures were measured. All medical records were obtained and analyzed. Vibration measurements were performed by an independent contractor. Reenactment of the incident was done with a thin plywood sheet and ample padding on soft earth. Analyses of the steel sheets were done for a variety of resting, static, and dynamic falling scenarios.

Each steel sheet weighed 360 lbs (1,440 lbs total). All personnel underestimated these weights by a factor of two or more. Site inspection revealed a sturdy steel frame securely bolted to a steel floor. No scratches were evident on the floor near the fallen sheets. No shoe damage was seen. Vibration amplitudes were insufficient to dislodge the steel sheets from their resting position. Bone and soft tissue injuries were consistent with a fall, impact of the left hip against the steel floor, and impact of the plates against the right knee. Analysis showed that only 115 foot-pounds of energy were required to get the plates vertical by a "clean-and-jerk" type effort. Static analyses showed that small angular changes from vertical resulted in large (irresistible?) horizontal forces. Dynamic analyses quantified the extra forces needed to keep the plates from moving past vertical. Only a small window of "opportunity" to arrest plate motion existed; efforts outside this window would require arresting forces likely beyond the employee's expectations or abilities.

The data and analyses supported the hypothesis that the employee misjudged the mass of the plates and pulled them in such a manner that, once moving, he could not stop their continued motion.

Human Injury, Injury Mechanism, Injury Analysis

C18 Quantifying Discomfort Glare From a Misaimed Headlamp: A Case Study

James B. Hyzer, PhD, Hyzer Research, 1 Parker Place, Suite 330, Janesville, WI 53545-4077*

The objective of this presentation is to demonstrate, through the example of a case study, how discomfort glare can be quantified to determine its affect on a nighttime visibility accident situation.

The presentation will impact the forensic science community by providing the attendee with insight into how discomfort glare can be considered in nighttime accident visibility reconstruction.

Bright headlamps on vehicles in an opposing lane are a well known cause of visual glare for drivers at night. The commonly recommended practice for drivers encountering excessive glare from oncoming headlamps is to avert their eyes down and toward the right edge of the road until the glare source is passed. The obvious problem with this practice is that the glare source may be hiding an obstacle or hazard in the lane ahead that the driver needs to know about.

The degree to which a glare source is *discomforting* in the visual field of an approaching driver is related to the De Boer rating, W, which is calculated from:

$$W = 5 - 2\log \frac{E}{0.02\left(1+\sqrt{L/0.04}\right)\theta^{0.46}}$$

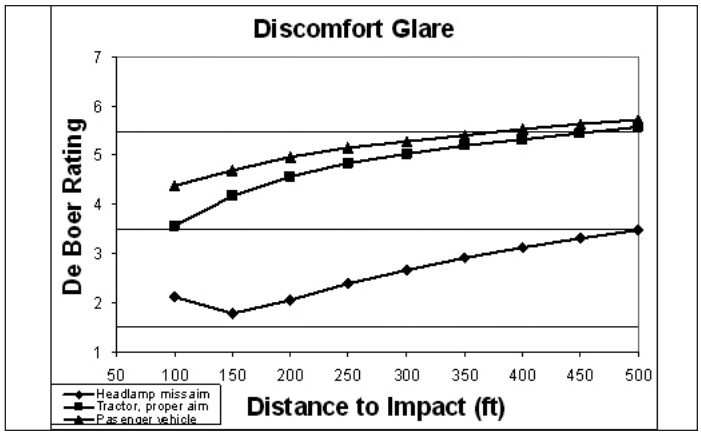
where, E is the illuminance at the eye in Lux,
L is the adaptation luminance in cd/m^2, and
θ is the angle between the glare source and the line of sight, in degrees [De Boer, 1967].
Glare sources with De Bore ratings of 7 or 6 are considered "satisfactory", 5 or 4 are "just admissible", 3 or 2 are "disturbing", and 1 is "unbearable."

Subject Case: The subject case involves a nighttime rear-end collision between an automobile and a stopped silage wagon under nighttime conditions on an unlighted rural two-lane highway. At issue is the ability of the automobile driver to detect and then recognize the stopped wagon as a hazard in his path at a sufficient distance to respond in time to avoid collision. A contributing factor to the visibility aspects of this collision was the presence of a Mack truck, stopped in the opposing lane next to the silage wagon, with its headlamps illuminating in a direction toward the eyes of the approaching automobile driver.

The stopped vehicles were blocking both lanes of traffic; therefore the automobile driver could not have encountered any oncoming vehicle headlamps for at least several minutes prior to encountering the headlamps of the Mack truck stopped alongside the back of the silage wagon. Due to the high mounting height of the truck headlamps and the upward and decreasing grade road geometry on his final approach, the automobile driver's eyes were always in the lower and more intense portion of the Mack's headlamp beam pattern.

During the inspection of the Mack truck it was found that the left (driver's side) headlamp was misaimed in such a way that the highest intensity portion of the low-beam intensity profile (the "hot spot") was directed 1.8 degrees to the left of the forward central vertical axis. As a result, the left headlamp of the Mack truck was significantly more intense in the direction of the automobile driver's eyes, as he approached the stopped vehicles, than it would have been had it been aimed properly with it's hot spot slightly to the right of the central vertical axis (in accordance with SAE J599 Standard).

According to output from the event data recorder, the automobile's brakes were engaged at between 1 and 2 seconds before impact. The back of the silage wagon was equipped with a slow-moving vehicle emblem, some reflective tape, and one or two operational flashing lights. The Sheriff's photographs of the crash scene show that some degree of dust reduced the efficiency of the retro-reflective and transmitting surfaces.



The figure above shows the calculated De Boer rating as a function of distance to impact for the condition of the subject accident where the opposing glare source is a truck with 4 foot high headlamps with the left (driver's side) headlamp misaimed by 1.8 degrees toward the centerline. For comparison, a similar truck with properly aimed headlamps, and a passenger vehicle with properly aimed headlamps are plotted to show the normally encountered condition of glare for an approaching automobile driver on a flat straight road.

Under conditions of no-glare (had the Mack truck not been there) the back of the wagon should have been sufficiently conspicuous and recognizable as a slow-moving (in this case stopped) hazard for the automobile driver to have responded and stopped in time to have avoided collision. Under the conditions that existed for him, as described above with a misaimed left headlamp, the "disturbing" level of discomfort glare from the stopped truck prevented him from detecting and recognizing the stationary silage wagon as a hazard until it was too late for his vehicle to come to a stop in time to avoid collision.

Reference:

De Boer, JB. Visual perception in road traffic and the field of vision of the motorist. In JB De Boer (Ed.), *Public lighting*. Eindhoven, the Netherlands: Philips Technical Library, 1967 [cited in numerous sources].

Glare, Nighttime Visibility, Accident Reconstruction

C19 Mitigating Radio Frequency in the Modern Lab

Rebecca Mikulasovich, BS, Office of the Chief Medical Examiner, 421 East 26th Street, New York, NY 10016*

The goal of this presentation is to identify solutions for radio frequency interference issues in the modern laboratory.

The presentation will impact the forensic science community by demonstrating how equipment in today's laboratories may be subjected to forces that have yet to be thoroughly documented and identified. This talk strives to address one issue of radio frequency interference.

In February of 2007 the Department of Forensic Biology of the Office of Chief Medical Examiner of New York City relocated to a modern, 13-floor facility. Equipment and personnel were scaled up to accommodate an anticipated increase in caseload. This talk will address specific challenges that emerged during the set-up of these new laboratories, specifically relating to the effects of radio frequencies (RF) on sensitive laboratory equipment using a real-time PCR instrument as a case study.

In 2003 the Department of Forensic Biology established a quantitative real time PCR assay using the Rotorgene 3000 manufactured by Corbett Research. Minor changes to the assay published by Nicklas and Buel (JFS September 2003) were made to enhance sensitivity for the lower amounts of DNA required for Low Copy Number (LCN) DNA testing. The assay was extensively validated, reviewed by auditors, and was successfully implemented with a 30% error rate. Moreover, during the course of the validation process and throughout the first year of its use for LCN casework in our old facility, the assay failure rate was overall 4%.

In January of 2007, our laboratory established partial occupancy in our new building, and, in the two months prior to full occupancy and increased equipment use, four Rotorgene 3000 instruments were installed and successfully passed their performance checks which encompassed three full runs performed on three different days. However, after the building became fully functional, Rotorgene assays began to fail intermittently with a 33-44% rate with no readily apparent cause. Data from the failed runs collectively displayed recognizable patterns such that we suspected the passing of data from the instrument through an exposed serial cable to the hard drive was the source of the failures.

Nevertheless, all plausible sources of failures were addressed including reagents, personnel, instrument function, ambient temperature, magnetic field, vibration, power quality, and radiofrequency interference. (The fact that the assay had performed successfully for 3.5 years eliminated the protocol as a cause.) Reagents were re-tested and personnel were re-trained to ensure quality; however, the intermittent nature of the failures and failures with the use of robotics for set-up, suggested that these factors were not the cause. The instrument also proved to be heating and cooling accurately. Furthermore, the ambient temperature, magnetic field, and power quality were measured and were within the instrument's specifications. Vibration did not appear to be significant. Additionally, in order to prevent total harmonic disturbance (THD) originating from other instruments sharing power sources, localized UPS units were utilized in lieu of the building's central UPS system. Despite these precautions, the failure rate was 20-25%.

After careful investigation, several new sources of radiofrequencies (RF) over a range of wavelengths and not present at the old facility were identified in our new environment. Radio frequencies are known to couple onto any metal surface or wire causing a buildup of signal that can and will be misinterpreted by data collection software. Radio frequency had a deleterious affect when assays failed consistently with the instrument encased in foil to create an antenna like effect was demonstrated. In an effort to mitigate RF, several tools were tested including external shielding of the instrument and cables, the attachment of lead core ferrites to the serial cables themselves, and custom braided cables. However, since the coupling of radio frequency to cables and equipment is a matter of probabilities, 100% coverage with one formulation was difficult to attain for every instrument location in the laboratory; therefore, photo-isolators, which remove the interference by cleaning up the signal as it passes down the length of the serial cable, were also tested.

As Bluetooth equipment and other wireless communications signals become more prevalent in society in general, mitigating the effect of radio interference presents a challenge. Due to positioning and even the structure of a building itself, the radiofrequency environment among and within each laboratory in a building may vary. Therefore, specific solutions and recommendations may not be applicable to every situation, and a more expansive preventative strategy may be necessary. It is incumbent upon manufacturers to take this into consideration in instrumentation design. Until these needs are met, results from our studies suggest some potential resolutions.

Radio Frequencies, Data Collection, Rotorgene 3000'

C20 Acoustic Analysis of Gunshot Recordings Utilizing Frequency Selective Integrated Loudness Envelope Evaluation

Philip M. Van Praag, MS, PVP Designs, PO Box 8174, Tucson, AZ 85738*

After attending this presentation, attendees will understand a unique methodology for the characterization of gunshot recordings in which the presence of gunshots from multiple guns is suspected but cannot be verified by other means. The testing process, findings based on the assassination of Robert F. Kennedy, and limitations of this methodology will be presented.

Although limited in applicability, this methodology has the potential of significant impact for cases in which gunshot recordings are of poor quality, obscuring the ability to identify the presence of gunshots from multiple guns. In one 40 year-old case of national scope, the assassination of Robert F. Kennedy, this methodology has uncovered evidence of the firing of two guns during that shooting.

This presentation will demonstrate the use of frequency selective integrated loudness envelope evaluation (FSILEA) methods in the analysis of a gunshot recording made during the assassination of Senator Robert F. Kennedy. Working with a poor quality recording, with limited frequency range and high noise levels, it is nonetheless sometimes possible to extract meaningful data regarding the number of shots fired and, in the case of multiple guns, differentiation between shots fired from those weapons.

The case involves the assassination of Robert F. Kennedy, wherein some of the original acquired evidence suggested the presence of a second gun. Due to premature destruction coupled with the circumstantial nature of evidence elements, that second gun presence could not be proven. A recently re-discovered audio recording (the only known recording of the actual shots) reveals the presence of two guns as a result of a unique forensic analysis methodology.

FSILEA exploits the acoustic principle of the directional distribution of radiated energy from a source as a function of frequency. Thus if two sources located close to each other, but in directionally opposite positions, alternately produce pulses of broadband noise, it might be possible to differentiate between those sources based on recorded analysis from a pickup device located a considerable distance from the sources and inline with one of them. This was the situation in the Kennedy assassination, wherein the two sources were low caliber handguns positioned close but directionally opposite to each other, with the microphone placed some 30 to 40 feet away, roughly inline with Sirhan's weapon.

Initial study of the recording involved the conventional use of time and frequency domain waveform analysis. These methods were useful to determine timing locations of suspected muzzle blast shot sounds. These locations were correlated with what was known from the crime scene through substantial video and audio coverage before and after the shooting, together with eyewitness testimony. The use of spectrographic imaging was helpful in differentiating the less prominent muzzle blast sounds, but – partially due to the high ambient noise levels – was not useful to differentiate between weapons. By extracting multiple high frequency slices over the entire gunshot interval, with each slice representing a quite narrow frequency band, and then overlaying these individual slices, subsequent slice comparisons

revealed markedly differing amplitude levels of some shot sounds. This measured phenomenon was consistent with the positioning of two known guns within the kitchen pantry of the Ambassador Hotel in Los Angeles, the scene of the crime. The resulting identification of which gun fired which shots was also consistent with the known number of shots fired from the Sirhan weapon, and the timing sequence of Sirhan's shots as recalled by the man who first apprehended him.

While the successful use of FSILEA is necessarily limited to cases involving a known set of positioning conditions as to sound sources and pickup device(s), it could also be used to exclude the possibility of such-positioned multiple sound sources. In addition, it is particularly useful under the conditions of poor recorded audio quality. In this particular recording, distinct shot sounds can be distinguished by the naked ear; but it is not possible to differentiate multiple muzzle blast sources simply by listening, due to the low grade of the recording equipment and the high ambient crowd noise.

This case study presents a specific practical application in the use of FSILEA wherein, after 40 years of unsuccessful attempts to conclusively establish the use of a second gun in the murder of a prominent U.S. senator, a long suspected aspect of that murder can now be firmly established. The test results are consistent with the consideration of multiple previously established fact sources such as the autopsy findings of Dr. Thomas Noguchi, recovered – but later destroyed - physical evidence, and the efforts of researchers through the years, such as those of Dr. Robert Joling.

Gunshot, Recording, Analysis

C21 Species Specific Differences in Dioxin Toxicity: Differences in Gene Regulation?

James S. Smith, Jr., PhD, Oak Creek, Inc., 60 Oak Creek, Buxton, ME 04093*

The goals of this presentation are to: (1) describe observed differences in dioxin-responsive element (DRE) prevalence and location in man and rat PEPCK gene sequences, (2) to clarify the nature and function of transcriptional enhancer elements in the control of gene transcription, and (3) to suggest a possible mechanism to explain why dioxin-mediated lethality in rats has not been observed in humans.

This presentation will impact the forensic science community by demonstrating the differential dioxin-mediated species toxicity, and how it may be dependent on dioxin's differential ability to regulate species-specific genes. Consequently, dioxin may not be as toxic to humans as regulators would have you believe.

Dioxin down regulation of the rat phosphoenolpyruvate carboxykinase (PEPCK) gene is the putative mechanism by which dioxin causes body weight loss, wasting, and death in rats. A search of the DNA sequence coding for the PEPCK gene, including significant non-coding flanking sequences, identified significant homology with the 10 base pair (bp) functional consensus sequence for the dioxin response element (DRE). Ten putative DREs with exact homology to the 5-bp core binding sequence (5′-GCGTG-3′) and more than 70% homology to the functional consensus sequence (5′-T/GNGCGTGA/CG/C-3′) occur in close proximity to the PEPCK gene and within a region previously suggested to be of significance in this genes regulation. Eight of these DREs contain specific nucleotide substitutions known to abolish DRE functionality and are therefore not functional as enhancers of gene transcription. The remaining two putative DREs are potentially functional transcriptional enhancers. Two potentially functional DREs and four non-functional DREs are located in a unique overlapping arrangement within a 102-bp region downstream of the PEPCK gene in a manner that suggests coordinate regulation of the gene by the aryl hydrocarbon receptor (AhR). The location, binding affinity, and potential functionality of these putative DREs suggest a novel mechanism by which dioxin may regulate this genes transcription. In contrast, the available sequence of the human PEPCK gene does not contain similarly arraigned DREs, an observation which may explain the apparent lack of dioxin-mediated acute body weight loss, wasting, and death in humans.

Dioxin, Toxicity, Gene Regulation

C22 Forensic Applications of the Transmission Electron Microscope

Whitney B. Hill, MS, MVA Scientific Consultants, 3300 Breckinridge Boulevard, Suite 400, Duluth, GA 30096*

The goal of this presentation is to present to the forensic community information about how Transmission Electron Microscopy (TEM) can be instrumental in forensic trace evidence analyses.

This presentation will impact the forensic science community by showing how TEM can be very useful in forensic trace evidence analysis due to its ability to analyze the morphology of small particles, gather elemental information on very small particles and determine the internal structure of small particles. This presentation will show the advantages of using TEM along with other microscopic techniques to characterize and identify particles, specifically nanoparticles, for forensic purposes.

TEM is rarely used as an analytical tool in forensic science. However, it can be very useful in this area because of its ability to analyze the morphology of small particles, gather elemental composition information on very small particles because of its beam concentration ability, and determine the internal structure of particles, whether crystalline or amorphous, via electron diffraction.

In a recent environmental forensic case study, there was a stain on the window of a building painted with an off-white architectural paint. There was a question of whether this stain was caused by the architectural paint itself or the caulk around the window. Scanning Electron Microscopy (SEM) and Polarized Light Microscopy (PLM) were used to characterize the constituents of the paint, caulk and stain to determine if the stain was caused by either the caulk or the paint. SEM and PLM observed 4 different constituents of the paint. By using TEM, the 4 components previously analyzed using the other methods, but also thin iron fibers, not detected by SEM or PLM, within the paint and the stain were observed. It can be concluded, using TEM, that the architectural paint was indeed the source of the stain on the window.

The production and application of nanoparticles continues to increase significantly. Therefore, it is very important to characterize these particles in order to study their impact on trace evidence examinations. Some nanoparticles that have become of significant interest are "fullerenes". Fullerenes are a 3rd carbon allotrope, along with diamond and graphite, with many unique properties that increase their potential use in various products. These products include clothes, concrete, sports equipment, water filters, lubricators, fuels and batteries, to name a few. The use of fullerenes in these products can eventually lead to their existence in trace evidence samples. For that reason, TEM was used to characterize some of the fullerenes and other nanoparticles because of its ability to analyze very small particles that aren't easily analyzed using other microscopical techniques. These fullerenes include; carbon 60 (C60), also referred to as "bucky balls", which are closed caged molecules, about 1nm in diameter, with 60 carbon atoms; carbon 70 (C70), which are also bucky balls with 70 carbon atoms; single-walled carbon nanotubes, which are elongated fullerenes with an average diameter of 1.2nm; and double-walled carbon nanotubes, which are also elongated fullerenes with varying nanometer range diameters. Other nanoparticles that I've characterized by TEM because of their potential importance to forensic trace evidence analyses are aciniform soot, carbon black, fumed silica, silicon carbide, aluminum nanospheres, fumed alumina, aciniform tantalum, aciniform nickel, fly ash, welding fumes, gunshot residue, and paint pigments and fillers. Present research also involves using TEM to develop a nanoparticle database that provides a reference comparable to other nanoparticles potentially observed during future trace evidence examinations. Using TEM in forensic science trace evidence examinations can augment other analysis tools by gathering morphological, elemental and internal structure information on very small particles that may be overlooked or not easily analyzed using other microscopical techniques.

TEM, Fullerenes, Trace Evidence Analysis

C23 Particle Contaminant Separation and Purification From a Nutritional Powder Supplement Using Light Microscopy

Richard S. Brown, MS, MVA Scientific Consultants, 3300 Breckinridge Boulevard, Suite 400, Duluth, GA 30096*

After attending this presentation, attendees will gain an understanding and appreciation of how light microscopy can be used to examine complex powders and to separate contaminants that are present at or below the detection limits of complimentary analytical techniques.

This paper will impact the scientific and forensic community by demonstrating a limitation to bulk analytical methods by demonstrating that purification of a complex powder mixture by hand picking contaminants can increase the analytical sensitivity exponentially.

The goal of this presentation is to present to the forensic community information about how the microscopical analysis of a complex powder supplement and subsequent isolation of contaminant particles by handpicking, can increase the detection limits for further analytical testing.

The microscopical analysis of a nutritional powder supplement resulted in the isolation of a few milligrams of a suspected contaminant. Testing the bulk powder by conventional analytical techniques resulted in trace amounts of the contaminant being detected. Because the contaminant concentration was so low in the bulk product, light microscopy was used to search the individual particles comprising the powder for particles that were unlike the manufactured powder product. Once the possible contaminant particles were located, they were removed from the powder matrix by hand until a few milligrams of material was isolated and the hand-picked particles were subjected to further conventional analytical testing. The subsequent analytical testing of the now concentrated contaminant confirmed the identity of the contaminant that was not possible in the bulk powder form due to its low concentration. One hundred retains were examined using light microscopy to determine if the manufacturing process could have created the contaminant. Contaminant particles were not observed in any of the retain samples, suggesting that the contaminant particles were from and outside source and not a result of the manufacturing process. This case illustrates a situation where separation of a solid particle contaminant from a bulk powder product was not possible by conventional liquid extraction techniques but was possible by mechanical and physical extraction techniques augmented by light microscopy.

Microscopy, Contaminant, Particles

C24 Acetaminophen Carcinogenic Dose Response Assessment

James S. Smith, Jr., PhD, Oak Creek, Inc., 60 Oak Creek, Buxton, ME 04093*

The goal of this presentation are to (1) to estimate the carcinogenic potency of acetaminophen, (2) to illustrate a lack of consistency in the evaluation and regulation of threshold carcinogens; and (3) to examine U.S. Environmental Protection Agency's (US EPA) methodology for determining cancer potency estimates for environmental carcinogens.

This presentation will impact the forensic science community by showing an inconsistency in the evaluation and regulation of carcinogenic compounds allows acetaminophen to be sold in over-the-counter therapeutic preparations, but regulates other carcinogens to very low levels in the environment.

Acetaminophen or paracetamol is one of the most popular and widely used over-the-counter analgesic and antipyretic drugs in the world. Physicians in the United States routinely recommend acetaminophen for use by children and adults as a safe alternative to products containing aspirin or aspirin-analogues. In recent years, however, studies have reported on the genotoxic and carcinogenic effects of this compound. Although acetaminophen does not cause gene mutations, there is clear evidence that it causes chromosomal damage in mammalian cells. This suggests that acetaminophen may have a similar effect *in vivo*, an effect supported by studies demonstrating increased incidence of liver and bladder tumors in mice and rats. Regardless, health professionals generally consider acetaminophen safe for human use. This is because the therapeutic dose for acetaminophen is much smaller than the threshold dose for genotoxic and carcinogenic effects.

Acetaminophen is a threshold carcinogen. For adults, the recommended therapeutic dose of acetaminophen in over-the-counter preparations is generally less than 1000 milligrams (mg), taken as often as 4-times a day (Tylenol PM). Assuming an adult body weight of 70 kg (US EPA 1996), administering the maximum amount of an over-the-counter preparation containing acetaminophen can result in a dose that exceeds 57 mg per kilogram (kg) of body weight (bw) per day (57 mg/kg/day). In contrast, doses of up to 300 mg/kg-bw/day in the rat and 1000 mg/kg-bw/day in the mouse do not cause cancer. In fact, even higher doses of acetaminophen in animal studies and in clinical cases of human overdose are most often associated with liver toxicity and not endpoints of cancer. Physicians and scientists take this as evidence that acetaminophen is safe for therapeutic use in humans. In contrast, the US EPA tends to ignore such low-dose-no-effect evidence for threshold carcinogens, using a linear low-dose non-threshold model to extrapolate to very low doses to regulate their allowable level in the environment. The assumption inherent in the use of this model is that a single molecule can cause cancer. The US EPA typically uses this model to extrapolate down to a compound concentration corresponding to a risk of one additional cancer in one million people. For threshold carcinogens, this level may be much lower than the threshold for cancer.

In this presentation, the carcinogenic potency (CSF) of acetaminophen is estimated using the linear low-dose non-threshold model typically employed by the US EPA. This CSF is compared to US EPA derived values for other threshold and non-threshold carcinogens. The results of this analysis suggest that the US EPA's use of the low-dose linear model for estimating the cancer potency of threshold carcinogens is flawed. In summary, there seems to be an inconsistency in the evaluation and regulation of carcinogenic compounds. This inconsistency allows acetaminophen to be sold in over-the-counter therapeutic preparations, but regulates other threshold carcinogens to very low levels in the environment.

Acetaminophen, Dose-Response Assessment, Carcinogen

C25 Automobile Shredder Residue: Waste or Wasted Resource?

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The goal of this presentation is to demonstrate a custom sampling and analytical approach designed to ensure representative results for an extremely heterogeneous matrix.

This presentation will impact the forensic science community by demonstrating how improved sampling and analytical techniques for ASR will positively impact the forensic science community's ability to determine the most appropriate final disposition of this material, including its potential for use as an alternative fuel source.

Automobile Shredder Residue (ASR) is made up of all the non-ferrous material obtained from shredding old automobiles at a recycling facility. ASR contains rubber, plastics, wire, seat foam, etc. Batteries, gasoline, crank case oil, and coolant are all removed before the automobile enters the shredder. The ASR material is a sampling nightmare due to the various densities and sizes of the residue as well as the ever-changing composition of the recycled automobiles.

There are two regulatory roads to cross for the determination of the regulatory status of ASR for disposal purposes. First, there is the Toxic

Substances Control Act (TSCA). ASR generally contains polychlorinated biphenyls (PCBs) in a non-liquid form. The PCBs come from electronic components, such as dry capacitors and condensers containing Aroclor 1242, hydraulic fluid, and plasticizers in wire insulation and other plastic parts containing Aroclors 1254, 1260, and/or 1262. EPA regulations under TSCA provide that ASR may be disposed in a municipal landfill as long as PCB small capacitors1 have been removed from the shredder infeed, or, alternatively, as long as the ASR leaches less than 10 µg/L (ppb) of PCBs. Second, there is the Resource Conservation and Recovery Act (RCRA), which specifies that the TCLP leachate of ASR may not contain more than 5 mg/L (ppm) of lead and 1 mg/L of cadmium. Lead in ASR is most frequently associated with batteries, but may also be related to the presence of PVC-containing materials, solder, and wheel weights, among other sources.

Obviously, valid analytical data are necessary in order to make these regulatory determinations. Equally important is the need to collect valid samples for analysis – not a trivial task for this matrix.

A sampling protocol has been designed to obtain representative samples of ASR. First, representative portions (based on overall volume generated) of the five separate waste fractions that exit the shredder on the selected sampling day are composited to form a single pile. The subsequent sampling approach is based on the specifications of EPA's SW846 Chapter 9, and starts with thorough mixing of the combined pile with heavy equipment. The pile is then flattened into a (roughly) rectangular pile that is approximately one foot deep and 400 square feet. This flattened pile is repeatedly quartered until each subsection approximates five to 20 gallons. Using a random number table, eight subsections are selected and removed from the large pile. These eight subsamples are then thoroughly mixed using heavy equipment, and the smaller pile is flattened to approximately one foot in depth and quartered twice to generate eight subsections. Using a random number table, one of the eight subsections is selected and becomes the sample that is sent to the laboratory in a five-gallon bucket.

Methods of analysis have also been modified to facilitate generation of representative results. The samples that are received from the field are first size-reduced by whatever means are necessary (cutting, chopping, etc.). Although the TCLP method specifies a 100 gram sample aliquot, a much larger aliquot (2 kilograms) of these samples is leached. To maintain the proper ratio of sample to leaching solution, this required construction of a shaker that could accommodate 40-liter containers instead of the normal 2-liter jars.

The success of these sampling and analytical methods is demonstrated in Figures 1and 2. Figure 1 compares results for Total lead and TCLP lead analyzed using routine-size (1 gram for Total and 100 grams for TCLP) aliquots of ASR collected as simple grab samples from large piles. No correlation is observed. In contrast, Figure 2 illustrates the much improved relationship between Total and TCLP lead analyzed using the customized large aliquots (100 grams for Total and 2 kilograms for TCLP) of ASR collected by the procedure described above.

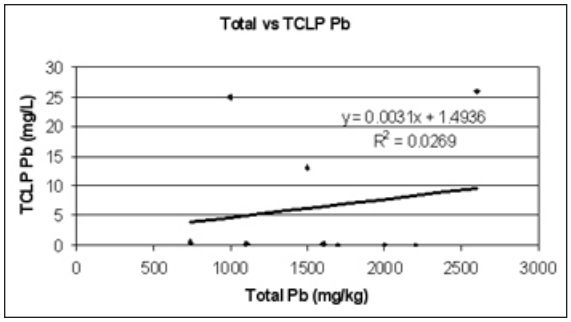

Figure 1: Total Pb versus TCLP Pb using routine analytical procedures.

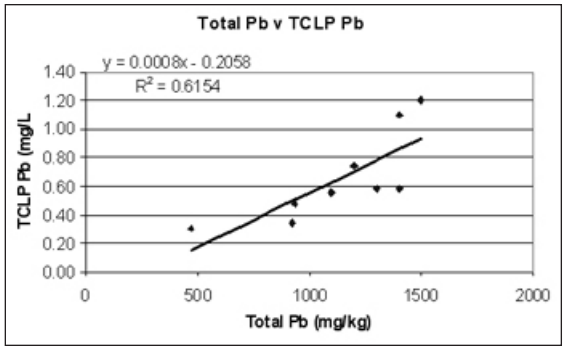

Figure 2: Total Pb versus TCLP Pb using customized (large aliquot) analytical procedures.

Reference:

[1] PCB Small Capacitors are capacitors containing less than 3 lbs of dielectric fluid containing PCBs at concentrations of 500 ppm PCBs or greater. Dry capacitors are not regulated as "capacitors." "The definition of 'capacitor' refers only to devices that contain dielectric fluid." EPA's *PCB Q&A Manual September 2001 Version* at p. 12 section 761.2(a)(4).

Automobile Shredder Residue, TCLP, Representative

C26 Faster Analysis, Custom Spreadsheets, and Lower Detection Limits Don't Guarantee Defensible Data

Denise A. Shepperd, BS, Trillium, Inc., 2014 Carol Drive, Wilmington, DE 19808*

After attending this presentation, attendees will learn to recognize a variety of software, hardware, and method-related issues that may adversely impact the usability of their data.

It is the goal of this presentation to help data users recognize potential differences between numbers on report forms and valid, defensible results.

Recent efforts to retrieve and review analysis results for volatile organic compounds in groundwater samples collected at an industrial site brought to light a variety of problems with data integrity, created by a laboratory's efforts to increase throughput, keep costs down, achieve low detection limits, and maximize computer software use. Some problems encountered with low detection limits, short analytical run times, laboratory contamination and carryover, the use of turn-key software systems, and the retention of records will be introduced. Laboratories are competing in a tough market and make use of the newest technology to shorten preparation and analysis times, limit the need for human activity in data handling, and move toward a paperless system in order to lower the costs and keep the throughput high. They are forced to strive for ever lower detection limits to meet their clients' needs. These factors can impact the accuracy and defensibility of the data produced. As data users, we need to be aware of this increasing problem and be on the lookout for warning signs. We have a duty to those who rely on our expertise to make sure that we can rely on the data we are using.

Defensible, Data, Detection

C27 So, You Didn't Think You Needed to Dot That I?

Carol A. Erikson, MSPH, Trillium, Inc., 356 Farragut Crossing Drive, Knoxville, TN 37934*

The goal of this presentation is to clearly demonstrate the importance of accurate documentation, and the potential consequences of not tending to even minor details.

The presentation will impact the forensic science community by sharing this case study, which will point out the crucial importance of accurate documentation and reporting, including may what seem like minor details, by analytical laboratories. This is also more broadly applicable to any forensic occupation.

Lack of attention to details, unintentional or otherwise, can have dire consequences. This presentation considers the case of a laboratory that sought help from another laboratory for water sample analyses when their instrument went down. Problems arose when it was determined that the first laboratory not only reported the results as their own work, but also made some significant changes. Subsequent legal actions against the first laboratory ultimately led to conviction of the laboratory owner on charges that may surprise you.

The year is 1998. Samples are piling up at Jekyll Labs, but their instrument is down. Holding times are looming, and the requested EPA 601/602 analyses need to be done soon. So, Dr. Jekyll sends them off to his friend at Hyde Analytical, following the time-honored tradition of subcontracting in a pinch. Problem solved. Well, maybe not. It seems that Mr. Hyde's 601/602 instrument is down, too. When Mr. Hyde offers to do EPA 624 analyses instead, though, Dr. Jekyll heaves a sigh of relief and accepts. Crisis averted? Well …

Fast forward to 2002. Now the federal government is asking questions about misrepresented results, using the wrong method, and even fraud. What happened? It seems that Hyde's analytical reports came back listing analysis by EPA 624, but Jekyll's reports to their clients show analysis by EPA 601/602 … and then there's the little matter of the analyte lists not matching … and, oops, some of the detection limits are different. Is it a big deal? Apparently so: big enough to get an indictment against the boss at Jekyll Laboratories, take it all the way to trial, and get a conviction.

Documentation and reporting – the devil really is in the details. Caveat venditor!

Subcontract, Litigation, Fraud

C28 Converging Evidence: A Bayesian Example

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After attending this presentation, the attendee will learn how mutually exclusive hypotheses and Bayesian inference are practical tools that can help sort and evaluate analytical information in complex cases. This presentation will incorporate examples from environmental casework, and will illustrate the use of a Bayesian network computer program in the evaluation of hypotheses as additional data comes in.

The presentation will impact the forensic science community by. The use of mutually exclusive hypotheses and Bayesian inference can assist forensic practitioners in meeting the interests of the courts in presenting defensible and falsifiable analyses in environmental and other cases. It should aid practitioners in performing focused work that can address the issues of interest in a scientifically reliable way.

Bayesian inference Preliminary results for a contaminated site performed to determine regulatory compliance do not always answer questions about who is responsible and what they should do about it. As a case moves from regulatory compliance to forensic investigation to litigation to remediation, and the first rounds of testing do not yield a simple and obvious answer, it is useful to have a few tools to sort through the information and to evaluate what the results mean. This is especially important when things are complicated, and multiple hypotheses can be offered in explanation. A clean experiment means that the scientist or engineer knows what questions have and have not been answered. It is critical to focus the analytical questions so that any additional work would have an impact on the case questions, and to eliminate untenable hypotheses so the remaining ones can be evaluated. The focus of this paper is on hypothesis formation after some of the results are in, and the use of formal mutually exclusive hypotheses and Bayesian inference as a means for narrowing down hypotheses, focusing any testing that should still be done, and weighing the final hypotheses.

For mutually exclusive hypotheses A and B, if A is true, B is not true, and if B is true, A is not true. A formal hypothesis suitable for comparing with its antithesis should be clean and simple, and any conditionals (the "true if's") placed into separate hypotheses so when the hypotheses are being compared, the comparison is easy to interpret. For example, if lead is found in soil samples from a site, and white paint chips and metal bearings are also found in the soil, the latter are both possible sources of lead. There may be unknown contributors as well. One could construct the following hypotheses: 1a) the lead in the soil is from white paint chips and metal bearings only; or 1b) the lead in the soil is from white paint chips, metal bearings, and an unknown source. "A" would be true if no lead is found in the extracts. It may also be true if lead from either or both sources has leached into the soil. "B" would be true if lead is found in the extracts but in a form not explained by leaching of the paint or metal bearings. Lead in the extracts may also be from both leaching and another source. This does not provide a clean answer, so additional hypotheses may be needed: 2a) The lead in the soil sample extracts is that leached from white paint chips and metal bearings only; 2b) The lead in the soil sample extracts is from another source only; or 2c) the lead in the soil sample extracts is from both paint-and bearing-leached lead and from another source. These hypotheses can probably be resolved through additional analyses, and the construction of the problem is now clean enough to allow focused testing. It may be that existing data can resolve them; the comparison of hypotheses allows us to quickly determine what data we would need to see.

It may not be possible to test this further. When additional testing is not possible, the existing information must be evaluated and weighed. In comparing hypotheses 2b and 2c, for example, the scientist or engineer should weigh the two possibilities to determine whether hypothesis 2C is not only possible, but whether it is reasonably likely. It is also important to remember that something may be true even if is unlikely. That is why formal statistical evaluation or other evaluations of likelihood should not be attempted until testing to distinguish hypotheses has been performed. Other tools to use in evaluating data after additional testing is not possible include asking: "if it is not what I think it is, what else might it be?" This can produce additional hypotheses to evaluate and can help re-focus on the actual data. Another tool is to find the best fit with the evidence via evaluation of the convergence of data. A specific test result and analytical conclusion may have several possible explanations, but when all the test results and conclusions are considered, each of them may include one or two of the many possible data point explanations. This is where the data converges. The explanation where all the data converges is usually the best explanation, and an explanation where some of the data converges and none contradicts it is another possible explanation. The latter should be included in a reporting of results, as it may be true.

After the mutually exclusive hypotheses have been constructed, and any additional testing performed, the remaining hypotheses should be evaluated and weighed. A useful statistical tool for doing so is Bayesian inference. Bayes's Rule expresses the probability that a certain event has occurred given a specific condition or conditions of measurement. It does this by relating the probability of the event given the evidence, to the probability of the evidence given the event. This is a way to measure the impact of the evidence on the overall probability. For example, it can be used to derive the

probability that lead contamination is attributable to the peeling white paint of oil storage company tanks at the site being investigated, and metal bearings from the railroad previously on the site, given the condition that lead was found in the soil in the corresponding white paint chips, the metal bearings and the extracts. As a model, it is broadly applicable to evaluating scientific endeavors, and is of particular interest in comparing a hypothesis with an alternative hypothesis in light of a particular analytical result(s). In the aforementioned example, an alternative hypothesis might be that despite the presence of lead in the paint chips and metal bearings, the lead in the soil extracts is actually from another source.

A particularly useful form of Bayes's Rule for forensic scientists and engineers is to write the rule as a statement of odds rather than as a statement of probability, so that any probability is compared with its antithesis. This is what an odds statement entails. Thus, the odds of the event occurring given specific evidence are related to the overall odds of the event via a ratio. This ratio is called the Likelihood Ratio, i.e., a ratio of the probability of the evidence given the event, versus the probability of its being there even if something else happened instead. Thus, when two mutually exclusive hypotheses are being compared, the probability of one is being divided by the probability of other.

In mathematical language: Where J is the event (i.e., the scenario) and I is the condition (i.e., the evidence or result), Bayes's Rule – written in terms of odds rather than probability — is: $O(J|I) = O(J)\ [P(I|J)] / [P(I|\text{not-}J)]$, where O(J|I) is the odds of event J occurring given the condition I; O(J) is the odds of event J occurring; P(I|J) is the probability of condition I being present if event J occurs; and P(I|not-J) is the probability of condition I being present if event J does not occur.

Even if a statistical evaluation cannot be performed for a lack of hard numbers, which may be difficult to come by when an unknown source is being considered, the reasoning involved in statistical evaluation can be applied, especially when Bayesian inference is used. It is more interesting to estimate some probabilities based upon data from other investigations to see how a comparison of the estimated probabilities would affect the overall questions being addressed. This gives the scientific evaluator a tool for objectively evaluating his or her thought processes. Bayesian inference directs the evaluation along statistical lines, a process which can greatly assist in explicating the scientist or engineer's assumptions and beliefs via a formal structure of evaluation. Scientists working within the legal system are frequently asked to evaluate competing hypotheses in terms of "more or less probable" or "more or less likely". Since this is the language of law rather than science, the scientist or engineer may not perceive this as a scientific question, and may fall back on hunches, or on opinions that are not expressed in terms of the science that produced them. Using this less rigorous framework for expressing a scientific opinion can result in explanations of opinions that are misleading. Even very good opinions can be lost if they are not amenable to scientific scrutiny. The Bayesian schema is well suited for such tasks, which are essentially decision-theory settings, to make explicit the assumptions, reasoning and estimations that go into the scientific opinion so that it can be understood with all of its underpinnings and uncertainties for proper evaluation. It is also useful to help us as scientists in assuring ourselves that we have not fallen prey to unscientific heuristic devices that are often sources of error. Putting a few numbers, even estimates, into the Bayesian equation can quickly expose such fallacies in our own thinking.

In this paper, we will present a Bayesian analysis of evidence in an environmental investigation using estimated probabilities of the data plugged into a Bayesian network computer program that is accessible even to those who are not expert in statistics.

In summary, mutually exclusive hypotheses are powerful tools for focusing analytical questions and narrowing down hypotheses in complex investigations once some of the analytical results have already come in. Bayesian statistical analysis is useful in evaluating and weighing the hypotheses that remain after testing has been completed. These tools, including the computer tools used in Bayesian networks, are accessible to the forensic scientist and the forensic engineer, even those who do not have formal training in statistics, and are useful in a broad range of investigations.

Environmental Forensics, Bayesian Inference, Forensic Science

C29 Multidisciplinary Symposium on Sick Building Syndrome

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After attending this presentation, attendees will be able to recognize the causes of Sick Building Syndrome (SBS), describe the signs and symptoms office workers experience, identify the most common genus and species of mold in contaminated buildings, and summarize risk management steps to minimize the occurrence of SBS.

This presentation will contribute to the audience's understanding of the health hazards associated with SBS, and provide those forensic scientists with minimal training in biology and mycology with the knowledge required to interact with the toxicology, medical, engineering, and legal professions, all of whom play an interdependent role in diagnosing, ameliorating, treating and resolving disputes involving SBS.

Sick Building Syndrome (SBS) is no joke. Ask those homeowners who survived Hurricane Katrina in New Orleans who returned to their barely remaining homes to find the interior walls covered with patches of black, ugly fungus, *Stachybotrus chartarum* (chartarum for paper, because this mold grows on the paper covering the plaster panels or panels of dry wall throughout the house). *Stachybotrus chartarum* may also be called *Stachybotrus atra.* SBS is actually a misnomer; it was coined in the 1970s by British physician Tony Pickering, MD, and the expression caught on. It is the people who work in the building who get sick, not the building.

SBS is usually caused in a building due to increased humidity (>55%) which provides an excellent environment for fungi and different types of microbiologic and biological species to proliferate. As these "biological babies" grow, they produce a variety of chemicals. Sometimes, the first thing workers notice is a peculiar odor, and visitors to an infested home, may ask, "Do you have a dog or a cat?" as derivatives of ammonia permeate the air with an odor reminiscent of urine.

Exposed individuals often experience irritation of the eyes, nose and throat, and a dry cough. Dry, itchy skin, headache, nausea, and difficulty concentrating are also frequently reported. Many people feel better when they go home or work in another part of the building, only to find their symptoms recurring when they return to the affected area again. SBS is distinguished from Building Related Illness (BRI) in that the source of the health hazard originates within the building. In BRI, a co-worker with the flu (or in the worst case, Legionnaire's Disease) infects other people, so the source of the health problems were an infected person who should have stayed home from work while contagious, and not a health problem that originated within the building.

According to a NIOSH study of 529 sites, SBS was caused by the following sources at the indicated frequencies: Inadequate Ventilation (52%), Chemical Contamination from indoor sources (17%), Chemical Contamination from outdoor sources (11%), Micro/Biological Contamination (5%), Building Fabric (3%), and Unknown (12%).

SBS can be prevented by: keeping temperatures between 68-79°F, maintaining humidity at 45-50%, providing adequate ventilation (at least 15 cfm), and designing building exhausts remote from air intake vents, garages, and dumpsters. The presence of mold usually indicates poor building maintenance. Also, be cognizant of furniture that emits Volatile Organic Compounds (VOCs), use of cleaning agents, kerosene heaters and floor polishers that are used after hours.

Sick Building Syndrome, Mold, Mycotoxins

C30 Studies of Building Related Asthma and Respiratory Symptoms in Relation to Dampness and Microbial Contamination of the Indoor Environment

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The goal of this presentation is to inform attendees of research done by the National Institute of Occupational Safety and Health in regard to building related asthma in offices and schools.

This presentation will impact the forensic science community by informing attendees of the use of resources to remediate damp indoor environments.

Background: Employee health in buildings with work-related asthma cases and a range of dampness from 2000-2005 was investigated.

Methods: Standardized questionnaires in 3 populations occupying 16 buildings for internal and national comparisons were used. Pulmonary function, methacholine challenge, and skin prick tests were conducted. Respiratory health outcomes in relation to semi-quantitative observational scores for moisture, water staining, visible mold, and mold odor and microbial indices in air and dust was analyzed.

Results: Asthma and symptom prevalences were 2-4 times expected. Observational exposure indices predicted building-related respiratory symptoms. Significant associations existed between respiratory symptoms and ergosterol, Penicillium/Aspergillus extracellular polysaccharides, and culturable fungi in floor dust and airborne total fungi and endotoxin. Symptoms were substantiated by abnormal lung function, methacholine results, or medication use in 2/3 of cases in a building in which risk of asthma onset increased 7.5-fold after occupancy; sick leave due to building-related respiratory problems accounted for 12% of sick leave in this building. Atopy was not associated with building-related respiratory complaints. Repair of the building envelope and cleaning did not interrupt incident cases of work-related respiratory disease in the 16 subsequent months.

Conclusion: Some water-damaged buildings have excess respiratory disease which warrants research on etiologic markers and effective remediation strategies.

Occupational Asthma, Damp Buildings, Mold

C31 Forensic Investigations on Mold Growth in Damp Buildings

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After attending this presentation, attendees will have an increased understanding of the role of mycology in forensic investigations in problem (damp-wet) buildings. The general principles for carrying out mold inspections and mold remediation recognized by cognizant authorities and professional societies will be explained. Limitations of laboratory analytical techniques and data interpretation will also be explained.

This presentation will impact the forensic science community by showing techniques essential for carrying out forensic mycology both in the field (in the building) and in the laboratory will be explained. Some sampling techniques such as collection of cellotape slides are simple and straight forward. Other techniques are complex (e.g., collection of air samples) and not routine. Direct microscope observation of fungal structures as seen in cellotape samples and culture analysis of samples using appropriate growth media (e.g., malt extract agar without dextrose; DG-18 agar, etc.) are used in most forensic studies. Sampling and analytical methodologies involved PCR, identification of mycotoxins, quantification of glucans, and microbial volatile organic compounds are currently the subject of much research interest.

It has been recognized since the time of Leviticus over 3000 years ago that the growth of mold on interior surfaces such as plaster, mortar, and timber in buildings is unacceptable. During the past 50 years mold growth problems in buildings have increased because (A) of greater use of highly biodegradable materials (e.g., products containing paper, fiber-board, porous finishes, etc.) and (B) dampness and water leaks often associated with construction and architectural defects. Mycological studies can be useful in identifying dampness-moisture problems in modern construction and sometimes in aiding epidemiologists and physicians determine health risk due to bioaerosols in indoor air.

In a "normal" dry building the rank ordor kinds of airborne mold spores found indoors is usually similar to the rank order kinds of spores present outdoors. Damp-wet buildings are often characterized by unique mold ecologies where *Aspergillus* or *Penicillium* species (e.g., *Penicillium chrysogenum, Aspergillus versicolor)* dominate the indoor air. Cellulose degrading molds such as *Stachybotrys and Chaetomium* often grow on water damaged paper products used in building construction.

Taxonomic studies are useful in determining if a building material was merely damp (xerophilic molds such as *Aspergillus versicolor* or *Wallemia sebi* grow) or soaking wet (hydrophilic molds such as *Stachybotrys*, *Chaetomium, Acremonium* grow).

Long term moisture problems on some building materials are indicated by complex microbial ecologies including the presence of mites and other organisms that feed on molds. The occurrence of fecal pellets containing undigested mold spores is an indication of a long term moisture problem and a long term mold ecology. Some mold species such as *Cladosporium cladosporioides*, *Alternaria alternata,* and S*tachybotrys, chartarum* are characterized by spores with a short half life (< 1 year) with regard to culturability. Thus, the presence of substantial amounts of these *Cladosporium, Alternaria*, and *Stachybotrys* species on moldy building materials suggests the occurrence of recent (< 1 year) moisture damage. Other mold species such as *Aspergillus flavus* and *Aspergillus versicolor* have a long (> 10 years) half life in terms of culturability. A key requirement for successful forensic investigations in moldy buildings always involves use of appropriate sampling and collection techniques in the field plus the collaborative involvement of an expert fungal taxonomist in the laboratory.

Several case studies as follows are presented showing the use of forensic mycology in diagnostic studies in "problem" buildings.

Case #1: *Stachybotrys* was the dominant mold found in spray-on cellulosic fire-proofing found in a new building. This evidence showed that the fire-proofing remained wet after its application and that this condition was likely caused by chronic roof leaks (a construction defect).

Case #2: During rainy periods water was observed on the floor in many rooms along external (envelope) walls in a new building. Air sampling for culturable molds showed that *Penicillium chrysogenum* dominated the mold spores present in indoor air in leaky rooms. Only trace amounts of this mold species were found in the outdoor air and in the indoor air of non-leaky (dry) rooms. This data suggested that a substantial amount of concealed mold growth was present in envelope wall cavities, a hypothesis later confirmed by destructive inspection of the wall cavities.

Case #3: Water leaks from windows were present in many rooms in a new building. Mold growth was visible on the wallboard in some rooms, which were subsequently vacated for mold remediation. Occupants in other rooms in the same building were concerned over long-term mold exposure. Settled dusts were collected from above floor surfaces in occupied rooms and these dust samples were analyzed for the presence of culturable molds. *Stachybotrys*, *Aspergillus*, and *Penicillium* species accounted for > 90% of culturable molds in the settled dust suggesting that occupant exposure in the building was atypical or different from that expected in a well maintained dry building.

Forensic, Mold, Dampness

C32 Sick Building Syndrome

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The goal of this presentation is to help the attendee learn how microbial species can impact human health, and how the building problem causing the health issues can be investigated, diagnosed, and addressed.

This presentation will impact the forensic science community by presenting an emerging area of science and engineering which allows identification and remediation of building problems leading to health impacts.

Sick building syndrome (SBS) refers to a pattern wherein building occupants associate certain sicknesses with spending time in a building. Sicknesses can range from malaise to coughing or allergy type reactions to more serious life threatening diseases associated with loss of life. Those with compromised immune systems are typically at elevated risk.

This presentation will examine several SBS cases. One involves a building which had a microbial impacted duct system and the second involved microbial contamination spread by a malfunctioning humidification system. For these cases, the steps involved in assessing and resolving the issues will be examined.

Demolition was indicated in one of the cases. It was found that there was microbial growth in building walls and in the HVAC duct system. Remediation estimates would total more than the buildings' worth. Occupants were reporting coughing occurring on an ongoing basis. In the second case, an elderly susceptible individual was kept from her residence due to the repeated nature of severe health effects. A leading hospital diagnosed the problem as related to indoor air. The source of the indoor air problem was very difficult to solve and was found to result from a past humidification problem. Other cases will focus on perceived sick building syndrome problems which were more easily resolved.

The causes of SBS will also be examined. These include the need for outside air changes, proper HVAC controls, building envelope design, and building maintenance. The role of HVAC systems will be specifically examined, including the tendency of many temperature driven HVAC systems to "stall" and provide little ventilation. Outside air changes are very important to avoiding SBS, and, two case studies involving over ventilating of building spaces will also be examined. In one case, the building was vacated after SBS symptoms continued for a protracted period.

This case study will be reviewed in detail, including how the case was first presented, and, how previous studies repeatedly failed to discern that the HVAC system setup was the ultimate cause. Renovation of the HVAC system ultimately resolved the problem, and, a new tenant self-reported no further symptoms.

Building envelope problems will also be examined. These problems are among the most difficult to understand, but, their detection can be relatively easy. These typically occur when moisture is trapped in walls, or walls are repeatedly wetted and microbial amplification occurs. Building moisture level criteria used to evaluate these situations will be discussed, along with example building envelope problems found in the field, along with how each was resolved.

Building maintenance issues leading to SBS will also be examined. Particular focus will be on roofing and wall situations which ultimately lead to indoor air impacts. Tips for proper building maintenance will be presented as well. The role of moisture in causing microbial amplification will be examined as well.

The reader will learn how microbial consultants approach the investigation process, how they evaluate specific situations, any how remediation approaches are formulated and implemented. Also examined will be methodologies used to assess microbial test results, along with the different testing methodologies available.

Microbial, Indoor Air, Remediation

C33 Mold and Moisture Control - EPA Voluntary Guidance

Laura Kolb, MPH, United States Environmental Protection Agency, 10818 Orchard Street, Fairfax, VA 22030*

After attending this presentation, attendees will learn several practical methods for controlling moisture in buildings; review new EPA technical guidance on moisture control for commercial buildings; learn about free resources available for the general public and professionals on mold and moisture control and related indoor air quality issues; and enable participants to get an overview of mold, moisture, and indoor air quality issues with an opportunity to discuss them with the EPA speaker.

This presentation will impact the forensic community and/or humanity by focusing on moisture control in buildings. Effective moisture control will prevent indoor mold growth and damage to buildings materials.

The focus of this presentation will be on moisture control in buildings. Effective moisture control will prevent indoor mold growth and damage to buildings materials. The presentation will include an overview of mold, moisture, and indoor air quality related issues. Discussion will also cover recent EPA technical guidance on moisture control in commercial buildings as well as review free EPA materials on mold, moisture, and related topics available for public and private use, and for customization. This is intended to be an interactive session with opportunities for discussion with the speaker. Sample EPA materials will be available.

Mold, Moisture, Indoor Air

C34 The Analysis of Microbial Volatile Organic Chemicals From Mold Using Air Canisters and Gas Chromatography Mass Spectrometry

Jack Cochran, BS; Kristi Seller, Irene Degraff, Dave Shelow, and Silvia Martinez, Restek Corporation, 110 Benner Circle, Bellefonte, PA 16823*

The goal of this presentation is to discuss sampling and analysis of mold microbial volatile organic chemicals.

The presentation will impact the forensic science community by demonstrating the analysis of microbial VOCs with an air canister and GC-MS.

Hurricanes and other events that cause flooding, as well as high humidity environments, lead to mold growth in houses and other building structures. Because the presence of mold can be harmful to human health (leading to a version of sick building syndrome) and its visual detection is not always possible analysts are turning to alternate ways to detect its presence, including chemical detection with gas chromatography – mass spectrometry (GC-MS). Mold produces volatile organic chemicals (VOCs) that in addition to giving a characteristic musty odor can be used to indicate its growth or perhaps even to fingerprint the type of mold. Geosmin and 2-methylisoborneol are well-known "earthy" smelling microbial VOCs, but there are a wide variety of other components representing alcohol, ketone, furan, and other mainly polar functionalities.

Because of their polarity and what may be very low concentrations of the compounds in a home, an inert and large volume collection device is needed for sampling. Air canisters that have been passivated are ideal for sampling microbial VOCs. VOC introduction is via a preconcentrator to a GC-MS for qualitative and quantitative determinations.

This paper will show the analysis of microbial VOCs with an air canister and GC-MS. Reference standards of microbial VOCs will be used to develop methods followed by "real world" sample analysis from homes with mold problems. The importance of proper deactivation of the air canister and other sample introduction equipment will be discussed.

Air Sampling, Microbial Volatile Organic Chemicals, Gas Chromatography - Mass Spectrometry

C35 Seat Belt Failure in a Vehicle-to-Vehicle Frontal Crash

Mark C. Pozzi, MS, Sandia Safety Sciences, 2 Marietta Court, Suite A, Edgewood, NM 87015*

The goal of this presentation is to present objective, scientific evidence of seat belt failure that occurred under controlled, repeatable test conditions. This testing proved that production seat belts do fail under foreseeable conditions that are well within design guidelines.

This research impacts the public that wears seat belts in motor vehicles. Any seat belt or other restraint system that can fail under such low loads is a significant hazard to the public. This research should be of interest to vehicle crash investigators, safety officials, and vehicle designers.

The objective of this presentation is to present dynamic crash testing depicting a failure of a production seat belt in an offset frontal collision. This test proves conclusively that even under intended design conditions, in a relatively low change-of-velocity impact that failed to deploy airbags, a properly-attached, apparently functional and undamaged production seat belt failed to remain latched. This has significant safety implications for the public, as well as vehicle designers, safety officials, and crash investigators.

A vehicle-to-vehicle crash test was conducted by a certified test laboratory that regularly performs similar crash testing for government safety agencies and auto manufacturers. A bullet vehicle traveling approximately 60 mph struck a stationary vehicle in the right rear quarter panel. The change in velocity of the bullet vehicle was low enough that airbags did not deploy.

A ballast dummy was restrained with the OEM lap-shoulder seat belt in the driver seat of the bullet vehicle. The seat belt was placed around the ballast dummy per normal test procedures. The belt can be seen around the dummy in pre-test photos and in high-speed video. The belt restrained the dummy through the initial phase of the collision, until crush was complete, at approximately the point of vehicle separation. The bullet vehicle began to ramp up over the target vehicle, and began to roll over after impact. The left front seat belt buckle then failed to remain latched and the seat belt flew out the driver window. The ballast dummy then was ejected from the vehicle during the rollover. A repeat test was conducted with identical vehicles and impact configuration, with no seat belt failure. This test series proved that restrained occupants can be subjected to seat belt failure, ejection and increased injury risk, even with seat belts that apparently meet applicable U.S. Federal Motor Vehicle Safety Standards.

Reasonably similar failures have been seen in a wide variety of seat belts found in other vehicles from various manufacturers. The defects in this seat belt system are not apparent to the average consumer, and are not clearly visible by external examination of the seat belt mechanism.

Seat Belt Failure, Occupant Protection, Frontal Impact

C36 Partial and Complete Ejection of Belt Restrained Occupants During Motor Vehicle Accidents

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The information being presented helps humanity by demonstrating that, with current vehicular designs, restrained individuals can be partially and even completely ejected from a vehicle during a rollover collision and other crash modes.

Understanding that ejection occurs to restrained occupants will encourage accident investigators conduct more thorough and accurate investigations. The presentation will impact the forensic science community by providing information that could also be used to help design safer vehicles and restraint systems to help eliminate this problem.

This presentation will help attendees understand that partial and complete ejection of belt restrained vehicular occupants can and do occur during motor vehicle collisions. Such ejections greatly increase the risk of injuries and death. Multiple real world case studies will be presented to demonstrate how and why these ejections occur.

Oftentimes, when police are investigating a motor vehicle accident where an occupant is ejected from the vehicle, they will indicate on the police report that the individual was not wearing their seat belt. That is, an assumption is made that ejection equates to non-belt usage. However, the evidence should be carefully examined before a determination regarding restraint usage is made.

Various conditions can lead to situations where individuals are wearing their seat belts, yet eject during a collision. The restraint system for an occupant goes beyond the seat belt itself. Generally, the restraint system in a modern vehicle includes seat belts (vehicle or seat mounted), airbags, the seats themselves, knee bolsters, doors, glazing, and other vehicle structures. Extensive damage or failure of any one of these structures may contribute to conditions that lead to ejection of a belt restrained occupant during an accident.

In rollovers, case studies will be presented that show failures of one or more of the components of the restraint systems. For pillar-mounted seat belts, pillar deformation during a rollover can induce slack into the belt system that can result in ejection. Failures in the seat belt retractor itself can also lead to additional slack and partial or complete ejection. Stronger roofs (pillars) and side glazing could help to mitigate these occurrences.

Ejection of belted occupants can also occur in other crash modes. In **rear-end collisions**, the seat back can collapse rearward from the inertial load of the occupant. Once this occurs, for a pillar-mounted belt system, the restraint system is compromised and the belt can no longer contain the occupant. The occupant can enter the survival space for the individual seated behind them, strike their body on a vehicular structure behind them, or be ejected through an open portal behind them. Seats with integrated belts help eliminate this problem due to their increased strength and the fact that the belt stays with the occupant. For pillar-mounted belts, stronger seats are necessary to mitigate this condition. In **side collisions**, seat belt buckles may release inertially or from false latching. Ejections also occur if the door opens during a collision. In **frontal collisions**, ejection can occur for a belt restrained occupant if the seat belt fails. Defects or damage to belt webbing fabric can lead to complete tears in the belt webbing.

In conclusion, current restraint system designs have failure modes that can result in partial and complete ejections of belt restrained occupants during real world collisions. There appears to be both a public and law enforcement perception that a restrained motor vehicle occupant will always be contained within the vehicle in a crash. The information being presented helps humanity by demonstrating that, with current vehicular designs, restrained individuals can be partially and even completely ejected from a vehicle during a rollover collision and other crash modes. Understanding that this occurs will help accident investigators conduct more thorough and accurate investigations. This information could also be used to help design safer vehicles and restraint systems to help eliminate this problem.

Partial Ejection, Complete Ejection, Belt Restrained Occupants

C37 An Experimental Investigation Into the Proper Installation of Child Belt Positioning Booster Seats

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The goal of this presentation is to compare two different methods for installing a belt positioning booster (BPB) and the effects each installation method may have on a child occupant. After attending this presentation, attendees will understand what a belt positioning booster seat is and the difference between an automatic locking retractor (ALR), an emergency locking retractor (ELR), and a switchable retractor. Using anthropomorphic child dummies, the effect of these different retractors on head and neck kinematics in a frontal crash is demonstrated.

The presentation will impact the forensic science community by demonstrating how ALR restraints provided the best protection for the booster positioned child.

Field accident studies indicate that, with the exception of a rear impact, the rear seat area of a motor vehicle is the safest location for placement of children, provided the child is securely restrained in a properly designed child restraint system. BPBs are one such system that position the child on a vehicle seat to improve the fit of the vehicle's lap and shoulder belt system. These booster seats do not have any attached or integrated components such as a belt system or a structural element designed to restrain the forward movement of the child's torso in a frontal impact. The vehicle belts provide the forward restraint. The National Traffic Safety Administration (NHTSA) Child Passenger Safety Technician Manual indicates two correct methods for using vehicle restraints for BPBs. According to the manual, if a vehicle is equipped with a switchable retractor, the retractor can be left in the emergency locking retractor mode or placed in the automatic locking mode if a child is "wiggly" or more active.

Previous sled tests by Bidez, et al., have examined the effects of using a retractor-mounted pretensioner to reduce torso rollout on both a Hybrid III 6-year-old and a Hybrid III 5th percentile female.[1] The purpose of the pretensioner is to reduce the slack in the belt system. Her findings were that the pretensioner prevented torso rollout of the 6-year-old dummy. Engaging the ALR will also eliminate the slack in a belt system utilizing equipment already available in most vehicles.

Two 48 kph frontal sled-buck impact tests, with 3 and 6 year-old child ATDs in BPBs, were run to compare the injury responses between the ELR and ALR modes. A model year 2000 4-door sedan body-buck sled system was towed into a crushable honeycomb barrier to simulate a frontal impact condition. The results of these tests were compared to the Federal Motor Vehicle Safety Standard (FMVSS 213) criteria.

Pitching forward, torso rollout, and head rotation can create dangerous neck stretch in young children. Cervical spine distraction injuries resulting in paralysis and death can result when neck tension exceeds tolerance levels. Axial neck tension force magnitude, the force creating spinal distraction, is directly related to the maximum head acceleration in the Z direction (A_Z). A comparison of dummy head A_z and dummy head motion using the ALR and ELR belt systems is presented. The comparison reveals that the ALR restraint provided the best protection for the booster positioned child. This study further compares the results from the sled tests to injuries in real world situations.

Reference:

[1] Bidez MW, Hauschild HW, Mergl KM, and Syson SR, "Small Occupant Dynamics in the Rear Seat: Influence of Impact Angle and Belt Restraint Design," SAE Technical Paper Series, Paper No. 2005-01-1708, SAE International, Warrendale, Pennsylvania, April 2005.

Child Restraint, Locking Retractors, Spinal Injury

C38 Modeling Occupant Head Displacement in Frontal Collisions

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After attending this presentation, investigators will gain insight into the development of a unique method and tool for assessing occupant head motion in automotive collisions. Specifically, the development of an improved head displacement model will be explored and a new mathematical model proposed.

This presentation will affect the forensic community by offering an advanced scientific method and tool for assessing occupant head displacement in frontal collisions. Investigators will gain insight into the effect of occupant height, weight, crash severity and seat belt geometry on peak head excursion in frontal collisions that will aid them in reconstruction of automotive collisions.

Accident reconstruction of real world collisions requires the quantification of occupant motion for the purposes of identifying likely points of contact within the vehicle and assessing the effectiveness and performance of the restraint system. Occupant protection research has led to extensive testing of seat belt systems and the effects of changes to vehicle and restraint system design on occupant performance. Using this data however for the reconstruction of real world crashes poses a number of challenges due to variations in test setup, crash severity, occupant size, restraint system, data reported, etc. Prior researchers have attempted to develop simple mathematical models based on grouping results from this wide range of available occupant displacement data found in the literature (Araszieski et. Al., 2001, Happer et al., 2004). However due to the confounding variables from study-to-study mentioned above, applicability of the model to real world cases has limitations as well as potentially significant error. Happer et al. (2004) acknowledged the need for the development of a model based upon controlled laboratory studies where variables may be controlled confounding factors minimized. In addition, simulation may be used model variations in vehicle and crash environment (Sieveka et al., 2001). From this type of controlled study, a more robust mathematical model may be developed for use in accident reconstruction where case-specific simulation and/or crash testing are not practical options for the reconstructionist.

The first stage of the research quantified the effect of occupant size on head displacement in simulated frontal collisions of increasing severity. Sled testing was performed utilizing a generic occupant compartment and popular passenger car seat and seat belt system. Three crash severities were evaluated utilizing two occupant sizes: 50th percentile male and 5th percentile female. Motion tracking of high speed video was performed for quantifying occupant head displacement. Linear regression analysis was performed to investigate the relationship with head displacement to occupant size and crash severity. Results compared well with prior research for the 50th percentile male.

The effects of variations in seat belt geometry were evaluated through MADYMO rigid-body-model simulations. Dummy response variables and seat belt loads from sled tests performed in the first stage of the research served as the validation data for the development of the models. A Design-of-Experiments (DOE) was be performed analyzing seat belt geometry by varying D-ring fore/aft location and buckle attachment location, in effect representing different vehicle environments.

Results demonstrated a linearly increasing relationship between impact severity and head displacement for both 5th and 50th percentile dummies. The 5th percentile female experienced significantly less head displacement at each impact severity compared with the 50th percentile male dummy irrespective of seat belt geometry ($p < 0.05$). The 50th percentile male dummy results were consistent with results from prior research studies. Occupant mass and height were investigated as key parameters accounting for the consistent offset between 5th and 50th peak head displacement. Peak head displacement as a function of change in occupant kinetic energy

demonstrated the best fit ($r^2 = 0.98$). Additional data are provided for modeling head displacement of the 95th percentile male dummy.

This presentation will affect the forensic community by offering an advanced scientific method and tool for assessing occupant head displacement in frontal collisions. Investigators will gain insight into the effect of occupant height, weight, crash severity and seat belt geometry on peak head excursion in frontal collisions that will aid them in reconstruction of automotive collisions.

Accident Reconstruction, Occupant Kinematics, Restraints

C39 A Discussion of ASTM E2493-07, a New Standard Guide for the Collection of Non-Volatile Memory Data in Evidentiary Vehicle Electronic Control Units

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After attending this presentation, and seeing procedural examples as presented, the attendee will learn several methods for conducting a controlled retrieval of the data in a subject vehicle electronic control unit (ECU). These methods provide an accepted and documented procedure which incorporates a protocol to retrieve EDR data with the highest assurance of not changing or disturbing that data, either by erasure or overwriting.

This presentation will impact the forensic community by providing a new and mutually accepted reference methodology by which crash event data can be retrieved from an evidentiary Electronic Control Unit (ECU). An investigator following such a reference methodology can more effectively face procedural inquiry and challenges common to such activities.

Electronic crash event data retrieval has become an increasingly important aspect of vehicle accident investigation. ASTM E2493-07 describes an acceptable methodology for the examination and interrogation of non-volatile memory data in evidentiary vehicle Electronic Control Units (ECUs) that are identified as having information related to such accident events. This presentation illustrates the methods and considerations implied by that guide by discussing the guide instructions and then illustrating those instructions with selected examples.

The retrieval of electronic crash data is commonly referred to as a *download* of information from the subject device, however, that term is not strictly accurate. Strictly speaking, SAE J2190:4.23 identifies that the process of requesting the transfer of data from an on-vehicle ECU to an external ECU (Mode $35) is called an upload request, whereas the process of requesting the transfer of data from an external ECU to an on-vehicle ECU to an (Mode $34) is called a download request. To avoid confusion, the term *data retrieval* is used in ASTM 2493-07 and herein.

ASTM E2493-07 was developed by participants from industry, government and private sectors, and has been approved and published by ASTM, April 2007. That Standard Guide describes acceptable methodologies and protocols for the examination and retrieval of non-volatile memory data in evidentiary vehicle electronic control units (ECUs) that may have been involved in an event or incident. As such, these methodologies and protocols can be considered to be operational benchmarks that are expected to be included in future standard forensic investigation practice.

ASTM E2493-07 presupposes that the data object (ECU and the data therein) is an evidentiary item. However per ASTM E860, as referenced in that guide, investigators dealing with units that are not yet evidentiary, but are reasonably expected to be involved in litigation, are well advised to be cognizant of ASTM E2493-07 as well.

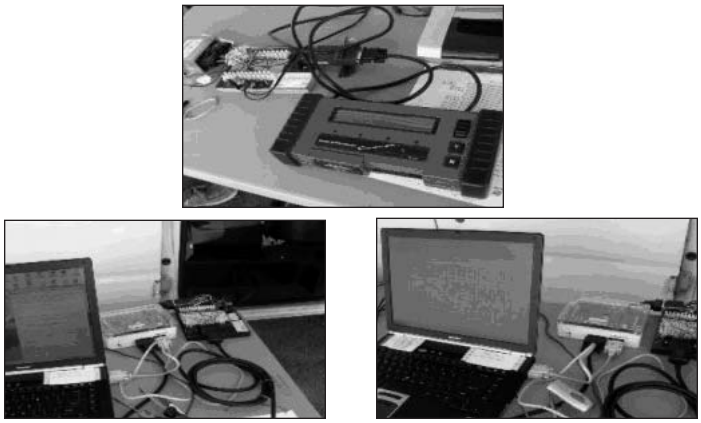
The accepted objective of ASTM 2493-07 is to provide *a forensically neutral* data retrieval process. A *forensically neutral* interrogation is one that will neither add or subtract diagnostic trouble codes (DTCs) or crash data information from any ECU under interrogation, and more specifically, from the data at issue within that ECU. This applies to in-vehicle and benchtop interrogation processes, including ECUs interrogated via direct umbilicals while still mounted in a vehicle. To be *forensically neutral*, benchtop or direct umbilical units must include provisions for actuator electrical loads (squib, solenoid, etc.), sensor electrical loads, MIL electrical loads and expected network communications as seen in situ, so that any ECU undergoing such a data retrieval will see only its original or equivalent in situ operating environment.

Certain commonly used commercial interrogating tools are not *forensically neutral* when used in a benchtop or direct umbilical mode to interrogate SRS ECUs (i.e., a direct connection to the SRS ECU). In that mode, certain external fault codes will be added or re-detected. If the data of interest is not changed (e.g., crash data parameters), then a non-forensically-neutral retrieval may be acceptable. However, if certain DTC's are of interest, or ECU sensor performance is at question, then a non-forensically-neutral interrogation may not be acceptable. Forensically neutral data retrievals can be accomplished by correct "load boxes", other test equipment, laboratory breadboards and/or the use of an exemplar vehicle. In general, it is expected that the test conductor will have a proper test fixture, and a proper exemplar component to demonstrate that his/her test bed is *forensically neutral*.

A general protocol for evidentiary electronic data retrieval involves baselining (qualifying) the data retrieval tool using an exemplar ECU, and then, when qualified, using that tool to retrieve data from the subject evidentiary ECU. That general protocol can be shortened when the investigator uses a commercial data retrieval tool to perform such a retrieval, however, even with such tools there is jeopardy that careless application of such tools can alter evidentiary data. Examples of *forensically-neutral* and *non-forensically-neutral* data retrievals are shown and discussed.

When a proprietary tool is used for data retrievals, the base lining procedure is very important.

In such a case, the test conductor should perform two test series, with two devices under test (DUT). The first series should involve an exemplar device to provide a baseline verification of the test fixture, and the second series should involve the subject ECU. Examples of data retrieval tools used in *forensically-neutral* and *non-forensically-neutral* data retrievals are shown and explained. The figures show a recent example of a baselined on-vehicle data retrieval.



Figures: Sequence of photos for on-vehicle data retrieval using a proprietary retrieval tool. This sequence shows the baselining process, followed by the actual evidentiary data retrieval and translation.

The last consideration in data retrieval activities is the preservation of electronic data according to new Federal Rules 16, 26, 33, 34, 37, and 45 (1Dec06). With respect to proprietary data retrievals, of special importance is Rule 26(a)(1)(B), identifying that a party must disclose its electronically stored information as well as methods and documents that it may use to support its claims or its defenses. This rule, if applied unilaterally can prove burdensome and crippling. However, if it is anticipated, and then applied in an even handed manner, it can be made livable. An illustration of one method of handling this situation is shown and discussed.

ASTM E2493-07, EDR Data Retrieval, Forensic Neutrality

C40 A Review of the Current Data Available in GM SDMs and the Positive and Negative Aspects of the Data

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At the end of this presentation, attendees will learn about the new information stored in GM airbag computers and the accuracy of this data.

This presentation will impact the forensic science community by educating the attendees about the information that can be obtained from the latest GM air bag computers.

The next generation of GM SDMs has the ability to contain several more crash relevant data parameters than the previous generation. Some of these parameters are extremely useful, while some may appear to be useful, but need to be fully understood before taking them at face value. As with any data collection system, the sample rate can influence the veracity of the data. Additionally, how the data is processed before it is recorded can also influence how much weight should be given to the data.

The majority of the new data comes from the vehicle's engine computer. Items such as the vehicle's power mode status (on, start, run) at algorithm enable, transmission gear, and engine MIL status. Several new parameters have been added to the pre-crash data: engine power mode, cruise control status, accelerator pedal position, antilock braking system status, lateral acceleration, yaw rate, and steering wheel angle.

The deployment and non-deployment data has also been augmented. Several parameters that help to determine the number of events and their order are now recorded. Additionally, the lateral Delta-V also has the capability to be recorded. The most controversial piece of new data is the estimated Principal Direction of Force, or PDOF.

PDOF is defined as the angle at which the vector representing the summation of all impact forces acting on the vehicle occurs. This angle can be used with simple trigonometric functions to resolve the resultant Delta-V into the lateral and longitudinal components, where the longitudinal component (Delta-Vx) is the front-to-back portion, and the lateral component (Delta-Vy) is the side-to-side portion. However, if the determination of the PDOF is inaccurate, then resolving the Delta-V into its two components becomes inaccurate as well.

The method by which the SDM calculates PDOF is wrong. This may seem like a surprising concept, but attendees of the first annual CDR User's Conference were treated with this insight. The SDM used the maximum recorded Delta-Vx and the maximum recorded Delta-Vy to calculate the PDOF. However, it is unlikely the two maximum values and Delta-Vx and Delta-Vy occur at the same point in time. Knowing the calculation methodology used will assist the engineer in determining the accuracy of the PDOF data reported by the SDM.

The method employed by the new generation SDMs to calculate the PDOF can generate inaccurate results. One must use traditional reconstruction concepts to determine the most accurate PDOF, and the SDM-calculated PDOF may be listed purely to complete the analysis.

Air Bag, Crash Data, Data Accuracy

C41 Late Deployment of an Air Bag Due to Multiple Sensor Bounce

Holly A. Adams, BS, Automotive Data Consultants, 15439 Smithaven Place, Centreville, VA 20120*

Upon completion of this presentation, attendees will have learned about one of the ways an electro-mechanical airbag sensor can delay a deployment.

This presentation will impact the forensic science community by highlighting one of the ways an airbag can deploy late and cause injury to the vehicle occupants.

Accident Scenario: A single vehicle accident involving a 1997 GMC Jimmy. The subject vehicle went off the road to the right, struck several smaller objects, went into a ditch, struck a tree and overturned. The driver of the vehicle (female, 5 ft tall, approximately 95 lbs) was found submerged and seat belted. The air bags deployed, and the cause of death was listed as neck injuries.

The1997 model year sport utility vehicle has a first generation air bag system. A first generation air bag system consists of external sensors connected to an air bag computer that does not make any deployment decisions. The air bag computer diagnosis fault codes, records them and records the timing between sensor closures in a deployment.

In order for the air bags to deploy in this vehicle, two different sensors with different sensitivities must be closed simultaneously to complete a circuit that allows current to flow through the air bag igniter. The closure of one sensor will not deploy the air bags. Additionally, if one sensor closes and then opens, and then the other sensor closes, the air bags will not deploy because the sensors were not closed simultaneously.

The data downloaded from the air bag computer showed the following information:

1. There was only one crash recorded.
2. The air bag warning light, or MIL (Malfunction Indicator Lamp), was off when the deployment circuit was completed (overlap).
3. There was no Active/Current, Cycle or History fault codes, or DTCs (Diagnostic Trouble Codes), present when the deployment circuit was completed.
4. The MIL was recorded as "off" at the time of overlap, and showed no indication of having ever been "on."
5. The arming sensor closed first.
6. The time from arming sensor closure until the first discriminating sensor closed (overlap or completion of the firing circuit) was 14.64 ms.
7. The time from first discriminating sensor closure until overlap was 124.44 ms.
8. Overlap lasted for at least 7.78 ms.
9. The driver's seatbelt was recoded as being buckled.
10. At the time of the data download, there was one DTC present in the history of the DERM. It was DTC 51: Crash Detected, which is an expected fault code after a deployment.

The vast disparity between the time from arming sensor closure to overlap (14.64 ms) and the time from first discriminating sensor closure to overlap (124.44 ms) indicates the following scenario. The arming sensor closed and then opened. After the arming sensor opened, one of the discriminating sensors closed, starting the clock for the first discriminating sensor to overlap time. Then the discriminating sensor opened and the arming sensor closed for a second time. Finally, one of the discriminating sensors closed simultaneously with the arming sensor, completing the circuit and deploying the air bag. This opening and closing of sensors is known as "bounce."

In this case, the bouncing of the arming and discriminating sensors caused a late deployment of the air bag, which may have caused the death of the driver.

Air Bag, Sensor, Bounce

C42 Improper Programming of a Load Moment Indicator on a Truck Crane

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After attending this presentation attendees will learn about data stored on a vehicle other than a passenger vehicle.

This presentation will impact forensic science by showing unlikely places to find data saved by vehicles.

Accident Scenario: Construction was being done on a two-lane bridge over a deep canyon. A truck crane was brought in to move some equipment on the canyon floor. The Department of Transportation did not want to close both lanes of the bridge. This forced the truck crane to operate with its

outriggers partially retracted. The crane successfully moved the first two loads. For the third load, which was the same as the first, the end point was altered to a point farther away from the bridge. As the operator was moving the third load, the truck crane's moment shifted, and the crane flipped over the side of the bridge. No warning lights came on in the cab of the crane to indicate to the operator that he was approaching an unstable crane configuration.

The subject truck crane was equipped with a programmable load moment indicator (LMI). This LMI did not have the capacity to record the crane's position during its operation; however, it contained tables of data that outlined the safe parameters for the crane's operation with different outrigger positions based on ANSI B30.5 requirements. If the crane was positioned into a space outside these defined safe parameters, a warning light illuminates in the cab. The operator uses an interface in the cab to input the crane's current operating configuration. The table below shows the selections available to the operator.

Table 1: LMI Operating Codes (from operating manual)

Setting	Crane Configuration	Outrigger Configuration
#1	Main Boom	Fully Extended
#2	Fixed Jib	Fully Extended
#3	Telescopic Jib – Retracted	Fully Extended
#4	Telescopic Jib – Extended	Fully Extended
#5	Main Boom	Intermediate
#6	Fixed Jib	Intermediate
#7	Telescopic Jib – Retracted	Intermediate
#8	Telescopic Jib – Extended	Intermediate
#9	Main Boom	Fully Retracted
#10	Personnel Lifting Platform on Main Boom	Fully Retracted
#11	Personnel Lifting Platform on Fixed Jib	Fully Retracted
#12	Personnel Lifting Platform on Telescopic Jib – Retracted	Fully Retracted
#13	Personnel Lifting Platform on Telescopic Jib - Extended	Fully Retracted

After the accident, the chips from the LMI were removed and brought to the manufacturer to be downloaded. Three sets of chips were downloaded. Set 1 were test chips from the LMI manufacturer used to test the LMI's functionality. Set 2 were dated May/June 2000 and were the original chips from the LMI. The third set was dated December 2000 and were the chips in the crane at the time of the accident. By comparing the data stored on these chips to each other and to the LMI Operating Codes, it was determined that the chips on the crane during the accident were programmed for the main boom with fully retracted outriggers to be setting #13. However, the parameter selection list the crane operator was given conformed to Table 1, which indicated that the main boom with fully retracted outriggers was setting #9. Therefore, the LMI was operating under the parameters set for intermediate outriggers instead of fully retracted outriggers.

Unfortunately, since the second drop point was farther from the truck crane it increased the moment of the crane causing it to flip over the bridge.

Black Box, Data Downloaded, Truck Crane

C43 Pros and Cons of Data Mining in the Forensic Context

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After this presentation, attendees will have a better understanding of data mining techniques.

This presentation will impact forensic science by showing the advantages and disadvantages of the use of data mining techniques in general and in the forensic context.

Data mining is a general term, which describes a number of techniques to identify pieces of information or decision-making knowledge in data. In contrast to many other techniques, data mining techniques do not work with a research hypothesis. This is both the strength and weakness of data mining. The techniques can help identify (seemingly useless) patterns in data that otherwise would not be discovered. Sometimes they can help to translate these patterns in valuable information. Other times it will result in drowning in the data.

Another strength of data mining is that it can handle huge amounts of data in automatic or semi-automatic way with the use of machine learning and computers. Though the techniques can also be applied to relatively small datasets (we will provide an example of that) it is especially designed for large datasets.

In this presentation a short (and not complete) overview is given of the use of data mining in forensics. The advantages and disadvantages of data mining in this context will be discussed in general and when applied to a few examples.

One of the examples concerns the clustering of MDMA tablets. 3,4-methylenedioxymethamphetamine (MDMA), the active compound of ecstasy, is one of the most widely spread illegal synthetic drugs in Europe. The Netherlands is one of the most producing countries. Therefore the Netherlands Forensic Institute is involved in a large research project concerning ecstasy. One of the goals of this project is to investigate whether it is possible to cluster XTC consignments by production batch, producer, or production method based on the chemical composition of the tablets. Mainly unsupervised clustering techniques are used for this goal, because in most cases tablets are not found in production facilities, and therefore there true origin is not known. It is found that (unsupervised) clustering by production method is possible, but clustering by producer or production method is much harder, not in the last place as a result of the dynamic market of ecstasy producers.

Another example will concern profiling and finding indicators for offenders for specific crimes by the Dutch Police. The ultimate goal of such profiling is to increase the success and efficiency of police actions by making better informed decisions. The first challenge lies in retrieving the data and merging data sources in different formats together. Importantly, there are legal limitations with respect to analysis of crime records, especially in relation to open source data. Finally, results that are extracted from the data need to be presented to the police in an understandable way on a routine basis.

Data Mining, Unsupervised Clustering, Drugs

C44 Hydrodynamic and Biomedical Engineering Factors in Propeller Contact Injury

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After attending this presentation, attendees will have a better understanding of factors that increase risk of injury due to propeller contact in certain types of recreational boating applications, especially those involving high thrust and relatively low vessel speeds such as waterskiing, wakeboarding and parasailing.

This presentation will impact the forensic community by describing risk factors not generally understood by vessel operators and by presenting a methodology for their analysis and mitigation. A specific example will be presented.

Propeller injuries generally involve multiple deep lacerations and bone damage distributed over a wide area of the body. There is a characteristic pattern to the geometry of these injuries, each cut corresponding to the path of a propeller blade as the moving water pulls the victim through part of the disk area swept by the propeller. The orientation of these lacerations can be useful in studying the angle of contact, boat/victim kinematics, principal direction of force for the trauma, and possible point of entry into the water.

Applications requiring high thrust at relatively low speeds result in unusual demands on both the propulsion system and on the maneuvering-capabilities of the vessel. As a result there are additional hazards associated with propeller contact that may not be anticipated by small craft operators.

Three unanticipated factors will be examined in this presentation: the first is the size and shape of the inflow field upstream of a propeller operating at relatively high thrust and low forward speed. This is the case for water-ski or wake board towboats, especially during the initial acceleration phase, and for parasail winchboats, especially when operating against a headwind.

1) Propeller inflow: Propellers work by pressurizing and accelerating water, resulting in forward thrust by momentum conservation. Continuity and incompressibility require that the flow field upstream of the propeller is wider than the propeller diameter.

In the case of towboats and winchboats, relatively low speed and high thrust is common. This results in a wider inflow field than would be experienced at speed or at low thrust.

While the operator may only be aware of the outflow jet, the inflow field ahead of the propeller is by far the more dangerous. The widening of the inflow field as speed drops and relative thrust increases is not understood by the majority of vessel operators, and is even less likely to be understood by passengers or guests swimming in close proximity to a propeller.

2) Maneuverability under tow load: The tow vessels discussed have the added complication of increased likelihood of placing people in the water near the propellers. In the case of ski and wakeboard towboats, the skier normally enters the water near the propeller. Parasail winchboats require an unobstructed aft deck with no rails around the stern of the vessel, making accidental water entry near the propeller a much more likely occurrence than on other types of boats.

3) Time required to stop propeller rotation: Time to stop propeller rotation can be a major contributor to propeller contact accidents. On a windy day, the inflated parachute of a parasailing vessel can keep the boat moving through the water and produce considerable torque on the propeller.

A vessel operator, when recognizing the emergency of people in the water, is faced with three choices: a) use power and steering to maneuver the stern of the vessel away from people in the water; b) shift the gearbox into neutral to disconnect the propeller from the engine; or c) cut the engine power but leave the propeller in gear so that propeller rotation stops quickly. Circumstances and power train characteristics will dictate which course of action is best.

The presentation will describe tests that: (a) quantified steering force to maneuver the propeller clear of people in the water, (b) determined time lag between shift-to-neutral and propeller stopped, and (c) mapped a victim's injuries with the reconstructed propeller motion as well as the current and wind effects on the movement of the vessel through the water.

Biomedical, Hydrodynamic, Propeller

C45 Identifying Fault in a Fatal Pedestrian Impact

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The goal of this presentation is to describe an iterative process that can be used in conjunction with a MADYMO simulation program to reconstruct a pedestrian impact when particular information about the accident has been provided.

The presentation will impact the forensic science community by identifying a verified method for determining the configuration and location of a vehicle-to-pedestrian impact.

This presentation identifies and demonstrates a method for determining fault in a fatal pedestrian impact. A mathematical dynamic modeling (MADYMO) simulation was utilized to reconstruct the accident and determine whether the pedestrian was at fault by being in the lane of travel or whether the driver of a pickup was at fault and contacted the pedestrian. The conditions of the roadway and factors involved in the accident allowed for a verified method in determining the point of impact and, thus, fault for this accident was determined.

This accident occurred when the driver's side mirror of a pickup made contact with the top of the pedestrian's head. When the impact occurred, the pickup was traveling at a speed of approximately 70 mph on a straight portion of a flat interstate highway. The approximate speed of the pickup was verified by multiple witnesses traveling behind the pickup. According to statements recorded at the accident scene by the investigation police officers, the driver of the pickup was distracted and did not see the impending impact. At the moment of impact, witnesses described the pedestrian as being in process of bending over at the edge of the roadway attempting to pick something up off the ground. Following the impact, the investigating officers found the pedestrian lying on the roadway shoulder along with multiple pieces of the side mirror. The pedestrian's point of rest was measured and photographed. Due to the severe nature of the head injury sustained by the pedestrian, death was immediate and no attempt was made to resuscitate or provide aid to the pedestrian. Blood spatter was documented on the shoulder of the roadway, in the lane of travel, and in the area surrounding the pedestrian's head. Based on the blood stains in the lane of travel, the investigating officers concluded that the pedestrian was at fault by being in the lane of travel when the impact occurred.

The MADYMO simulation was conducted with various critical factors incorporated to provide the most accurate results. The pickup and the pedestrian were modeled independently within the program. Multiple measurements of the pickup and its' side mirror were recorded. Since the side mirror was the only portion of the pickup that was contacted and the mirror properties were critical to the analysis, an exemplar side mirror was purchased for accurate data. The shape and contours of the contacting surface of the side mirror was modeled within the program. The mirror was tested to determine the force required to adjust the mirror angle. The pedestrian was modeled within the simulation to be the same approximate height and weight. Additional measures were taken in the modeling of the neck to represent human neck response in compression.

Once the vehicle and the pedestrian were independently modeled within the simulation program, an iterative approach was taken to determine the position of the pedestrian relative to the roadway. The configuration of the pedestrian relative to the vehicle and location of the impact were adjusted until the final resting point of the simulated pedestrian matched the final resting position of the actual pedestrian as documented at the scene. This revealed the point of impact to be in the region of the roadway shoulder and outside the lane of travel. As a check, the impact location was hypothetically assumed to be inside the lane of travel, where the investigating officers concluded the impact occurred. Under this hypothesis, the final simulated resting position did not match that documented at the scene. Thus, the driver of the pickup was found to be at fault for the fatal accident. Because the final resting position of the actual pedestrian was well-documented, the location of the impact relative to the roadway was able to be accurately reconstructed.

In conclusion, when the final resting position of the struck pedestrian is thoroughly documented, this method presented can be utilized to reconstruct the accident determine the configuration and location of the impact.

Pedestrian, Fatality, MADYMO

C46 Efficacy of Full90 Performance Headgear™ in Soccer Related Impacts

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Attendees of the presentation will have a greater understanding of the effectiveness of a common type of soccer headgear in reducing the potential for mild traumatic brain injury (MTBI).

The presentation will impact the forensic community by providing information on MTBI injury potential with and without headgear, possibly improving the diagnosis and treatment of soccer related MTBI.

Head injuries as a result of common impacts that occur during a soccer match are of high concern, especially to parents of youth soccer players. Head protection has recently been approved by U.S. Soccer and the National Federation of High Schools for use in all games at all age levels. This recent change in the interpretation of equipment rules has led to questions from parents regarding the effectiveness of headgear in preventing injury. The most easily found headgear is the Full90 Performance Headgear™, manufactured by Full90 Sports. However, aside from performance claims on the manufacturer's website, little to no data is available to the public to assess the efficacy of this model of headgear in mitigating head injuries that occur as a result of common impacts on a soccer field such as head-to-ball, head-to-head, head-to-elbow, head-to-ground, or head-to-goalpost.

The efficacy of three types of soccer headgear, including the Full90 Performance headgear, was investigated for head-to-ball and head-to-head impacts in a blinded study.[1] Ball-to-head impact speeds of 6.4-8.4 m/s and 10-30 m/s were used for volunteer and dummy testing. The authors concluded that none of the headgears tested reduced the impact response, most likely due to the very large deformation of the ball during impact.[1] Head-to-head impacts of 2-5 m/s conducted with Hybrid III dummies were found to provide a "measurable" improvement in the impact response, depending on impact speed and impact location.[1]

The purpose of this study was to investigate the protective abilities of the Full90 Performance Headgear™ in head-to-goalpost, head-to-concentrated load, such as an elbow, and head-to-ground impacts. Thirty-eight head-drop tests were conducted using a 50th percentile male Hybrid III dummy head, equipped with a tri-axial accelerometer and tri-axial angular rate sensors at the head center of gravity. Indoor tests were conducted at 78°F. Figure 1 shows the headgear on the Hybrid III head.

Five sets of Full90 headgear were used, with each set of headgear impacted once at the forehead, bilateral temples and occiput for each of the following impact configurations: head-to-round goalpost, head-to square goalpost, head-to-concentrated load, and head-to-ground. Impact speeds of 2.5 m/s and 3 m/s were used for the goalpost and concentrated load tests respectively. Head-to-ground tests were conducted with an impact speed of approximately 5 m/s, corresponding to a drop height of about 48 inches.

Figure 3: Full 90 Headgear on Hybrid III

A general trend of reduced values for HIC36 and average acceleration was seen, and thus only the data for HIC36 is presented in table 1 below, where HG designates an impact the headgear in place. However, rather than comparing percent reductions between headgear use and non-headgear use, it may be more useful to compare the head injury severity using the AIS injury scale.[2,3]

Table 1 Impact test data

	HIC	
	No HG	HG
Round Goal Post (2.5 m/s)		
Forehead	49.10	40.53
Temple	39.95	27.33
Occiput	56.80	51.07
Square Goal Post (2.5 m/s)		
Forehead	59.80	52.00
Temple	52.60	40.10
Occiput	74.80	40.90
Concentrated Load (3 m/s)		
Forehead	190.30	89.30
Temple	149.60	94.95
Occiput	219.70	158.50
Ground Impact (5 m/s)		
Forehead	551.90	525.25
Occiput	507.40	418.80

The abbreviated injury scale (AIS) was developed to aid in impact injury assessment. Examples of AIS head injuries are: AIS1 – scalp abrasions/contusions; AIS2 – scalp laceration > 10 cm, unconscious < 1 hr without neurological deficit; AIS3 – cerebral contusion; AIS4 – subdural hematoma, open basilar skull fracture; AIS5 – diffuse axonal injury, penetrating brain injury, arterial laceration.[4]

The risk of suffering an AIS1-AIS5 category injury for each impact configuration is shown in table 2 below. The numbers in the table indicate the percent risk (0-100) of incurring an AIS injury of a certain level.

Table 2 Percent Risk of AIS1+ Injury

	AIS1	AIS2	AIS3	AIS4	AIS5
Round Goal Post (2.5 m/s)					
No HG Forehead	0.5	0.2	0.1	0.0	0.0
HG Forehead	0.2	0.1	0.0	0.0	0.0
No HG Temple	0.2	0.1	0.0	0.0	0.0
HG Temple	0.0	0.0	0.0	0.0	0.0
No HG Occiput	0.9	0.3	0.1	0.0	0.0
HG Occiput	0.6	0.2	0.1	0.0	0.0
Square Goal Post (2.5 m/s)					
No HG Forehead	1.1	0.4	0.1	0.0	0.0
HG Forehead	0.6	0.2	0.1	0.0	0.0
No HG Temple	0.7	0.2	0.1	0.0	0.0
HG Temple	0.2	0.1	0.0	0.0	0.0
No HG Occiput	2.3	0.8	0.3	0.1	0.0
HG Occiput	0.2	0.1	0.0	0.0	0.0
Concentrated Load (3 m/s)					
No HG Forehead	20.5	6.8	2.3	0.5	0.0
HG Forehead	3.9	1.3	0.5	0.1	0.0
No HG Temple	13.0	4.3	1.5	0.3	0.0
HG Temple	4.6	1.6	0.6	0.1	0.0
No HG Occiput	26.5	8.8	3.0	0.6	0.0
HG Occiput	14.5	4.8	1.7	0.4	0.0
Ground Impact (5 m/s)					
No HG Forehead	84.4	45.3	15.5	3.5	0.3
HG Forehead	81.7	41.7	14.0	3.1	0.3
No HG Occiput	79.6	39.3	13.0	2.9	0.2
HG Occiput	66.9	28.0	9.0	2.0	0.1

As seen in the above table, use of the Full90 headgear decreases the risk of AIS3 or lower head injuries for impacts to the square goal post and concentrated loading configurations by nearly 50% or more. However, there was little to no effect for the round goal post and ground impact situations. In addition, there was little appreciable difference in AIS4+ injury risk across all testing.

The Full90 Headgear™ seems to be most useful in decreasing the risk of AIS3 or lower head injuries in certain loading situations. The most likely injuries to be prevented are the AIS1 and AIS2 scalp lacerations, contusions, abrasions, and minor penetrating wounds, but this may be due more to the use of an extra layer between the head and the contacting object than any protective properties of the headgear itself.

Parents, coaches, and others need to make informed decisions about the protection they wish to provide to the players on the field, regardless of age group. If the primary concern is reducing the number of relatively minor injuries such as abrasions and small cuts, than use of the Full90 headgear may be warranted. However, if the primary concern is reducing the risk from falls where the player is knocked down, either while in the air or while standing, and is unable to "break" their fall with ensuing head-to-ground contact, the Full90 Performance Headgear™ does not appear to be an effective safety device.

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MTBI, Soccer, Full90 Headgear™

C47 Face Recognition on CCTV Material Using a Biometric System

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The goal of this presentation is to inform the forensic community about the possibilities and limitations of biometric face recognition on CCTV surveillance material.

This presentation will impact the forensic science community by providing information about the possibilities and limitations of biometric face recognition on CCTV surveillance material.

Biometric face recognition is still advocated as a good option for person identification and detection of people on watch lists. However, the current state of the art in face recognition is mostly not sufficient for forensic applications. Although some of the techniques reach reasonably high levels of recognition under controlled circumstances with frontal face images, of course surveillance images hardly ever capture a suspect frontal face, with good lighting conditions, and a neutral facial expression. Of interest for the forensic use of biometric systems is knowledge about the reliability of the matching results, even under imperfect conditions. The performance of the FaceVacs software from Cognitec using different public and private databases of different quality was studied.

Verification match results were used to construct receiver-operator curves (ROC), and the Equal Error Rate (EER, setting at which the fraction of false accepts is equal to the fraction of false rejects) was used as performance criteria. When using good quality controlled lighting and frontal pose images, an EER of 1.5% could be reached. However, the EER quickly increased to around 24% when non-frontal images were included. When less controlled, but still ISO/IEC nr952 compliant, frontal images were used, the EER was about 3%. However, when document scanner images of passports were used for the comparison, the EER increased to around 20%!

Verification using images with degraded quality (query as well as database) showed that at an eye distance below 30 pixels failure to enroll (FTE) quickly increased, but that the EER of the accepted images remained relatively constant. Compression of passport-type photo's had no clear influence at files sizes of 5KB or more. Blurring of ISO/IEC nr952 compliant passport size images resulted in significant increase in the EER when Gauss filters with a radius of 5 or more pixels were used.

Hit list results (above a certain threshold level) were determined to study the influence of image quality on probability of detecting persons in a 'watch list' setting. When frontal, ISO/IEC nr952 compliant, frontal images were used, the correct identification level reached more than 80%, with 1-2% of the people incorrectly identified, and the remaining not recognized. It should be noted however, that these were images of cooperating people, not trying to conceal their identity and motivated to be correctly recognized. Reduction of the resolution of the query images (but not the database images) below 30 pixels between the eyes resulted in a decrease in correctly identified people, due to the increased FTE. The number of incorrectly identified people did not increase when resolution was decreased. The results for increased compression were similar: reduction of the correct recognition of passport-type photo's 5KB or less due to an increased FTE, without an increase in incorrect identification. Blurring passport quality images resulted in a decrease in correct as well as incorrect identifications and an increase in FTE. A point to note is that some people gave a high number of false hits even with good quality images: up to 9 false hits for one person were found above default threshold level in a database of about 1200 people. This means that some (unfortunate) people will be highly prone to false 'identification' in a watch-list situation.

It is clear from the above that the performance of this biometric system is severely influenced by the quality of the images.

To study the performance of this biometric system using CCTV camera recordings, a surveillance system with multiple cameras, and made recordings under controlled conditions was acquired. Similarity scores of the biometric system using images made from the same person can then in turn be used to define an overall quality of the CCTV images at certain resolution and compression settings. Preliminary data indicate that the match values using the FaceVacs system are below the default threshold for all cameras and settings investigated, even when only zoomed-in frontal images under controlled lighting conditions at 2.5 m distance are used. These data suggest that the forensic value of biometric face recognition of faces on (704x576 pixel size) CCTV images is limited at best.

Face Recognition, Biometrics, Surveillance Images

C48 Strong vs. Weak Seats: Analysis of Matched Rear Impact Tests for Head and Neck Injury Risk Evaluation

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The goal of this presentation is to present quantitative and statistical evaluation methods, including static testing and side-by-side sled and crash testing, to determine relative risks of various vehicle seating systems. This has implications for vehicle crash investigators, safety researchers, and vehicle designers.

The presentation will impact the forensic science community by demonstrating how the experimental "side-by-side" & "matched pair" test protocol (properly matched in impact severity, etc.) provides a scientific means for evaluating vehicle rear-impact seat performance as related to high & low velocity neck injury risk & head injury risk for both front seated adults & rear seated children located behind.

A recent study, presented at the 2007 Society of Automotive Engineers International Meeting (SAE paper 2007-01-0708), has suggested that, during rear-impact, the weaker, single-recliner (SR) vehicle seat designs (i.e. about 3.2 kN strong), which tend to collapse rearward during moderate to severe rear impacts, provide similar occupant protection over the much stronger and available "belt-integrated" seat (BIS) designs (i.e., about 14.5 kN strong), for impact severities ranging from low velocity "whiplash" levels (i.e., 15 kph or less) on up to more severe rear impacts of 40 to 50 kph. Unfortunately, the above referenced study only examined data for front occupants and ignored dangers and risks to rear occupants like children. In addition, the article contained numerous serious errors, misrepresentations, and omissions that render the results scientifically invalid when properly corrected. The current study focuses on examining the complete seat performance issue as it relates to head & neck injury risks of both front & rear seated occupants subjected to rear impacts.

The current study uses an experimental matched pair, or side-by-side, scientific test method and protocol (presented by the authors at the 57th and 59th Annual Meeting of the AAFS) to evaluate head & neck injury risk of weaker SR seat designs compared to stronger BIS designs, for various sizes of Hybrid III surrogates (i.e., a 50 kg small 5th percentile female, a 80 kg average 50th percentile male, and a average male surrogate ballasted to 110 kg) seated in a sled-body buck system that in some cases includes rear seated child surrogates of various sizes and in different types of child restraints. Typical sedan & minivan vehicles, with full interiors, were used as baseline test vehicles. Strong and weak seat comparisons were made for the same size surrogates under identical impact conditions. Each surrogate was instrumented with head, neck, and chest instrumentation. In some cases the

front adult surrogates were leaned forward "out-of-position" (OOP) from the headrests with a gap of 5 inches, to examine effects of front only occupants in non-optimum positions for both seat types (SR & BIS) during low & high velocity levels. Adult neck injury risk measures are based on the NHTSA "Combined Load NIJ Criteria" & probability curves. Head injury risk is based on "% population at risk of AIS 4+ head injury" using HIC criteria.

The data and results of the "matched pair" seat test comparisons for front-seated adults without rear children are summarized in several tables. Included in each table is a category for "% Risk of AIS 3+ Neck Injury Potential" & "% population at risk of AIS 4+ Head Injury". Rear seated child head & chest injury risk comparisons are made for both seat types with various size front adults, subjected to a wide range of impact severity. The NIJ criterion is analyzed statistically by the "Student T-Test" to compare responses between the strong and weak seats for the front only adult cases. What the "statistical" results indicate is that for "low velocities" (i.e., 12 to 15 kph) there is no significant difference between the neck injury risks of either the SR or BIS seat designs for all sizes of front adult surrogates. Neither seat type indicated a severe risk of neck or head injury. However, with the exception of the newer "self aligning headrests" (like those on many Volvo & Saab vehicles) the headrests of both seat types (SR & BIS) appear to be non-optimum and could be improved. On the other hand, at the moderate to higher impact severities (i.e. 18 to 50 kph) there is a clear high level of injury risk associated with the weaker SR seat for both the front adult average males and larger, as well as the rear seated child located behind. In contrast, the stronger BIS design appears to provide much improved occupant protection over the weaker SR seat for both the front seated adult and the child located behind for these higher impact severities. As a result of the "matched pair" study it is concluded that in the moderate to high impact severity range (i.e. 20 to 50 kph) the weaker SR designs pose a high risk of injury to both front adults and rear seated children, as compared to the improved protection of the stronger BIS designs (even without optimum headrest performance). Most importantly, however, ultimate evaluation of rear-impact seat system performance must consider protection of both the front seated adult and rear occupants like children located behind the front seat.

Seat Performance, Rear Impact, Occupant Protection

C49 Rear Seat Safety Hazards: Collapsing Seats, Cargo Shift, Restraint Failure, and Loss of Occupant Survival Space

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The goal of this presentation is to inform investigators, vehicle designers and others of the multiple hazards found in the rear seat areas of passenger cars. This presentation is a companion study to "Safety Modification of Rear Seats and Restraint Systems in Vans and Utility Vehicles to Improve Occupant Protection" that studies rear seat occupant safety in Vans and Utility Vehicles.The presentation will impact the forensic science community by identifying an emerging safety defect trend that has serious implications for occupant safety, especially children. Attendees should obtain a clear understanding of increasing risks to rear seat occupants of passenger cars in frontal and rear impacts, as well as the reasons for those risks.

The goal of this presentation is to present case studies and testing depicting various hazards to passenger car rear seat occupants in front and rear impacts. There are emerging safety risks to children and adults from collapsing front and rear seats. Front and rear seats in various passenger cars have been demonstrated to fail at well below human tolerance levels. This study will inform other researchers about why seat failures are occurring, and how injury is being imparted to rear seat occupants.

Rear seats in late model passenger cars are subjected to increased hazards caused by open bulkheads between cargo areas and occupant seating areas, combined with weak seat structures and attachment hardware. Significant loss of occupant survival space has been seen in both front and rear impacts that are well below human tolerance levels. Because of front and rear seat failure, occupants can be severely injured due to direct contact by other occupants, seat structures, and shifting cargo. Restrained occupants can be trapped between seat belts and the failed rear seats pushed forward by intruding cargo. Additional hazards are created to restrained occupants when rear seats fail, even without cargo shift, because seat movement can lead to submarining under lap belts, as well as misalignment of the upper torso relative to shoulder belts. These combined rear seat safety issues create risk factors for various size occupants that are not foreseeable to typical users of passenger cars, and which are not typically warned about in owner's manuals.

Reasonably similar failures have been seen in a wide variety of passenger cars from various manufacturers. In several instances the most significantly injured person was in the rear seat in a frontal impact, despite being located furthest from the potential intrusion effects affecting the front of the occupant compartment. This includes abdominal and spinal trauma, as well as significant head and extremity injuries that are disproportionate to any injury seen by front seat occupants in the same collision. This is especially significant considering that since 1996, NHTSA and the auto industry have advocated placing children in the back seat to avoid airbag hazards.

Available evidence indicates that some passenger car rear seats are not remotely as safe as they should be, especially for children. Many late model passenger cars have rear seat structures fabricated entirely from plastic, which can and do fail at loads well below human tolerance. Alternative designs will be shown that address some of these hazards.

Rear Seats, Occupant Protection, Child Safety

C50 Safety Modification of Rear Seats and Restraint Systems in Vans and Utility Vehicles to Improve Occupant Protection

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The goal of this presentation is to present objective, scientific testing and prototype development of Van and Utility Vehicle rear seats and restraint systems. This is a companion study to "Rear Seat Safety Hazards: Collapsing Seats, Cargo Shift, Restraint Failure, and Loss of Occupant Survival Space." The present research will show how static testing reveals seat defects and also demonstrates how designs can be improved with simple, cost effective methods. Static testing is validated by dynamic crash testing.

The presentation will impact the forensic science community by identifying an emerging safety defect trend that has serious implications for occupant safety, especially children. Attendees should obtain a clear understanding of increasing risks to rear seat occupants *of* Vans and Utility Vehicles in frontal and rear impacts, as well as the reasons for those risks. Anyone who rides in the rear seats of these vehicles is at risk from hazards posed by seat and restraint system design, as well as cargo shifting. There are additional hazards posed by "Third Row Seating" in these vehicles which place occupants, often children, within the crush zone at the rear of a vehicle.

The goal of this paper is to present case studies and testing depicting various hazards to rear seat occupants in Vans and Utility Vehicles subjected to various impact vectors. There are emerging safety risks to children and adults from collapsing rear seats and inadequate restraint systems in vans and utility vehicles, which are capturing an ever-larger share of the vehicle market. This study will inform other researchers about why rear seats and restraint system failures are occurring in Vans and Utility vehicles, and how injury is being imparted to rear seat occupants despite use of available restraint systems.

Occupants of rear seats in vans and utility vehicles, and some hatchback-type passenger cars, are subjected to increased hazards caused by the fact that there is no bulkhead or structural separation between cargo areas and occupant seating areas, combined with weak seat structures and attachment hardware. Significant loss of occupant survival space has been seen in both front and rear impacts that are well below human tolerance levels. Because of rear seat failure, occupants can be severely injured due to direct contact by other occupants, seat structures, shifting cargo, and intruding rear vehicle structures. Restrained occupants can be trapped between seat belts and the failed rear seats pushed forward by intruding cargo. Additional hazards are created to restrained occupants when rear seats fail, even without cargo shift, because seat movement can lead to submarining under lap belts, as well as misalignment of the upper torso relative to shoulder belts. Many rear seats in vans and utility vehicles utilize lap-only seat belts, which fail to protect the upper torso, and which also are more likely to lead to abdominal and spinal trauma than an effective lap-shoulder harness. In addition, many rear seats in vans and utility vehicles are designed with no or inadequate head restraints, inadequate seatback height, and lack of structural integrity compared with a conventional passenger car rear seat, in order to accommodate fold-and-tumble features, and/or easy removal of seats from the vehicle. There is a lack of dynamic testing of rear seat areas by safety agencies and auto manufacturers to validate the actual safety of these designated seating positions. These combined rear seat safety issues create risk factors for various size occupants that are not foreseeable to typical users of vehicles, and which are not typically warned about in owner's manuals. Reasonably similar failures have been seen in a wide variety of vehicles from various manufacturers. This is especially significant considering that since 1996, NHTSA and the auto industry have advocated placing children in the back seat to avoid airbag hazards.

"Third Row Seating" in Sport Utility Vehicles, etc., where the rearmost seat is in very close proximity to a liftgate and rear window, as well as being in close proximity to open rear cargo areas, exacerbates these hazards because the "Third Row Seats" are often located within the rear crush zone of a typical vehicle. Alternative designs will be shown that address some of these hazards.

Utility Vehicles, Rear Seats, Restraint Systems

C51 Sampling for Airborne and Surface-Associated Microorganisms

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Upon completion of this presentation, participants will be familiar with the theory and objectives of air and surface sampling, the equipment and methods available, and the factors to be considered in developing a monitoring plan for measuring the concentration and composition of airborne microorganisms and biocontamination sources.

The Microbiology Division of the Harry Reid Center for Environmental Studies has been involved in bioaerosol research for over twenty years and has extensive expertise and peer-reviewed publications in this area. As a result, this presentation will impact the forensic science community by providing the most current and relevant information to maximize the utility of the presentation to professionals in the forensic community that are interested in air and surface sampling and analysis.

The concentration and composition of airborne microorganisms is of interest in diverse areas such as agricultural and industrial settings, medicine, home and office environments, and military research. The term "bioaerosol" is used to refer to airborne biological particles, such as bacterial cells, fungal spores, viruses or pollen grains, and to their fragments and |by-products. The objective of active bioaerosol sampling is the efficient removal and collection of biological particles from the air in a manner which does not affect the ability to detect the organism (e.g., alteration in culturability or biological integrity). A wide variety of bioaerosol sampling and analysis methods have been used and new methods are being developed. However, several problems remain to be solved. For instance, no single sampling method is suitable for the collection and analysis of all types of bioaerosols and no standardized protocols are currently available. Therefore, data between studies are often difficult to compare because of differences in sampler design, collection times, air flow rates and analysis methods. In addition, human exposure limits have not been established for bioaerosols because of the lack of exposure, dose, and response data. This complicates the use of sampling results for risk assessment. Measurement of airborne microorganisms with a bioaerosol sampler often aims at documenting the presence of specific sources. However, when no biological particles are collected and identified by air sampling, one cannot conclude that their sources are absent. To fully evaluate health effects associated with airborne spores, it is important to be able to measure airborne concentrations and the source strength. Therefore, surface samples are often collected in conjunction with air samples in the indoor environment to provide information about microbial sources. Direct source evaluation through surface sampling is used to locate and identify potential bioaerosol hazards and to predict the bioaerosol dispersal and deposition. Qualitative and quantitative information on the concentration and composition of surface-associated microorganisms can be obtained with surface sampling. It is important for the investigator to carefully consider the objectives of sampling before any samples are taken. After determining what information is desired, an appropriate sampling and analysis method can be selected and incorporated into the monitoring design. The purpose of this presentation is to present the principles of bioaerosol and surface sampling and various sampling methods available. Published performance evaluations and guidelines, equipment calibration, and other sampling considerations will also be discussed.

Bioaerosol, Airborne Microorganisms, Sampling

C52 A Rapid High Volume Sampler for Trace VOCs Collection in the Field

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The goal of this presentation is to introduce a new device and methodology for trace volatile organic compound collection and analysis in situations that require rapid sampling and/or field measurements.

The presentation will impact the forensic community by providing an alternative approach to sampling volatile organic compounds in a variety of field situations involving public health or for investigations where canines require corroborative data.

An adaptable air sampler based on high surface area solid phase microextraction (HSA-SPME) has been developed and characterized for rapid collection of trace VOCs in the field or in buildings. The sampling device consists of a thin wire coated with carboxen/polydimethylsiloxane (CAR/PDMS) material wound in the annular space between two concentric glass tubes and uses post-sampling resistive heating for desorption. Detection limits of 0.2-6.9 ppt (v/v) were observed for several toxic organic compounds via selected ion monitoring GC-MS analysis, resulting in an improvement of several orders of magnitude when compared to dynamic sampling with a commercially available 10 mm CAR/PDMS SPME fiber. The low power requirements and the potential for rapid analyte uptake and good sensitivity using the HSA-SPME design will make it possible to rapidly collect and analyze samples in field settings for situations involving public health.

VOC, SPME, GC/MS

C53 Analysis of Bioaerosol Samples

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Upon completion of this presentation, participants will be familiar with the methods available for the analysis of air and surface samples. Participants will have an understanding of the advantages and limitations of various approaches to sample analysis, the compatibility of analysis methods with sampling methods used, and the factors to be considered in developing a monitoring plan for measuring the concentration and composition of airborne microorganisms and biocontamination sources.

The Microbiology Division of the Harry Reid Center for Environmental Studies has been involved in bioaerosol research for over twenty years and has extensive expertise and peer-reviewed publications in this area. As a result, this presentation will impact the forensic science community by providing the most current and relevant information to maximize the utility of the presentation to professionals in the forensic community that are interested in air and surface sampling and analysis.

Respiratory exposure to certain pathogenic or toxigenic microorganisms and/or elevated concentrations of airborne environmental organisms could result in adverse health effects, such as allergic reactions, irritant responses, toxicosis, and respiratory illness. Determination of the concentration and composition of bioaerosols and their sources in indoor environments is necessary for assessment of contamination levels and to estimate potential exposure of occupants. The need for accurate measurement of bioaerosols has received increased attention in recent years owing to concerns with mold contamination in indoor environments and the threat of bioterrorism. Unfortunately, standardized sampling and analysis protocols are lacking, and human exposure limits have not been established for bioaerosols. In addition, there are limited exposure, dose, and response data that are necessary for applying sampling results for risk assessment. Sample analysis methods include culture, microscopic, biochemical, immunological, and molecular biological assays. Traditionally, airborne microorganisms have been analyzed by culturable and microscopic total count determinations. However, there are limitations to both of these methods. For example, culture analysis is limited to only those microorganisms that can be cultivated on artificial growth media and those that are culturable may take days or weeks to grow. Microscopic enumeration can be laborious, lacks sensitivity and requires special techniques or expertise to identify microorganisms. The limitations of traditional methods have led to the development and application of other techniques that can increase the sensitivity and accuracy of bioaerosol monitoring. The selection of an analysis method is a critical component of a bioaerosol sampling plan, and it should be designated before air sampling is conducted. Factors which influence the choice of an analytical method include the cost and length of time required for analysis, the sensitivity and specificity of the analysis method, the sampling methods to be utilized, and the expected characteristics of the bioaerosol of interest. The purpose of this presentation is to provide an overview of available methods for the analysis of bioaerosols and surface samples, including traditional methods and emerging technologies designed to enhance monitoring of bioaerosols, such as polymerase chain reaction (PCR), biochemical, and immunological assays. The advantages and limitations of various sample analysis approaches will be discussed. The use of real-time quantitative PCR will be emphasized.

Bioaerosols, PCR, Analysis

C54 Use of Microscopy in the Sick Building Syndrome Investigations

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The goal of this presentation is to present to the forensic community information about how microscopical analysis can be very useful in the initial stages of a sick building syndrome investigation to help determine the source of the problem.

Sick Building Syndrome investigations often start with building occupant symptoms that may be caused by a wide variety of agents. This presentation will impact the forensic science community by showing the tools of microscopy, polarized light microscopy, electron microscopy, and infrared microscopy and how they can be used with other analytical procedures to more efficiently determine the cause of the problem.

Microscopical analyses are used in conjunction with other procedures to characterize materials collected from building interiors when trying to sort out the various possible reasons that person may feel concerned that a building environment is affecting their health. In a number of studies, light, electron, infrared and raman microscopy techniques have been used singly or in combination to study complaints raised about building safety and healthiness. This presentation will describe each type of microscopy, sampling procedures and the types of information that can be obtained. Case studies dealing with dark stains (mold verses soot), glass fibers, allergens, and other particulates will be used to illustrate how microscopy can be very useful in the initial stages of a sick building syndrome investigation to eliminate some agents of concern and to narrow the field of possible answers to what is actually causing the complaint.

One of the case studies to be presented is titled: A Spot Called Ralph.

In a Courthouse in South Carolina a mysterious stain appeared in the new carpet. Employees even gave the spot a name – "Ralph". At first it was the size of a half dollar but it grew after cleaning to about 2 square feet. Because of employee concerns, a section of the courthouse was closed while the nature of the spot was determined. Environmental mold specialists initially tested the stain in the carpet and determined that the growing stain was not caused by mold. A section of the stain was cut from the carpet and delivered to a forensic microscopy laboratory for inspection. Analysis by light and scanning electron microscopy showed that the carpet contained a variety of particles typical of the particles often found in office dusts. A sticky substance was also found on the carpet fibers. Infrared microscopy analysis of the sticky material showed that it was consistent with corn syrup. It was theorized that some one spilled a soft drink on the carpet and the stain was caused by office dust particles adhering to the sticky drink residue. Efforts to clean the stain removed the dark office dust particles but did not completely remove the sticky drink residue. In fact, the cleaning efforts spread the sticky residue which collected more office dirt over time and therefore appeared to grow in size. Not surprisingly the newspaper reporter who interviewed the laboratory after the findings were made public was disappointed that the stain called "Ralph" was not something exotic but caused by a spilled soft drink.

In another case study titled: The Itchy Nun, residents of a convent in Oklahoma complained of eye irritation and general itchiness. Glass fibers from the duct insulation were suspected of causing the problem. Air samples collected on polycarbonate filters and examined by light microscopy did not show the presence of glass fibers or other particles that are considered normal irritants. Analysis of particles associated with the duct insulation sent as a reference showed a high concentration of mites. Additional testing for mite antigens was recommended.

Microscopy, Dust Particles, Sick Building Syndrome

C55 ERMI and MSQPCR: State-of-the Art DNA Mold Diagnostic for Use in the Science of Building Forensics

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The goal of this presentation is to provide the audience with a set of guidelines to follow to ensure an accurate assessment of fungal contamination when using MSQPCR and ERMI, to educate the audience to the many benefits that MSQPCR and ERMI analysis provide over standard assessment methodologies and to inform the audience of the potential pitfalls associated with MSQPCR data interpretation.

ERMI and MSQPCR analysis hold the potential of becoming the standard for mold detection in the United States. This presentation will impact the forensic science community by showing the annual medical costs incurred by asthma patients suffering from mold-related symptoms are estimated to cost 3.8 billion dollars annually. Much of the suffering and expense can be foregone, if the focus of treatment shifts from patient treatment to treating the source, which in most cases, can be found in our homes, schools and offices.

MSQPCR or mold specific quantitative PCR is a highly accurate and sensitive molecular technique for the detection and quantification of molds. The assay was developed by the U.S. E.P.A. in response to the ever increasing mold problems associated with homes and buildings in the United States. MSQPCR, which is a variation of quantitative PCR, provides the input data from which the Environmental Relative Moldiness Index (ERMI) is derived. ERMI, while a relatively new tool, is rapidly gaining a stronghold as the gold-standard for mold detection in homes and building. Herein, several case studies will be reviewed; each serving as a testament to the power of ERMI and MSQPCR in the field of building forensics and indoor air quality. In each study, MSQPCR was used to identify fungal contamination, or lack thereof, in a variety of indoor environments. The ERMI indices derived from MSQPCR data will be presented. Moreover, an in-depth examination of data interpretation will be explored, from laboratory to the final site assessment and recommendation. The winding path called "data interpretation" will be decomposed to, 1) describe the methodologies to ensure an accurate assessment of fungal contamination, 2) highlight the scientific inquiry required to compose a compelling and highly accurate assessment, and 3) determine the level, complexity, and potential health effects, to occupants, exposed to fungal contamination, in the indoor environment.

ERMI, DNA, MSQPCR

C56 Fire Dynamics Simulation for Courtroom Presentation

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The objective of this presentation is to introduce attendees to available software and methodologies for simulating fire spread and development.

This presentation will impact the forensic community and/or humanity by presenting the availability of the latest techniques in fire dynamics simulation.

This case involves the use of the Fire Dynamics Simulator developed by the National Institute of Standards and Technology (NIST). The Fire Dynamics Simulator consists of a computational fluid dynamics model of fire driven fluid flow. The software developed by NIST involves the numerical solution of a form of the Navier-Stokes equations appropriate for low speed thermally driven flow. The emphasis of the program is on the smoke and heat transport produced by fires. A separate program called Smokeview enables the results of the simulation to be visualized. Smokeview is a software tool designed to visualize numerical predictions generated by the NIST Fire Dynamics Simulator. The visualization includes the movement of smoke and flames throughout the structure as well as temperature changes and air flow.

The authors will present a case study where multiple fire simulations were used to dispute claims regarding a large residential structure fire. In this case, the time frame regarding the development of the fire was in question. Multiple fire simulations with varying sources, heat release rates, and ventilation patterns were developed to investigate the alleged time frame.

The fire development was documented by a passerby beginning approximately one half hour after the homeowner left the home and continuing for the next thirty minutes. The first photograph taken by the passerby displayed the house when it was totally involved at the half hour. At this time all the rooms of the two story structure were beyond flash-over and completely engulfed in flames. Roughly 45 minutes after the home owner's departure, the structure began to collapse. After the fire, the homeowner submitted a detailed list of the contents of every room with photographs so that the fuel load could be accurately determined. Additionally, the homeowner provided accurate plans and measurements of the home so that the structure could be accurately modeled.

Based on the information provided by the homeowner, four separate simulations were developed. Three of these simulations involved starting accidental fires at different locations and levels of the home. The fires were typified by high heat release rates, adequate ventilation, and the greatest possible fuel load according to the evidence presented by the home owner. The simulations of the accidental fires revealed that within a one hour time frame, the fires would not develop as depicted in the photographic evidence. However, a simulation involving the use of accelerants throughout the home produced nearly identical results as depicted in the photographs and in conformity of the time frame of the photographs.

Fire dynamics simulations are powerful investigative tools. Coupled with physical evidence, the simulations can be used to show the progression of fires and can aid juries in the assessment of whether fires are accidental or incendiary or whether the fires originated in particular locations of a structure.

Fire Dynamics, Simulation, Heat Transport

C57 Perception vs. Reality: Countering Claims of Co-Solvency Effects Using Good Science

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The goal of this presentation is to provide a reference for other practitioners who encounter similar challenges during investigations of ground water contamination.

This presentation will impact the forensic science community by demonstrating the use of fundamental organic chemistry principles and straightforward testing methods to overcome a persistent misconception about ground water contamination and solubility.

A groundwater plume of trichloroethene (TCE) and its degradation products was found to intersect a plume of manufactured gas plant (MGP) contaminants and MGP-DNAPL. It was alleged that the presence of TCE had reduced the viscosity of the MGP-DNAPL and increased its ability to flow in the subsurface. This assumption implied that, as a solvent, TCE had increased the dissolution of BTEX compounds and PAHs from the non-aqueous phase into the dissolved phase.

Initially, a literature review was conducted to understand the conceptual model. Our team then developed an approach to quantify any effects that

TCE might have on the viscosity and solubility of the MGP-related constituents. The method of standard additions was employed for the viscosity evaluation: TCE was added in increasing concentrations and viscosity measurements were taken. No significant changes in viscosity were measured at the TCE concentrations known to exist within the groundwater plume, or within the MGP-DNAPL. A decrease in MGP-DNAPL viscosity was only observed at concentrations that were orders of magnitude greater than those observed in groundwater. For the solubility evaluation, samples of MGP-DNAPL containing TCE and its degradation products were tumbled with laboratory-pure water, and both phases were analyzed to develop a distribution coefficient. The results confirmed that TCE in groundwater cannot increase the dissolution of the MGP-DNAPL constituents from the non-aqueous phase. The laboratory work confirmed the conceptual model, and conclusively demonstrated that TCE in groundwater cannot have co-solvent effects on hydrocarbons in the non-aqueous or dissolved phases.

The methods employed were not complex, innovative or challenging. The greatest challenge was to overcome the misperception that TCE retains solvent-like properties when dissolved in groundwater. Direct testing confirmed our understanding of fundamental organic chemistry principles. It is hoped that this demonstration can serve as a reference for other practitioners who encounter similar challenges.

Co-Solvency, TCE, DNAPL

C58 Forensic Evaluation to Determine Multiple Release Contributions at a UST Site

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After attending this presentation, attendees will understand through a case study how to use multiple methods to evaluate site conditions and contributions of different petroleum hydrocarbon releases.

This presentation will impact the forensic science community by showing that this research has direct impact on allocating release contributions between multiple liable parties.

A case study is presented evaluating the contributions of multiple and different petroleum hydrocarbon releases under three different owners at a leaking underground storage tank (LUST) site. Three gasoline underground storage tanks (USTs) were installed in 1961 by the initial gasoline station owner. A diesel UST was installed in 1995 by the second owner, who had purchased the property in 1993. A fuel oil UST was discovered and removed in 1996. An initial gasoline release was reported by the first owner in 1993, based on the assessment of soil and groundwater and identification of free product. In addition, a gasoline UST failed a tightness test in 1990. A diesel surface spill of approximately 20 to 80 gallons occurred in 1999, when a dispenser nozzle fell from an unattended school bus. A gasoline dispenser connection release occurred in 2004 and was reported by the third owner, who had purchased the property in 2001. Approximately 16.6 gallons of free product and 3,300 gallons of groundwater with free product were recovered between 1993 and 2006. Oxygen was injected into the groundwater between 1999 and 2001 in association with the 1993 reported release in order to (1) enhance biodegradation in the UST basins and on the downgradient site boundary, and (2) limit the further offsite migration of contaminants. Approximately 40 to 60 cubic yards of source soils were excavated in the 2004 dispenser release area during the 2006 repair and replacement of dispensers and piping.

Comparison of available volatile organic and polynuclear aromatic compound soil and groundwater data, collected from 1993 through 2006 and between releases, indicates that the initial gasoline release(s) are dominant and the contributions of the other known 1999 diesel spill and 2004 gasoline dispenser releases are limited. The degradation and transport of benzene, toluene, ethylbenzene, xylenes, trimethylbenzenes (TMBs), and methyl *tert*-butyl ether (MTBE) are consistent with an older release pattern, where ethylbenzenes, xylenes and TMBs are primarily observed in the upgradient plume area and MTBE dominates on the plume front. Excel radar plots are constructed to evaluate petroleum hydrocarbon composition over time and identify contaminant source types. Review of 2006 soil and groundwater chromatograms supports that the residual contaminant mass is predominantly weathered gasoline; however, diesel impact is identified. The 2004 dispenser release appears limited because it would be expected that a near-by well be impacted, but this was not observed. Observations of the historic and continued presence of free product and increases in groundwater contaminant levels are associated with low groundwater levels in a deeper-screened well, the installation of shallow-screened wells that intersect the groundwater table and associated free product, and the termination of oxygen injection allowing the free product present to re-source groundwater impact, such that new release scenarios were not indicated or readily identified.

Gasoline and diesel have composition ratios of ethylbenzene to xylenes of approximately 0.20 ± 0.05. Biodegradation will remove xylenes faster than ethylbenzene and the ethylbenzene to xylenes ratios (EXRs) in groundwater will increase with time. EXR data not showing an increasing trend and remaining near the range anticipated for new releases can indicate the presence of "free product" and/or significant source material. Groundwater time series data between 1994 and 2006 show such a free product response, except for a temporary increasing EXR trend associated with the 1999 to 2001 injection of oxygen enhancing biodegradation within the free product area and is not indicative of a new release response.

In conclusion, three releases were reported and identified in the available data: the 1990 to 1993 gasoline UST releases, the 1999 diesel surface spill, and the 2004 gasoline dispenser release. Inventory records were requested to review for evidence of other unknown release(s), if any. The initial gasoline UST releases contribute the predominant contaminant mass. Diesel impact is identified, but is not a significant mass compared to gasoline contributions. The 2004 gasoline dispenser release appears limited or the nearby well should have shown some impact, which was not observed. EXRs indicate persistent free product/source material since at least 1994 and enhanced biodegradation during the 1999 to 2001 oxygen injection, but no observable new release over historic levels.

Petroleum, Release, Allocation

C59 Field Evidence for Abiotic Degradation of Trichloroethylene in a Thick, Weathered, Surficial Aquitard

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Upon completion of this workshop, participants will gain knowledge about the fate and distribution of TCE in a complex geological medium and how to use multiple data sets, including geologic, soil contaminants, aqueous geochemistry, water quality, and environmental isotopes together to determine chlorinated solvent fate and distribution. The focus will be on gaining an understanding of the abiotic process of TCE degradation to 1,1-DCE in the subsurface from field data, rather than laboratory experiments.

The forensic science community will gain further understanding and insight into the abiotic process by which TCE, a commonly encountered contaminant in soil and groundwater, degrades in the environment. This will enable forensic scientists to better evaluate the impact of TCE contamination on the environment and to support evidence for site characterization, source and extent of contamination, risk assessment, remediation technology development, and litigation issues. These evaluations and evidentiary support will result in better protection of human and environmental health and well being.

Abiotic reductive dechlorination of TCE to 1,1-DCE appears to have occurred at a former chemical landfill (the Site). The Site is situated on a fractured, surficial, clay aquitard, approximately 130 ft thick. The upper 3 to 4 m of the aquitard is highly weathered, beneath which the subsurface transitions into an unweathered zone. Chemical waste containing VOCs was deposited at the Site from the mid-1950s through the early 1970s. The

disposed chemical waste was a large volume of PCE-dominant, multi-component DNAPL, containing neither 1,1-DCE nor 1,1,1-TCA.

Although biotic reductive dechlorination of TCE may produce *cis*-1,2-DCE, *trans*-1,2-DCE, and 1,1-DCE, the predominant biotic degradation product of TCE is *cis*-1,2-DCE. When TCE undergoes abiotic reductive dechlorination, the primary degradation product is 1,1-DCE. The results of the investigation conducted at the Site indicate that the production of 1,1-DCE in the unweathered zone of the aquitard is the result of abiotic degradation of TCE.

Subsurface conditions at the Site support the abiotic degradation of TCE. Laboratory studies by Klecka et al. (1990) and Kastner (1991) indicate that 1,1-DCE in groundwater can occur as a product from the abiotic degradation of TCE in the presence of sulfide. Kriegman-King and Reinhard (1992) observed in a laboratory study that abiotic degradation of another chlorinated solvent, carbon tetrachloride, was enhanced by the presence of pyrite (iron sulfide) and vermiculite. The clay soil at this site contains both pyrite and vermiculite (Abbott 1987, Quigley and Ogunbadejo 1976).

Abiotic degradation of 1,1,1-TCA may also produce 1,1-DCE, but it does not appear to be a source of the 1,1-DCE in the unweathered zone at the Site. Attributable to the degradation of 1,1,2,2-TECA, which was a component of the DNAPL, low concentrations of 1,1,1-TCA were detected in soil cores in the weathered zone, with no apparent relation to 1,1-DCE. In contrast to 1,1,1-TCA, TCE occurs in nearly all soil samples where 1,1-DCE was detected, and, in the unweathered zone, the mole fraction of 1,1-DCE increased as that of TCE decreased. The mole fraction shifts between TCE and 1,1-DCE indicate that TCE is the source of the 1,1-DCE in the unweathered zone.

TCE, Abiotic, 1,1-DCE

C60 Resolving Uncertainty in Groundwater Plume Investigations

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The goal of this presentation is to raise awareness of the critically important role which the scale of inquiry plays in the development of an adequate understanding of groundwater plumes, their sources and the processes affecting them.

This presentation will impact the forensic science community by showing how geology and classical water-supply type hydrogeology have focused on the macro-scale, subsurface contamination is controlled on the micro-scale and the ability to adequately understand groundwater contaminant plumes and their sources depends on very different approaches than have commonly been applied.

New investigation techniques such as the Triad Approach focus on understanding and managing uncertainty in decision-making relative to investigation of a site. Decision uncertainty stems from both sampling uncertainty and analytical (or measurement) uncertainty. Sampling uncertainty, by far the largest source of uncertainty, arises from the heterogeneity inherent in natural porous media. Examples include the spatial structure of: (1) hydraulic conductivity controlling groundwater flow, (2) capillary pressure controlling non aqueous phase liquid movement, and (3) soil water partitioning coefficients, controlling retardation of VOCs. In addition, hydrodynamic dispersion is a very weak process in directions normal to the primary groundwater flow direction, resulting in very steep concentration gradients.

Conventional techniques used to investigate groundwater contamination in porous media, such as monitoring wells, result in depth-integrated, flow weighted average concentrations and large spacing between samples that result in a high level of uncertainty in the conceptual site model and hence in decision making. The Triad approach utilizes real-time measurement techniques that provide many more data points at a more appropriate scale than conventional methods. The real-time data are used to update the conceptual model and modify the investigative approach while the investigation is under way.

Direct push investigation tools and techniques have advanced greatly in both capability and acceptance over the 12 years since the Waterloo Profiler first entered commercial use. Investigators of plumes in porous media are now equipped with a toolbox that they can rely upon for managing uncertainty.

The Waterloo Profiler is a direct push groundwater sampling tool that has been modified to allow for the collection multiple data sets that are used collaboratively to test and revise the conceptual site model. The modified Waterloo Profiler provides discrete groundwater samples at virtually any vertical spacing while developing a continuous log of the Index of Hydraulic Conductivity as well as hydraulic head distributions and specific conductance, pH, oxidation/reduction potential and dissolved oxygen of groundwater. With these modifications the Waterloo Profiler has become a very powerful data collection system for sites with solvents in porous media. The number and range of sites at which the profiler is an effective technology has been increased by the modifications to the profiler tip; the drive rod; the addition of the gas drive pump and the use of a variety of drive platforms.

The Membrane Interface Probe is a relatively new semi-quantitative screening tool that can rapidly provide a large body of data on the distribution of VOCs in the subsurface. The MIP provides a continuous log of the responses to various detectors to VOCs in the subsurface along with a continuous log of the electrical conductivity of the porous medium. The MIP can complete on the order of 200 linear feet of exploration in a day. However, correlation between MIP data and results of laboratory analysis of soil and groundwater samples is not straightforward.

The MIP and the Waterloo Profiler/Onsite Lab data were used collaboratively to test and revise a conceptual site model on an industrial site in Connecticut. This site had been under investigation for 17 years and had remedial systems in place. The remedial efforts were ineffective because the essential site contaminant distribution and transport issues had not been resolved. A Triad investigation team incorporated source zone data collection in the vadose zone using a passive soil gas survey, membrane interface probe explorations and conventional soil coring and onsite analyses along with the integrated data sets provided by the Waterloo Profiler below the water table to revise a conceptual site model through a dynamic investigation. The uncertainty that had been hindering use of the site for over a decade was reduced as a result of the investigation and the stakeholders were able to move forward.

Groundwater, Plumes, Investigation

C61 New Jersey Hillbillies

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The objective of this paper is to show the use of environmental forensic techniques to identify and date the releases of hydrocarbon products.

The presentation will impact the forensic science community by identifying useful tools for use in environmental forensic investigations.

The forensic work will include two separate sites from which very unexpected hydrocarbon substances were found in a well. The process of collecting the separate phase hydrocarbon and identifying the product and explaining its release to the environment will be discussed. Unlike the Beverly Hillbillies, these materials are refined products and not crude oil.

Site 1: The site was originally used as an open-air trolley yard, possibly for horse-drawn, then electrically driven. In 1925 it was developed as a state-of-the-art "bus barn" covering the entire ½ city block site. The new development included mechanic's lube pits, a washing station and refueling island, all internal to the site. Underground storage tanks were installed under the sidewalks, external to the building footings, but not in the street proper. The first buses were powered by gasoline. The bus fleet was converted to diesel fuel in the late 1940s and 1950s. Site operations ceased during 1995 and the tanks were closed at the end of that year. The building was demolished.

In 2005, a temporary well was placed on the site near the sidewalk. A clear, light yellow hydrocarbon was obtained from this well. A sample of this hydrocarbon was submitted for gas chromatographic analysis using both a flame ionization detector (GC/FID) and an electron capture detector (GC/ECD). The GC/FID chromatogram is shown in Figure 1. This chromatogram was obtained without use of a diluting solvent. The chromatogram is a straight run gasoline that does not contain any tetraethyl lead antiknock additive. This gasoline appears not to be weathered by water washing, evaporation or biodegradation. Since the use of tetraethyl lead as a gasoline additive was used in the late 1920s then the age of this gasoline release is in the 1925 to 1930 time frame. It is obvious that age-dating of gasolines and other hydrocarbon products is very questionable when the basis for the age determination is a weathering process.

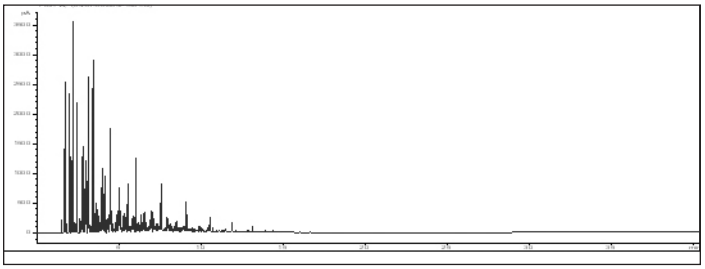

Figure 1

Site 2: This site was an industrial location last used for the recycling of materials with gold and silver. The plant recycled circuit boards by ashing the organic material, dissolving the inorganic ash and recycled metals with aqua regia. The process continued until gold and silver bars were produced. No use of a hydrocarbon was apparent in any of the recycling processes.

Again, punching holes into the ground brought an unusual substance to the surface. In only one well, there was a clear, light purple oily substance that clung to the rock in the well and to the glass of the sample vial. This substance appeared to float in the water. GC/FID analysis of this sample produced the chromatogram shown in Figure 2. The substance did not react with concentrated sulfuric acid. The infrared spectrum indicated a saturated hydrocarbon. A GC/mass spectrometry analysis (GC/MS) indicated a series of sharp peaks with the molecular weight of 352. The interpretation of these mass spectra indicated that these compounds were alkyl substituted naphthalenes. A patent search identified the substance as a synthetic motor oil. This material was most likely used as a vacuum pump oil in the recycling processes of the site's former company.

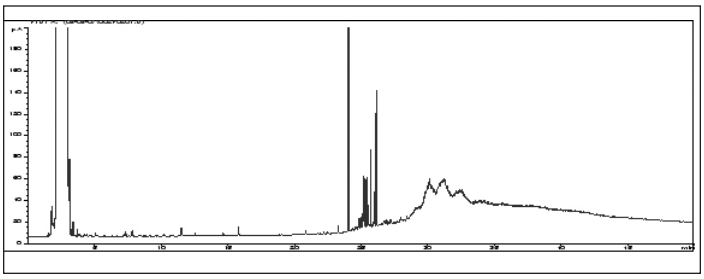

Figure 2

Hydrocarbon, Synthetic Motor Oil, Gasoline

C62 Heat Damage to Cotton Fabrics as a Clue to the Conditions That Produced It

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After attending this presentation, the attendee will learn about the variables in producing heat damage to textile materials, specifically cotton, and the observed stages of damage in actual burns.

This presentation will impact the forensic science community by offering the beginnings of a tool for correlating observed residues from textiles damaged fires and other heat sources with the conditions under which the damage was produced.

Textile fabrics from clothing, rags, and home furnishings are often damaged at fire scenes and by other sources of heat. It would be useful if the conditions that caused the damage could be inferred from the type of damage observed. The focus of the existing forensic literature is on the identification of fabrics and fibers that have been damaged, with several papers by Jolanta Was-Gubala and colleagues that do treat the effects of flame vs. radiant heat and another treating scorch damage from vapor cloud explosions. Forensic pyrolysis studies, even of fabrics, tend to focus on pyrolysis products that appear in vapor phase samples, where the interest is in the textile pyrolysates as contaminants. Textile flammability literature treats factors affecting ignition temperature and flame propagation, but not the burn residues themselves. There is also a body of literature treating charred materials as energy sources, and pyrolysis as a way to dispose of wastes. However, little information is available correlating the thermal damage itself with the variables in burning and heating processes. This is the focus of our study.

The processes by which heat results in fabric damage can be affected by several types of variables: the heat source (does it continue to produce heat, or is it removed after fabric ignition); the type of heat (flame, radiant heat, convection, etc.); the temperature, amount and duration of heat; the type of fabric (fiber type, thread and fabric structure, etc.); ambient conditions (temperature, humidity, air movement, oxygen-rich or oxygen-poor); and interactions between heat source and fabric (is the heat-source a fuel that continues to burn along with the fabric, or does the fabric self-ignite and burn with the initial heat source removed).

The authors decided to begin our study with cotton. It is the most commonly encountered clothing fabric type, is highly flammable, and typically sustains a flame after an ignition source is removed. After several experiments with cotton swatches that reflected variables in fabrics, including type of weave, nap (fuzziness), and loft (tightness of weave) of the fabric; and horizontal vs. vertical orientation when exposed to flame, we decided to focus on variables of burning and heating conditions and to limit the fabric variables by studying one type of fabric at a time. Denim blue jeans were burned and heated in the first test series, and white cotton t-shirts were added in the second series.

Garments and sections of the garments were exposed to heat under the following conditions: outdoors, ignited with match flame on an open grill with good air flow; outdoors, placed into an open can and ignited; and stuffed into a closed but not airtight can and heated on an existing fire but not ignited. Swatches were also heated indoors in a muffle furnace. Regardless of burn conditions, the cotton fabric proceeded from scorching then charring in response to ignition with an outside flame, to self-sustaining flame producing charring near the flame and scorching (brown discoloration) at the char margins, to brown ash that maintained the weave structure, to white ash. The formation of white ash was accompanied by a major loss of mass; it is likely that evolved gasses are significant reaction products at this stage. The white ash at first retains a skeleton (only) of the fabric structure then disintegrates. Pieces of black charred flakes and white ash float away or blow away with air movement and wind. Different ratios of the several reaction zones (scorch, black char, brown ash and white ash) were observed in burnt residue produced under different conditions. In addition, a sticky brown viscous material was observed; the literature indicates a liquid viscous residue to be

a product of burning cellulose. Observations of the residues were made using a stereobinocular microscope. The fire itself begins with open flame and continues by smoldering. The time spent in flame vs. smolder can vary considerably.

Variables in ambient conditions included temperature, wind, and humidity, but the temperature range was probably too small to be significant. Higher winds contributed to flame propagation and air movement, thus affected the rate of burning, but did not affect the types of residues observed. Humidity was a significant enough variable that it was varied artificially using a plant mister to compare it with burn results when other conditions were the same. When the humidity rose by 20 - 30%, ignition was slower, burn times were much longer, garments did not burn to completion, more char than ash was produced with little white ash, and residues included a greater proportion of charred fabric that retained some flexibility even after storage in drier conditions.

Variation in air flow: Tests were conducted with the good air flow of an open grill, with low to moderate winds, and with the restricted air flow of a burn can. The burn can fire residues exhibited the same stages as the fires on an open grill, but the fire itself did not flame for long, but burned with long smoldering. Nevertheless, the same sequence of burning was observed. The smoldered burn resulted in extensive areas of black charring, a quantity of layered gray ash towards the top, a small amount of brown sticky residue, and thin brittle black scale on the sides of the can. Upon sieving, the ash resolved into black charred fibers, brown ash, white ash, and mineral particles. The mineral particles were a part of the ash, and more numerous in the white ash. White ash and brown ash were significant components of the upper part of the burn residue, and black charring was more significant deeper in the can. This differs from the residue from open fires that consisted principally of black char and white ash, with smaller amounts of brown ash. This was evaluated by sieving portions of the ash then examining samples of each fraction microscopically (PLM).

The black residue consists of charred black fibers. The brown ash consists of individual brown non-birefringent fibrils, glass and fine minerals. The white ash consists of more glassy and highly birefringent tiny minerals. It was difficult to evaluate any differences in production of the brown sticky material under different conditions, as we did not have a good method to estimate the amount. It is possible that this material reacts further to form a hard black scale observed on the sides of the burn can and on some of the non-fabric items from the clothing such as buttons and rivets. Prior studies of thermal damage to hair suggest that length of time may be a factor in the low-temperature formation of brittle blackened residue. However, has not yet been tested on cotton fabrics. If the latter hypothesis is true, a finding of black scale may provide a clue to the burn conditions, whether air flow, heat intensity, length of burn, temperature, or some combination of the above.

The cotton garments and garment swatches that were burned in covered cans but not directly ignited, exhibited only scorching and charring in those portions of the fabric nearest the surfaces of the cans. It may be that the fires were not hot enough to permit self-ignition, and of insufficient duration to permit more extensive charring. This will be the subject of further study.

As would be expected, the burn residues from denim blue jeans also included metal buttons and rivets, and metal zipper pull-tabs and slides, but also the metal teeth from the zipper, as the fabric holding the zipper together had burnt. This argues for the sieving of ash to find not only the burnt components, but also small artifacts such as the zipper teeth. Some of the metal rivets had plastic shanks; the plastic melted and burned with decomposition. Even the 100% cotton blue jeans sometimes had cotton/polyester blend pockets, which burned leaving microscopic hollow black spheres adhering to blackened cotton fibers and also producing hardened areas of charred cotton fabric. A more surprising artifact from one burn included microscopic pieces of what is likely to be a brown glass. The source was not determined, but it is possible that a rope trim on this garment burned leaving phytoliths (glass formed from the burning of silicate inclusions in the fibers). This will also be the subject of further study. In addition to the physical characteristics of burnt artifacts, it was observed that in a burn test on one pair of blue jeans, the rivets popped off explosively and were propelled several feet. Accompanying char and ask fragments traveled as much as ten feet.

Further work: In addition to the topics mentioned above, heat damage to cotton fabrics in low-oxygen environments that have sufficient flow has not been studied, as well as including large quantities of other gasses such as carbon dioxide instead of oxygen is planned. This is a situation sometimes encountered in areas of fire scenes. Most of the burn products either microscopically or chemically have not been identified. These topics in the next phases of this study will be addressed.

Summary: Preliminary information suggests that it will be possible to correlate the alterations to fabrics damaged by heat and any resulting residues with the conditions under which the damage was produced. The most significant variables appear to be humidity, air flow and perhaps the amount of oxygen. Information from heat damage and burn residues can be useful to fire investigators in mapping the different areas of a fire and in deciding whether something burned in a flame or was exposed to radiant heat.

Thermal Damage, Textile Flammability, Forensic Science

GENERAL

D1 25 Years of HITS: An Analysis of 10,000 Murder Cases From 1981-2006

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The goal of this presentation is to enable the police and the public to better understand the risk of victimization from a murder and the complex nature of these types of investigations.

This presentation will impact the forensic science community by providing valuable information and topics to be further explored relating to murder investigations.

This paper provides an overview of descriptive information about the victims, offenders and other factors affecting murder investigation solvability by examining variables in the Homicide Investigation Tracking System (HITS) from 1981 to 2006 dataset. Characteristics of the victims and offenders will be examined, including a description of the victim-offender relationship. Information relating to the victim's cause of death and offender's crime scene behavior will also be presented. The HITS dataset used for analysis includes more than 10,000 murders in Washington State and the surrounding area between 1981 and 2006. The HITS data were collected from municipal police departments and county sheriff's offices in close proximity to the Seattle metropolitan area with a service population of 100,000 or more, or that had fifteen or more murders reported to the Federal Bureau of Investigation's (FBI) Uniform Crime Report (UCR) in 1987 (Hanfland et al., 1997). Information on homicides was collected from several states including Washington, Oregon, Idaho, Alaska,and parts of Canada.

The findings from this research provide valuable information relating to murder investigations which should be explored in further detail. In addition, the information obtained from this preliminary analysis of the HITS 1981-2006 dataset will prove useful for law enforcement personnel investigating murders. It is imperative that data from murder investigations be further explored in order to give police a larger arsenal of investigative tools and parameters for murder investigations. The information in this presentation is a valuable resource which will enable the police and the public to better understand the risk of victimization from a murder and the complex nature of these types of investigations.

The current study attempts to answer four general questions prompted by previous homicide research: (1) which demographics are related to case solvability, (2) can case solvability be correctly predicted from knowledge of the victim and offender's age, race, gender, relationship, the time between murder incidents, and distance between murder incident sites, (3) if case solvability can be accurately predicted, which predictor variables are essential to status prediction, and (4) how good is the model at correctly predicting case solvability? While this study is by no means an exhaustive examination of all solvability factors in murder investigations, it provides information on over 10,000 cases and highlights predictors of murder solvability. Logistic regression is used to determine which variables are accurate predictors of case solvability. In general, it is expected that race, gender, age, time, and distance will have a significant impact on case solvability in murder investigations.

Because of the public fear of stranger crimes, solvability will also be examined by victim-offender relationships in this sample. There may be significant factors in case solvability depending on the nature of the relationship between the victim and the offender. Initial findings that the age, sex, and gender of both the victim and the offender effect case solvability are not surprising. The confirmation that the time elapsed and distance between murder incident component pairings affect case solvability would be consistent with previous findings by Dr. Robert Keppel (1992).

Homicide Investigation Tracking System (HITS), Solvability, Murder

D2 Modes of Killing and Rituals in Apulian Mafia Homicides

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The goal of this presentation is to show a series of murders committed by the local Mafia in Puglia (Apulia) (Sacra Corona Unita: United Holy Crown), in order to analyze the particular ritualistic aspects of murders and the different manners of execution.

This presentation will impact the forensic community by showing the ferocious manner of killing and rituals used by affiliated members of Sacra Corona Unita.

The early 1980s witnessed the birth of the *Holy Crown United (SCU)*. This is a Mafia organization, which formed in the south of Italy and is noted for the ferocity of its homicides and the correlating ritualistic methods it used. The name of the organization itself relates to strong mysticism; *Holy*: because its principles are absolute and unchangeable, *Crown*: because its members are bonded together like the beads in a rosary, *United*: because the positions in a rosary are absolute and unchangeable.

The discovery of a considerable number of manuscripts has contributed to support the image of the SCU as an elite criminal organization, which uses rituals for affiliation and killings. The internal structure of the organization is similar to a pyramid, which is articulated on different levels ("minor society", "major society", and "secret society"), the entrance to which is secured only via some "baptism rites" that signify the passage of the subject from a condition of layman to affiliated member.

In keeping with the typical customs of the clan, each affiliated member has a nickname. On this basis are based those rituals related to killings, and in fact it is often possible to find objects and symbols laid next to the dead bodies of the victims, that help both to identify the individual and the killing as that of the SCU. One example was the discovery of the horns of a baby bull next to the body of the son of an affiliated member whose nickname was "the bull" or a rat skull in the clothes of a dead member known as a "sewer-rat".

In this research 83 corpses were examined that had undergone autopsies between 1980 and 2000. Of these corpses, 77 were male and 6 were female. The age of the victims ranged between 21 and 40 years. The bodies are mainly of SCU members, and in some rare exceptions police and law enforcement agencies and other citizens who were accidentally caught in the crossfire. Some of the bodies were found after a period of three years from the official denouncement to the police of a missing person, and were largely discovered thanks to the help and collaboration of SCU member's confessions. The condition of the bodies varies in relation to the date and mode of killing. In particular there were fifty-one "fresh" bodies, thirteen burned bodies, twelve skeletons, and seven adipocere bodies.

The killing and successive burning of the body in cars relate to a symbolic code for all affiliated members of the SCU. It relates to the specific initiation ritual, which states that those who betray the organization will be reduced to ashes. This ritual draws back to the ceremony of affiliation in which an image of a saint (Saint Michel Archangel) was burned. Above all, this technique is a strategy that serves to make it more difficult to determine the identification of the victim and to eliminate all traces left by the executioner.

In other cases killings were followed by body destruction in acids. The most frequent event was the disappearance of the subjects that was supposed to be killed: a homicide without the body buried somewhere in hidden places. These cases were referred as "Lupara Bianca". Lupara refers to the hunting gun that it is used by the SCU to execute its victims and bianca means white, which refers to the fact that there is no victim to identify.

The antropometric research method was necessary in cases where the body was in an advanced state of decomposition (i.e., burnt, skeletonized, adipocerized). This technique was used to ascertain the race, age, sex, weight, and height of the victim along with individual characteristics (i.e., dental records, scars, tattoos, and fractures), which were determined via photos, radiography and clinical records of suspected victims.

Ballistic investigations were conducted in order to identify the types of arms used, and to determine if the same gun had been used in other executions. By the 83 homicides examined, it was determined that most of the victims were killed by a firearm; only in four cases were fatal lesions sustained by blunt objects and in other three cases death was caused by explosive materials.

In more than a third of the cases (73%), lesions at the head (66 by means of a firearm and 3 by means of another blunt object i.e., stick or stone) were the only marks left on the body; in particular lesions caused by a firearm were found to be located on the back of the head, which is hypothesized that at "the moment of execution", the victim was on their knees, maintaining a reverent position. In three cases lesions were caused by a powerful firearm able to cause considerable damage to individuals. Moreover the identification of one victim of the SCU was uniquely made via an examination of an isolated patella.

The conclusion of the ballistic investigation on the firearms and munitions used by the SCU evidences the different origins of the firearms (i.e., from Yugoslavia, Czech Republic, China, etc.) confirming the role of the SCU in the trafficking of international arms.

Homicides, Ritualism, Italian Mafia

D3 Cars Gone Wild: Auto-Pedestrian Homicides in Harris County

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After attending this presentation, attendees will become familiar with the concept of pedestrian homicide by motor vehicle collision, and will gain insight into the various features of pedestrian fatalities.

This presentation will impact the forensic community by showing the importance of a thorough investigation into all pedestrian fatalities, even those that may initially seem accidental.

Pedestrian and non-motorized bicycle fatalities constituted 21.4% of all motor vehicle fatalities investigated at the Harris County Medical Examiner's Office over a one year period. The manner of death in the vast majority of these fatalities is classified as accidental in Harris County, including those in which the vehicle driver fails to stop and render aid, the so called "hit-and-run." While most motor vehicle accidents involving pedestrians are found to be genuinely accidental in nature, a small number are caused by a deliberate, volitional act with the purpose of harming or killing someone. Without a timely and thorough scene investigation and search for possible witnesses, these cases may be overlooked and/or misclassified.

Over a seven month period, four pedestrian fatalities at the Harris County Medical Examiner's Office were determined to be homicides. In two of the cases, the driver and the decedent were not known to each other, and the cases were initially thought to be accidents. In the remaining two cases, the driver and decedent were known to each other and the cases were initially investigated as potential homicides.

The first case was that of a 25-year-old man whose body was found on a roadside near a sewer drain at approximately 7 a.m. by a passerby. He was last known to be alive the night before by his wife, who reportedly spoke to him on his cell phone as he walked home from a night club. His injuries at autopsy were consistent with being struck by a vehicle, and his postmortem alcohol level was 0.21 g/dL. Houston Police Department investigators noticed a surveillance camera at a business parking lot across the street from which the decedent was found. Although no intentional act was initially suspected in this case, police investigators obtained the video which depicted a car deliberately waiting for the decedent to approach an intersection, and then speeding forward and striking the decedent. Two people were then seen exiting the car, walking up to and stopping near the decedent, then returning to the car and leaving the scene. Because the wallet that the decedent normally carried was missing, robbery was presumed to be the motive of this intentional hit-and-run.

The second case involved a 42-year-old woman who was witnessed to be struck by a black pick-up truck as it swerved off the road along which she was walking. The truck carried her on the hood for approximately 62 feet and failed to stop and render aid. Shortly thereafter, a similar hit-and-run incident involving a black pick-up truck occurred in the Houston area. Collaboration between the medical examiner and the police revealed that a single individual had perpetrated these crimes.

In the two cases involving decedents who were known to the perpetrators, the decedents were struck in the parking lots of night clubs. Both of these events were reported to occur following arguments between the decedents and perpetrators.

Additional features of these four cases as well as features of pedestrian hit-and-run fatalities presumed to be accidental encountered at the Harris County Medical Examiner's Office will be reviewed. Factors such as road type and condition, speed of the vehicle, location of the pedestrian (intersection vs. non-intersection), alcohol/drug levels, age of the persons involved, and the time of day will be discussed with regards to intentional and unintentional pedestrian fatalities.

Although rare, there are occurrences in which a motor vehicle is deliberately used as a weapon against another person. Without a complete and thorough investigation that begins promptly at the time the body is found, the ability to effectively classify the manner of death, as well as gain evidence for effective prosecution of hit-and-run pedestrian deaths, may be impaired.

Hit-and-Run, Pedestrian, Homicide

D4 Female Suicide Victims From Gunshot Wounds to the Head: Investigatory Considerations

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The goal of this presentation is to provide eight (8) investigative steps for evaluating females who are shot in the head and determining that their manner of death is unequivocally a suicide.

This presentation will impact the forensic community and/or humanity by demonstrating investigatory considerations when investigating suspected female suicides by gunshot to the head.

This presentation focuses on investigative strategies for examining cases where female victims are found with a gunshot to the head and suicide is considered the manner of death. Families of female victims who commit suicide in this manner have more difficulty accepting this as a cause of death than others. Investigation of female victims who have sustained a gunshot to the head should be approached with extreme vigilance and an aura of suspicion.

Data collected from the Center for Disease Control and the National Center for Health reflects that the number of suicides has remained relatively consistent from 1990 thru 2004. Groups that collect and analyze suicide statistics identify data as to the means of suicide, i.e., firearms, poisoning hanging, etc., however, they do not specifically indicate the location of the fatal wound. Even though the method of suicide for women vary, gunshots are not the most common method, yet it is not an uncommon method. Suicide by women shooting themselves in the head does occur, however, even though rare, this is seen. This presentation proposes eight investigatory procedures which should be considered in documenting these cases as suicide and not a homicide.

1. **Position of victim:** If the victim is evaluated by emergency responders, and it is determined that she is deceased, every effort should be made to leave the victim in the position in which she is discovered until documentary photographs are taken. This initial step can save investigators literally hours of investigative reconstruction.

2. **Bloodstain patterns on hands:** Victims that succumb to self-inflicted gunshot wounds to the head are likely to have either high or medium back spatter on their hands. This can be photographed and preserved by placing paper bags over the victim's hands prior to transportation from the scene.

3. **Gunshot Residue collection:** Again by placing paper bags on the victim's hands, the death investigator is minimizing the possible loss or contamination of gunshot residue. This step should be initiated as soon as possible and before the victim is transported from the death scene. The paper bags should be retained as evidence and entered into a chain of custody for later examination of trace evidence.

4. **Examination of the gunshot wound:** Careful consideration and examination should be given to the victim's gunshot wound prior to autopsy prepping. Checking the gunshot wound for muzzle impressions, searing, and/or the presence of stippling can later be used to determine distance from the entry wound to the weapon's muzzle. Pre-autopsy examination can also support the medical examiner's findings. High quality photography is imperative to document the presence or lack of searing, soot and stippling.

5. **Radiograph of victim's skull:** Radiographs of the victim's skull are imperative. These x-rays may identify the location of the bullet and any trauma that is associated with the gunshot would itself.

6. **Complete examination of the victim's "home environment":** This investigation activity is likely to require a family members consent or a warrant from a court describing that additional investigation is need to positively establish the manner of death. Since many suicides are committed in settings away from home, frequently preparatory activities take place at a different location than where the victim actually commits suicide. These activities include acts such as computer entries on the topic of suicide, receipts for purchasing the firearm, suicide notes, or instructions to be implemented after the victim's death.

7. **Comprehensive psychosocial autopsy:** Suicide literature contains many components that should be considered in a psychological autopsy. Investigators should not only examine the victim's mental state preceding death, i.e. depression, but the social circumstances that contribute to their mental state. The death investigator should look for 'landmarks' such as the 'anniversary dates' of the death of a loved one, divorce, the diagnosis of a terminal illness or changes in the victim's financial circumstances. A comprehensive psychosocial autopsy can answer many of the families' questions, and make the death determination an unequivocal suicide.

8. **Firearm examination:** In many jurisdictions law enforcement responding to a suicide will take responsibility for entering the weapon used in the death into the chain of custody. Who examines the firearm and how the weapon is analyzed varies considerably. Some forensic laboratories will not examine weapons used in a suicide, because suicide is not classified as a crime in that State. Ballistic comparison can also be conducted to compare a bullet from the victim or the death scene with the gun used in the death.

These guidelines are proposed when females are discovered with gunshots to their head and that the comprehensive investigation differentiates suicide from homicide. Victim's families have difficulty accepting this manner of death when the victim is shot in the head. These procedural guidelines help assure families that every investigative avenue was explored before concluding that this act was in fact a suicide and not a homicide.

Female Suicides, Head Gunshots, Investigative Procedures

D5 A 10 Year Epidemiologic Review of Homicide Cases in Children Under Five Years Old in Fulton County, Georgia: 1996-2005

Geroncio C. Fajardo, MD,and Randy L. Hanzlick, MD, Fulton County, Medical Exam Center, 430 Pryor Street, South West, Atlanta, GA 30312*

After attending this presentation, attendees will know the epidemiology of homicide deaths certified by the Fulton County Medical Examiner's Office from January 1, 1996 through December 31, 2005 in children under five years of age and who were Fulton County residents, and they will be able to determine if the observed cases of homicide deaths among children under five years of age in Fulton County are significantly greater than expected when compared to the State of Georgia.

This presentation will impact the forensic community by enabling the local and state government officials to recognize the epidemiology of children at risk, to help them allocate limited resources efficiently, and to implement preventive measures to at-risk populations effectively. Furthermore, this presentation will enable the forensic community to recognize the continued need to collect current and accurate data on child abuse homicides and to conduct further study to determine the reasons for homicide in children under five years of age.

The primary purpose of this study is to present the epidemiology of homicide deaths certified by the Fulton County Medical Examiner's Office from January 1, 1996 through December 31, 2005 in children under 5-years-old. The secondary purpose of this study is to determine if the observed cases of homicide deaths among children under 5-years-old in Fulton County are significantly greater than expected when compared to the State of Georgia. For purposes of this study, only homicide deaths of Fulton County residents were included.

All homicide cases in children under 5-years-old were reviewed: infancy (less than 1 year old) and early childhood (1-4 years old). Chi-square values were calculated using Epi Info to determine differences in homicide among age group, race and sex variables. In addition, a chi-square test at the α=0.05 level was done to determine if the observed cases of homicide deaths among children under 5-years-old in Fulton County were significantly greater than expected when compared to the State of Georgia.

There were 49 homicide cases in children under 5-years-old identified over this 10-year period. The yearly distribution of these 49 homicide deaths ranged from one death in 2003 to nine deaths in 2004. Most of the cases were male (n=29, 59.2%) and black (n=44, 89.8%). Between infancy and early childhood cases, homicide victims were nearly equally divided between the two groups. However, chi-square values showed that decedents under 5-years-old are 1.7 times more likely to have died of homicide compared to decedents 5-years-old or older (OR = 1.74, 95% CI = 1.29-2.35). Black decedents < 5-years-old are 3.2 times more likely to have died of homicide compared to other races (OR = 3.21, 95% CI = 1.21 - 9.28). Male decedents and female decedents are equally at risk to have

died from homicide (OR = 1.14, 95% CI = 0.61 – 2.11). It was also determined that the total homicide risk for children under 5-years-old in Fulton County during the years 1996-2005, at the α=0.05 level, is 1.8 relative to the State. Brain injury was the primary cause of death in majority of the cases (n=23, 46.9%). Although this study was unable to collect information on the victim's suspect/offender characteristics, it was noted that only 37% of the cases (n=18) went to trial. Majority of the homicide investigations were under the Atlanta police jurisdiction (n=28, 57.1%).

Results from this study may assist Fulton County and its various cities as well as the State of Georgia in recognizing the epidemiology of children at risk to help them allocate limited resources efficiently and implement preventive measures to at-risk populations effectively.

Homicide, Children, Under 5-Years-Old

D6 The Diagnostic Value of Doll Reenactment for the Investigation of Sudden Unexplained Infant Deaths

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The goal of this presentation is to demonstrate the contributions of doll reenactment in the investigation and certification of sudden unexplained infant deaths (SUID).

This presentation will impact the forensic science community by showing how doll reenactments are important in documenting the infant's position as well as their physical relationship with environmental factors and co-sleeping companions. This evidence based practice allows the forensic pathologists to better visualize first responder observations and therefore provide more reliable death certification.

The Centers for Disease Control and Prevention (CDC) has found that the decline in sudden infant death syndrome (SIDS) rates since1995 have been offset by increasing rates of other types of sudden unexplained infant deaths (SUID). A recent review by the Medical Examiner Office in Wayne County, Michigan where doll reenactments are routinely performed during SUID scene investigations, suggests that asphyxia plays a greater role in many sudden infant deaths than has been previously reported. Co-sleeping continues to be a significant risk factor involved with SUID. Doll reenactments are important in documenting the infant's position as well as their physical relationship with environmental factors and co-sleeping companions.

The CDC has identified scene reconstruction using a doll to depict both "placed" and "found" positions as important in SUID investigation. It is suggested that doll reenactment allows the forensic pathologists to better visualize first responder observations and therefore provide more reliable death certification. However, death investigators, law enforcement professionals, and medical examiners remain reluctant to perform or dismiss doll reenactments because of emotional concerns for the parents and for themselves. Using an evidence-based model, this study documents the contributions of doll reenactment in the investigation and certification of sudden, unexpected infant death by the Milwaukee County Medical Examiner Office in Milwaukee, Wisconsin.

Beginning in June 2005, the Milwaukee County Medical Examiner Office implemented CDC's doll reenactment protocol as a routine component of pediatric death investigation. This review examines the contributions of doll reenactment in determining the cause and manner of death in cases from June 2005 through May 2007 in comparison to the previous two-year period during which doll reenactments were not performed. Initial findings indicate an increase in the percentage of deaths certified as accidents with a corresponding decrease in the percentage of deaths certified as undetermined. Co-sleeping was a risk factor in approximately 60% of all SUID cases reviewed.

Doll Reenactment, Sudden Unexplained Infant Deaths (SUID), Co-Sleeping

D7 Assessment of Living Siblings While Conducting a Comprehensive Child Death Investigation

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The goal of this presentation is to describe the essential components that must be considered in child death investigations. It will analyze procedures to determine children at risk for abuse and the collaborative components of a forensic multidisciplinary team. The presence of physical and mental injury will be demonstrated and the outcome from a case review.

This presentation will impact the forensic science community and/or humanity by demonstrating the need to conduct a thorough investigation to ascertain the entirety of the circumstances surrounding the death of a child and to determine if risk is present to associated children in the home to further protect them from harm.

Death by unnatural means require the death investigation team to research the historical components, the scene, and social history and along with the forensic pathologist's findings to determine the cause and manner of death. Child deaths command a thorough assessment of the home environment to determine risk in the remaining siblings. The following case will provide details of serious injury in two children subsequent to the death of their brother.

Potential sexual assault was suspected during the forensic investigation of a three year old male who was dead on arrival to the emergency department. Findings noted were the presence of petechia and anal dilation. Final autopsy reported cause of death to be asphyxiation due to cohabitation during sleep and the manner of death was ruled accidental.

The case was investigated by the Child Advocacy Center (CAC) in conjunction with the Department of Social Services (DSS) and local law enforcement. Child protective services, part of the multidisciplinary team at the CAC initiated a risk assessment on the siblings remaining in the home. A five-year-old male and an eight-year-old female were temporarily removed from the home pending the outcome of the investigation. Forensic interviews were conducted using the Finding Words protocol on both children. Each was referred for forensic medical examinations.

The medical examination was conducted by a forensically trained pediatrician and a forensic nurse examiner certified in adult and pediatric sexual assault. Evidence of injury was found in both children. Additionally, they each exhibited significant psychological stress and trauma. Both children exhibited behavior issues, aggressivity in play and delayed development. Each child was referred for intensive psychological treatment on site by a licensed therapist.

Further investigation provided a background of previous intervention by DSS in another county for neglect. The social history determined the primary care provider was the father who was unemployed and disabled. The mother was employed outside the home during the daytime.

The outcome of the case is permanent removal of both children with the parents relinquishing custody of their children to the state. Current status of the female is ongoing intensive therapy in a state mental facility. The male sibling resides in a group home for boys with all efforts exhausted for foster placement.

Child Death Investigation, Forensic Nurse, Child Abuse

D8 Forensic Aspects of Suicides and Multiple Gunshot Wounds

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The goal of this presentation is to find common features in multiple gunshot suicides and to explain the suicidal action in these multiple gunshot suicides.

This presentation will impact the forensic science community and/or humanity by illustrating the difficulties encountered by the forensic medical doctor to explain homicide or suicide.

Introduction: Suicidal gunshots are generally intended to kill rapidly. Therefore, the head and the thorax are the targets in the majority of the gunshots in suicides cases. Sometimes, some people who commit suicide are able to fire two or more gunshots to these body regions. In a 5-year study of 60 autopsies of clearly-defined gunshot suicides, five persons (6.5%) fired two or more gunshots to the body. Among these five cases, one case involved a combination of gunshots to the chest and abdomen and one gunshot to the head without immediate incapacitation. The trajectories were restricted to the chest for the three other cases. The goal of this presentation is to find common features in multiples gunshot suicides and to explain the suicidal action in these multiple gunshot suicides.

Materials and methods: The 2000 to 2005 autopsy records of the forensic institute of Lille were checked for clearly defined gunshot suicides. The autopsy record, the past history, the characteristics of the weapon, the toxicology analysis, the scene of death report were available in all the cases and were used to demonstrate the suicidal characteristics in spite of multiple gunshots wounds in the bodies.

Results: *Case 1*: A 40-year-old woman, suffering from a chronic depression syndrome, committed suicide with a 12 caliber rifle. She performed three gunshots in the abdominal area and one in the head. Findings of scene crime and autopsy were used to determine that suicide was intended. These elements are described and detailed. *Case 2*: A 30-year-old police officer committed suicide in his car with his service gun. His suicide occurred in front of other police officers approaching the car; they had been called by his wife. An autopsy was performed in order to confirm the origin of the weapon. Survival time was studied to explain the possibility of these four gunshots. *Case 3*: A 75-year-old man killed his wife with three gunshots and then shot himself six times in the thoracic area. This was diagnosed as a case of post-aggression suicide. *Case 4*: A 35 year-old man killed his son and took his car. The weapon used was a 12 caliber rifle. He committed suicide with the same weapon in his car. During the autopsy, an entrance wound was discovered in back area. The origin of this wound was not due to his rifle; the bullet was shot by policemen chasing the man's car and trying to stop him. The survival time was mentioned and compared to literature. *Case 5*: A 60-year-old man killed himself with two gunshots with a 22 caliber revolver. The reason for the suicide was determined to be financial debt. Crime scene was analyzed and autopsy performed in order to determine the weapon used and if suicide was intended.

Discussion: The incapacitation is important to be considered and a general classification (immediate, late) can be determined and illustrated by the cases presented. The survival time, the type of weapon, the characteristics of weapon (automatic, semi-automatic), the location of the gunshot wounds, the lesions of deep organs observed during the autopsies are described, studied and used to determine a classification in order to differentiate a crime from a suicide. Suicide can only be excluded if immediate incapacitation injuries are caused by more than one bullet. Some aspects as mental or emotional state of the victim, especially the expectancy of being prepared for a hit, have an important role. The autopsy is of course necessary. The amount and the location of tissue disruption must be established with an autopsy in order to estimate the potential for physical activity following the injury. For long firearms, a comparison between the path of the trajectory and the anatomical features is important. All these aspects are discussed and compared to the forensic literature of multiple gunshots wounds in cases of suicide. A large iconography is associated to illustrate the cases presented.

Gunshot Wounds, Multiple Gunshot Suicide, Incapacitation

D9 The Multidisciplinary, Intercontinental Investigation of an Unusual Homicide/ Suicide

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After attending this presentation, attendees will understand the importance of the multidisciplinary approach to a medicolegal death investigation and of "thinking outside the box" when considering potential avenues to pursue in determining the cause and manner of death.

This presentation will impact the forensic community by emphasizing the necessity of considering nontraditional sources of potential information and specimens for laboratory analysis in the investigation of decomposed, mummified, and skeletonized bodies.

The determination of the cause and manner of death in cases that fall under the jurisdiction of the medical examiner or coroner is rarely made by postmortem examination alone, but is most commonly made by the correlation of the autopsy results, scene investigation, and the medical and social history of the deceased, as well as laboratory studies. The investigation of deaths of individuals whose bodies are decomposed, mummified or skeletonized is particularly difficult for medical examiners and medicolegal death investigators, and frequently requires consultation with experts in a variety of disciplines in the forensic sciences, including anthropologists, odontologists, entomologists, botanists and behavioral scientists. In such cases, the investigation of the scene and circumstances of the death may provide the only clues to the cause and manner of death.

The majority of decomposed and skeletonized bodies are found in rural or isolated settings in which the remains go undetected for a period of time. However, we report an unusual case of an apparent murder/suicide involving two individuals and a canine. The deaths of the 63-year-old woman, her 34-year-old son, and the family German shepherd occurred in their home within a residential neighborhood. In spite of the close proximity to neighboring homes, these deaths went undetected for almost four years, as estimated by expiration dates on containers of food in the refrigerator and from paperwork in the house. Eventually, a former caretaker of the property went to the residence after he noticed that the property was being sold by the county because of unpaid property taxes and discovered the bodies, which were mummified and partially skeletonized. The bodies of the male decedent and the dog appeared to have been posed, suggesting that the deaths were not of natural causes. The identification of the decedents necessitated the collaboration of the medical examiner's office, law enforcement, a forensic anthropologist, and a forensic odontologist, as well as Interpol, since the decedents were German nationals who were only part-time residents of Florida. The determination of the cause and manner of their deaths proved more problematic. Numerous potential causes of death were explored. The only known medical information was that the male decedent suffered from a chronic neurological disorder. The forensic anthropology examination found no antemortem trauma or pre-existing natural disease processes that could have contributed to the deaths. Investigation of the residence revealed no evidence of carbon monoxide, suffocating gases or other toxic fumes, and there was no evidence of drugs or alcohol at the scene. Ultimately, their cause of death was identified by forensic toxicologic studies performed on specimens not commonly analyzed, including the dried residue found in a coffee cup at the scene and the desiccated material in the dog's food bowl.

Homicide/Suicide, Investigation, Cause of Death

D10 Case Study Ritualistic Homicide at Fort Lewis, Washington

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The goal of this presentation is to introduce the members of the forensic community to a unique murder scene where a multidisciplinary approach was used to show that this was a planned, methodical killing executed in a ritualistic style.

This presentation will impact the forensic community by examining this unusual case and discussing the impact that the crime scene processing, autopsy protocol, and laboratory work had in supporting the prosecution and conviction of the offender.

The goal of this presentation is to introduce the members of the forensic community to a unique murder scene where a multidisciplinary approach was used including crime scene analysis, medicolegal investigation, and multidisciplinary laboratory examinations were used to reconstruct the series of events surrounding this savage murder. Investigation demonstrated this was not a crime of passion as the defense suggested, but rather a planned and methodical killing executed in a ritualistic style.

In this case, on 12 July 2005, the body of the 19-year-old wife of an Army soldier was found posed on the kitchen floor of the husband's assigned U.S. Government quarters located at 2025 Bitar Avenue, Fort Lewis Washington amidst massive amounts of bloodstain patterns from the crime itself as well as actions of the subject and transfer stains from the family dog running through the scene. The examination of her body revealed numerous complex chop wounds inflicted with a meat cleaver, and the crime scene contained ritualistic aspects to include posing the body, insertion of a phallus device, and attempted decapitation.

The Special Agents of the U.S. Army Criminal Investigation Command (commonly referred to as CID) discovered during the course of the investigation that while her husband was deployed to Iraq, his wife allegedly became involved in an affair with another soldier. Upon her husband's return from deployment, he was taking part in group mental health counseling and was being treated for post traumatic stress disorder. The investigation further determined that the soldier idolized Richard Ramirez ("the Nightstalker") and frequently fantasized about killing and becoming a serial killer. Computer forensic analysis established that just hours prior to the murder, he had taken an online quiz entitled "Are you a serial killer?"

On the night of the murder, the victim went to the kitchen and began an online chat with her alleged lover. While she was seated near the kitchen island chatting on the computer, the soldier entered the kitchen, where he confronted her, struck her first with his fist, and then he retrieved a meat cleaver from a butcher block type knife holder. The subject then brutally attacked her with the meat cleaver striking her about the head and shoulders. Once she was immobilized, he stripped her, posed her, vaginally inserted a phallus, and wrote in her blood upon the refrigerator door "Satan said she deserved it." Further, he wrote a note which said "Til death do us part" and signed the note which he attached to her body.

Bloodstain pattern analysis of the scene was used to determine the facts surrounding the incident in question through the examination of the physical characteristics of stains; looking at the dispersion, the shape characteristics and morphology, the volume, the pattern, and the number of bloodstains and their relationship to the surrounding scene. Conclusions were based on evaluation of the stains and their relationship to one another and their relationship to the other physical evidence at the crime scene.

This presentation will examine not only the scene itself, but also the killer's behavior before, during, and after the murder as it relates to his state of mind and draw correlations to the ritual of a human sacrifice as defined in Anton LaVay's satanic bible, a book found in his possession when apprehended.

The husband took pictures of her body, packed his bags, and fled the area. He later became filled with remorse, and turned himself in. Forensic sciences, including bloodstain pattern analysis, latent print examination, questioned documents examination, and forensic pathology were used to determine the sequence of events surrounding the murder, ensuring his successful prosecution for which he received a life sentence.

Murder, Ritualistic, MultidisciplinaryApproach

D11 State Sponsored Torture in Rome: A Forensic Inquiry and Medicolegal Analysis of the Crucifixion of Jesus Christ

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The goal of this presentation is to present to the members of the forensic community a forensic examination of the trauma involved in the crucifixion along with a medicolegal analysis of crucifixion focusing on the mechanisms and cause of death.

This presentation will impact the forensic community and/or humanity by describing the significance of the crucifixion process and how the physical effects of such a barbaric execution caused major medical distress in the human body.

The presentation will illustrate with medicolegal art and explanation the pathology, physiology, cardiology, anatomy, and forensic aspects of this event.

Crucifixion was a barbaric from of capital punishment practiced by the Romans, Persians, Phoenicians, Egyptians and others. The word crucifixion is derived from the word *"cruciare"* (to torture and torment). The Romans were well trained in every step of this technique. There were five soldiers assigned to each crucifixion. The team consisted of a centurion (*exactor mortis*), who was in charge of four soldiers called the *quaternio*.

This presentation is based on the research and text entitled, The Crucifixion of Jesus: A Forensic Inquiry by the eminent forensic pathologist and forensic scientist Dr. Frederick T. Zugibe, MD, PhD whose study touched on the entire range of scientific and medical background involved in various areas of forensic pathology and human anatomy as it relates to the crucifixion.

The presentation will start with events as they unfolded in the Garden of Gethsemane and introduce the audience to the term "hematidrosis" (The sweating of blood). This medical condition as defined in Stedman's Medical Dictionary is an excretion of blood or blood pigments in the sweat. Hematidrosis is associated with a severe anxiety reaction triggered by fear. Reportedly, Jesus was able to envision the entire gamut of suffering to come. This prelude produced the all of the medical criteria to initiate the sympathetic autonomic response as well as the severe counter parasympathetic response causing severe dilation and rupture of the blood vessels into the sweat glands.

The presentation will then focus on the scourging and the use of the flagrum in this barbaric method of torture prior to the crucifixion. The physical effects of the scourging on Jesus will be presented along with a discussion on hypovolemic shock.

Illustrations will be presented through medicolegal art the crowning of thorns and how these thorns caused Jesus to suffer trigeminal neuralgia one of the worst pains that humans can suffer.

Torture was the prelude to crucifixion. The nailing of both the hands and feet were the rule. Jesus, who was already weak from the hematidrosis and hypovolemic shock as well as the lancinating pains from the crown of thorns, was forced to carry his own cross. This exhaustion was accompanied by shortness of breath, pleural fluid accumulating within His lungs with possible pnuemothorax due to the scourging. The intense heat and weight of the cross piece caused Him to fall. The exactor mortis could not allow Jesus to die before crucifixion so Simon of Cyrene was designated to carry the patibulum for Jesus.

This presentation will be instructive and informative to the forensic community and will dispel some of the myths of the crucifixion as depicted in the media and popular movies. It will also present compelling evidence to support the actual cause and mechanism of death of Jesus Christ on the cross.

The impact of the presentation occurs when the audience understands the significance of the crucifixion process and how the physical effects of such a barbaric execution caused major medical distress in the human body. The medicolegal aspects of the crucifixion will be presented in lay terms augmented with specific illustrations to depict in exquisite detail the findings and determinations regarding the cause and mechanism of death.

Jesus was brought to the place of crucifixion and stripped of both His outer garment (a cloak) and His tunic beneath the coat. He was gasping for air as he clutched His chest with every breath…the result of the scourging. Every movement caused unbearable pain. Jesus was thrown to the ground and made to lie on his back with His shoulders and outstretched arms on the patibulum (cross piece). One of the executioners then laid across His chest and another across His legs to hold Him down so that a third cohort could nail His hands to the crosspiece. This caused excruciating pain in His chest and sever difficulty breathing causing him to scream out in agony.

A large spike like nail measuring about 4¾ was nailed through the palm of each hand just below the bulge at the base of the thumb and into the cross piece. The pains would have been brutal, like hot pokers traversing the arms causing Jesus to arch His torso. Two of the *quaternio* grabbed the ends of the crosspiece while a third member grasped Jesus around the waist, getting Him to his feet backing Him up to the upright. Two of the *quaternion* lifted the crosspiece while two others lifted Jesus by the legs and inserted the crosspiece into a mortise on the top of the upright. His knees were then bent until his feet were flush to the cross.

His feet were then nailed into the cross. Jesus would likely have cried out in agony as each foot was nailed. "They have pierced my hands and my feet, I can number all my bones." (Psalms 22:16-17)

Forensic Reconstruction

When one considers each phase of Jesus' suffering beginning at Gethsemane and ending at Calvary the forensic conclusion is that Jesus died of shock. Jesus had experienced hematidrosis prior to being viciously scourged and severely flogged, causing extensive damage to the lungs, ribs and body wall, thereby throwing Him into early shock manifested by extreme weakness, tremors, probable lung collapse, seizures and fainting. Add the mental anguish, the crowning of thorns, the carrying of the cross piece of the cross, and the crucifixion process and anyone with a background in forensic pathology or emergency medicine would wonder how Jesus lasted as long as He did.

There are various types of shock. Hypovolemic shock is shock marked by a significant fall in the blood volume due to hemorrhage or loss of body fluids. Traumatic shock (injury shock) results from a serious injury. The presence of pain alone from a traumatic event stimulates certain nervous mechanisms of the brain, resulting in a drop of blood pressure and a reduction of blood flow to the tissues. Jesus suffered severe blood and fluid losses as well as excruciating pain.

The scourging resulted in penetration of the skin with trauma to the nerves, muscles, rib fractures, dislocations, lacerations, infiltration of significant amounts of blood throughout the intercostal spaces and back and chest musculature, bruises, and alveolar rupture and possible collapse of a lung (pnuemothorax). Over a short period of time, an inflammation of the sac of the heart termed percarditis would have ensued manifested by stabbing pains in the chest.

The irritation of the trigeminal nerves of the scalp from the crown of thorns would have caused lancinating pains across the scalp and face. This would have added to the state of the traumatic shock from the scourging. The splinting of the chest wall and the causalgia from the nailing of the hands and feet also added to the traumatic shock.

As Jesus hung on the cross with the weight of His body pulling on the nails in the hands and feet there would have been episodes of agonizing pain every time He moved. These episodes and unrelenting pains in the chest wall from the scourging would have worsened the state of traumatic and hypovolemic shock. Increasing pleural effusion, pulmonary edema and excessive sweating was induced by the trauma as well as heat of the sun. As Jesus arched his body to relieve the cramps in his legs and arms He would have had to press His head with the crown of thorns against the upright and this would have reactivated the trigeminal neuralgia, which caused further shock and pain.

The Cause of Jesus' Death

According to Dr. Zugibe's exhaustive study: The Cause of Death: Cardiac and respiratory arrest, due to hypovelemic and traumatic shock, due to crucifixion.

Crucifixion, Hematidrosis, Hypovolemic Shock

D12 Can a Scoring System Accurately Reflect Cadaver Decomposition?

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After attending this presentation, the attendees will understand that several ecological variables influence cadaver decomposition, making it problematic to treat decomposition as a semi-continuous variable to accurately predict postmortem interval (PMI).

This presentation will impact the forensic science community by demonstrating the current challenges of using stages of decomposition to determine PMI and by proposing a system to determine PMI using key decomposition characteristics.

Estimating postmortem interval can be vitally important in a death investigation. Not only can PMI help determine the possible victims to identify the cadaver, but an accurate PMI can also assist in retaining or eliminating suspects. Using key physical characteristics of decomposition coupled with consideration of the ecological factors could help investigators estimate PMI more accurately. However, developing a reliable method to uniformly identify the current stage of decomposition becomes a challenge that the forensic community should be aware of and work together to overcome. To help achieve this, we tested a proposed point-based system in which a number is assigned based on the physical characteristics of the cadaver. This number, along with accumulated degree days (ADDs), has been reported to provide an accurate estimate of PMI.

The experimental site was located at the University of Nebraska Agricultural Research Development Center located approximately 48 km north of Lincoln, Nebraska, USA. The site is a pasture that is intermittently grazed by cattle and horses. The climate is temperate mid-continental characterized by hot summers, cold winters, and moderately strong surface winds. Average annual precipitation is 695 mm. Approximately 75 percent of the precipitation occurs between April and September. Mean annual temperature is 9.8 °C with mean minimum and maximum temperatures ranging from 0 C (January) to 31°C (July). The vegetation at site is dominated by non-native grass (smooth brougham) and forb (white clover) with some native vegetation, including daisy fleabane, yellowwood sorrel nut sedge, and pasture rose. Swine (Sus scrofa) carcasses of four contrasting masses approximating sizes from neonate to adult (~3 kg, ~20 kg, ~40 kg, and ~50 kg) were used. Swine were killed with blunt force trauma to the cranium, weighed, and placed on their right side on the soil surface facing west. Each day for two weeks, the remains were scored using the provided scale for three body regions: the head and neck, the trunk, and the limbs. Cadavers were photographed each day. At the end of the two weeks, cadaver decomposition was scored using the photographs. This experiment was replicated three times, which resulted in a total of twelve swine cadavers.

The scoring method failed to have uniformity between measurement in the field and measurement in the laboratory using photos of cadavers. A major flaw with the system is the lack of detail and number of stages of the decomposition process. Not only do the stages of decomposition vary with body region, but the stages of decomposition are not extensive enough to give the necessary detail to determine PMI. Thus, to improve the system, we suggest that five broad descriptions of decomposition (Fresh, Bloated, Active Decay, Advanced Decay, Remains) should be used, with additional detail and specificity of key characteristics of each stage and the progression of each stage. In particular, details of insect activity, patterns of tissue loss, and changes in cadaver anatomy, all coupled with environmental data (especially temperature) are necessary to develop more accurate tools for associating the status of decomposition with time.

Forensic Taphonomy, Decomposition, Postmortem Interval

D13 Cadaver Mass and Decomposition: How Long Does It Take for a Cadaver to Increase the Concentration of Ninhydrin-Reactive Nitrogen in Soil?

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After attending this presentation, attendees will understand the relationship between cadaver mass and the concentration of ninhydrin-reactive nitrogen (NRN) released into the soil during decomposition, as well as the time required for a significant ($P < 0.05$) increase in gravesoil NRN.

This presentation will impact the forensic community and/or humanity by showing that NRN can be used to detect gravesoil within one week of the onset of decomposition.

A significant amount of NRN is released into gravesoil during cadaver decomposition. However, the time required for this process to occur is currently unknown. Further, it is unknown if this release is related to initial cadaver mass. It was hypothesized that a correlation exists between cadaver mass and the time required for a significant increase in gravesoil NRN, which would assist in locating sites of cadaver breakdown. To do this, cadaver mass loss and the concentration of gravesoil NRN over a period of 21 days during the summer (June 2007) was measured.

The experimental site was located at the University of Nebraska Agricultural Research Development Center located approximately 48 km north of Lincoln, Nebraska, USA. The site is a pasture that is intermittently grazed by cattle and horses. The soil at the site is a deep silty clay loam of the Yutan series (Mollic Hapludalf). The climate is temperate mid-continental characterized by hot summers, cold winters, and moderately strong surface winds. Average annual precipitation is 695 mm. Approximately 75 percent of the precipitation occurs between April and September. Mean annual temperature is 9.8°C with mean minimum and maximum temperatures ranging from 0 C (January) to 31°C (July). The vegetation at site is dominated by non-native grass (smooth brougham) and forb (white clover) with some native vegetation, including daisy fleabane, yellowwood sorrel nut sedge, and pasture rose.

Swine (*Sus scrofa*) carcasses of four contrasting masses approximating sizes from neonate to adult (~3 kg, ~20 kg, ~40 kg, and ~50 kg) plus a control (no cadaver) were used. Swine were killed with blunt force trauma to the cranium, weighed, and placed on their right side on the soil surface facing west. Soil samples were collected (0-5 cm depth) from adjacent to the cadaver at intervals of 24 hours for the initial 14 days. This experiment was replicated three times, which resulted in a total of 12 swine cadavers.

The concentration of gravesoil NRN increased significantly within the first week of cadaver decomposition. This demonstrates that NRN can be used a presumptive test for gravesoil within seven days of death. Neither a simple correlation nor a simple correction factor between cadaver mass and NRN concentration developed. The smallest mass, the neonatal swine, decomposed much faster than the other the adult (50 kg) swine, probably because there was less tissue to be consumed by insects and microbes. The neonatal swine were dry within 10 days, whereas adult cadavers took up to 18 days to dry. Future research should focus on the persistence of NRN in gravesoil to determine the maximum amount of time gravesoil NRN is significantly greater than basal NRN.

Ninhydrin, Forensic Taphonomy, Decomposition

D14 Decomposition Patterns Associated With Cadavers of Contrasting Mass

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After attending this presentation, attendees will understand the fundamental patterns of cadaver mass loss during decomposition on the soil surface and a methodology used to analyze cadaver breakdown.

This presentation will impact the forensic community and/or humanity by demonstrating that neonate cadavers follow a pattern of mass loss different to adult cadavers.

The rate of decomposition has been estimated to be the same throughout different sizes of bodies. Ideally, every cadaver would have the same equation for determining the time of death, however, different body types and masses might offer different rates and patterns for decomposition. It was hypothesized that cadavers of contrasting mass will decompose at different rates and, thus, be associated with contrasting patterns of decomposition.

The experimental site was located at the University of Nebraska Agricultural Research Development Center located approximately 48 km north of Lincoln, Nebraska, USA. The site is a pasture that is intermittently grazed by cattle and horses. The climate is temperate mid-continental characterized by hot summers, cold winters, and moderately strong surface winds. Average annual precipitation is 695 mm. Approximately 75 percent of the precipitation occurs between April and September. Mean annual temperature is 9.8 °C with mean minimum and maximum temperatures ranging from 0 C (January) to 31°C (July). The vegetation at site is dominated by non-native grass (smooth brougham) and forb (white clover) with some native vegetation, including daisy fleabane, yellowwood sorrel nut sedge, and pasture rose. Coyote (*Canis latrans*) and turkey vulture (*Cathartes aura*) are the primary scavengers in the area.

Swine (*Sus scrofa*) carcasses of four contrasting masses approximating sizes from neonate to adult (~1 kg, ~20 kg, ~40 kg, and ~50 kg) were used. Swine were killed with blunt force trauma to the cranium, weighed, and placed on their right side within a PVC frame on the soil surface facing west. PVC frames with polypropylene mesh were constructed for mass loss measurements. The use of PVC frame construction allowed free movement of decomposition fluids into the gravesoil. For two weeks, each cadaver was weighed every day. After two weeks the weight measurements were taken less frequently due to the stabilization of cadaver mass.

The smaller pigs lost their weight much faster than the larger pigs, but also showed a difference in pattern of mass loss. Generally, remaining mass of all pigs followed a sigmoidal curve with an extended tail (reflecting

the remains stage of decomposition). However, smaller pigs (1kg and 20kg) had both steeper slopes of maximum decomposition rate and different patterns of weight stabilization than did larger (40kg and 50kg) pigs. Thus, the hypothesis that decomposition rates and patterns of decomposition of the smaller and larger pigs were significantly ($P < 0.05$) different was accepted.

With this information, it is suggested that human cadavers of contrasting mass might also follow different rates and patterns of decomposition. In particular, babies and small children likely follow different rates and patterns of decomposition relative to adults. This phenomenon needs to be explicitly considered, particularly when the physical characteristics of a cadaver are used as the basis for estimating postmortem interval.

Forensic Taphonomy, Mass Loss, Postmortem Interval

D15 Controlled Prescription Drugs Commonly Associated With Pain Management: Evidence Analyzed by State and Local Crime Laboratories in the United States From 2004 to 2006

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After attending this presentation, attendees will have an enhanced understanding of prescription drug seizures of diverted pharmaceutical drugs associated with pain management including the geographical distribution of seizures in the United States over a three year period, 2004 through 2006.

This presentation will impact the forensic community and/or humanity by providing crucial information on the diversion of narcotic analgesic drugs.

After attending this presentation, attendees will have an enhanced understanding of prescription drug seizures of diverted pharmaceutical drugs associated with pain management. Analysis of the data will include the geographical distribution of seizures in the United States over a three year period, 2004 through 2006. The presentation will be based on data from the National Forensic Laboratory Information System (NFLIS) which reflects drugs seized by law enforcement agencies and analyzed by forensic laboratories, focusing specifically on controlled prescription drug analgesics commonly associated with pain management.

Chronic pain affects over 50 million Americans. The non-medical use of diverted controlled substance prescription drugs commonly used in pain management is a serious and growing problem in the United States. An estimated 168,476 narcotic analgesic items were analyzed during this period. The estimated number of prescriptions dispensed per drug item reported in NFLIS for 2004 through 2006 indicates that methadone, morphine, and oxycodone had low prescription-to-seizure ratios compared to other drugs, indicating a potentially higher level of diversion. Hydrocodone (65,161 items), oxycodone (50,668 items), and methadone (15,728 items) were the most commonly reported narcotic analgesic prescription drugs in participating state and local crime laboratories from 2003 to 2006, representing 78% of narcotic analgesics. In 2006, hydrocodone was the 5th most common drug reported in NFLIS followed by oxycodone (7th), methadone (11th), morphine (16th), codeine (21st), and fentanyl (25th). Highlighted findings will include regional findings which demonstrate that in the West, the most prevalent narcotic analgesic drug item identified was hydrocodone (37%). In the Northeast, Midwest and South regions; oxycodone was identified as the most prevalent narcotic analgesic drug item at 49%, 33% and 25% item counts respectively. The number of items reported as fentanyl by NFLIS laboratories has dramatically increased in this time period (1,728 items in 2006) with the highest increases reported in the Northeast. The lowest fentanyl item count was found in the data report from laboratories in the West region. Additional data will show population adjusted regional trends and depict spatial distribution of selected analgesic drugs (e.g., hydrocodone, oxycodone, methadone, fentanyl) by using Geographic Information System (GIS) analysis.

Laboratories participating in NFLIS analyze and report on drug evidence secured in law enforcement operations, offering a unique resource for monitoring drug abuse and trafficking, including the diversion of legally manufactured drugs into illegal markets. NFLIS is an important analytical resource for drug policy and can provide timely information on the illicit trafficking of prescribed drugs across the United States.

Pharmaceutical Diversion, Prescription Drug Analysis, Drug Seizures

D16 Databasing the Disappeared and Deceased: The Use of Internet Resources in Resolving Missing and Unidentified Persons Cases

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After attending this presentation, attendees will have an awareness of the various resources available on the World Wide Web that may be helpful in resolving missing and unidentified person cases. This presentation will provide attendees with information on how to implement and maintain websites that deal with missing and unidentified person cases and offer suggestions on how the function and efficacy of existing websites can be improved.

This presentation will impact the forensic community and/or humanity by evaluating the effectiveness of web-based resources in resolving cases of missing and unidentified persons.

When an individual goes missing or an unidentified body is found, many resources, both public and private, are available to assist in resolving the case. Apart from the traditional means for drawing attention to cases such as flyers and media coverage, it has become common for information on missing and unidentified persons to be provided on the World Wide Web. An Internet search for "missing persons" or "unidentified dead" will result in a long list of websites that are operated and contributed to by a wide variety of entities including state, county and local law enforcement agencies, state clearinghouses and departments of public safety, coroners, medical examiners, odontologists/forensic dentists, forensic anthropologists, nonprofit organizations, volunteers, and concerned citizens among others. For law enforcement and the public alike, the sheer number of websites available can make it difficult to know where to start an Internet search regarding a missing person's whereabouts or unknown decedent's identity.

These resources differ greatly in the type and extent of information they offer online. Websites for missing and unidentified persons information may choose to provide any number of details about each case and often include photos, physical descriptions, dates of birth and/or death, facial reconstructions or age progressions, information or photos of victim's clothing, personal effects, jewelry, etc. The amount and quality of information provided span the spectrum, but websites that offer more detailed information may have greater success in resolving cases. Unfortunately, the benefits of such websites can be rendered less effective by design faults such as poor ease of navigation, or the employment of search functions that are not adequately broad. Inaccuracies and inconsistencies in the information posted can occur if there is no protocol

for entering and following up on information, or if the information posted is not verified against other sources. Despite the large number of websites devoted to this issue, few seem to coordinate with each other or even with other organizations within their own counties or states.

For the families and friends of missing persons, online searches can offer a new outlet for hope when they feel all other efforts have been exhausted. Websites that supply information on missing and unidentified persons can also aid law enforcement by broadcasting case information to a wider audience, raising public awareness of missing individuals and unknown decedents. Improving the usability and effectiveness of web-based searches and databases for missing and unidentified persons information may lead to swifter justice for victims and closure for both families and law enforcement agencies.

The raw data and statistics provided in this presentation have been collected from the following sources: (1) interviews with family members and friends of missing persons that are currently still missing, or were once missing but are now confirmed deceased, (2) surveys completed by coroners, medical examiners, forensic anthropologists, odontologists/ forensic dentists, members of law enforcement, employees and volunteers of nonprofit organizations, state clearinghouses, departments of public safety and other professionals with experience in missing and unidentified persons cases, and (3) interviews with Webmasters and employees of websites that house information on missing and unidentified persons. This presentation will include a list of items that should be provided online that can be useful in solving such cases. Finally, it will indicate some of the most effective websites that assist in this effort.

Missing Person, Unidentified Person, Websites

D17 From Researcher to Practitioner: Bridging the Technology Gap

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The goals of this presentation are to: (1) describe instructional design process to effectively deliver technical research data to forensic practitioners, (2) discuss multimedia options available for distribution to a wider audience, and (3) describe a suitable evaluation process to optimize technical transition of research data to practitioners.

This presentation will impact the forensic community and/or humanity by providing a model to facilitate future technical transfer training at the National Forensic Science Technology Center and the National Institute of Justice which effectively bridges the gap between researcher and forensic practitioner.

The National Institute of Justice (NIJ) sponsored the National Forensic Science Technology Center (NFSTC) to facilitate the transfer from researcher to practitioner of six emerging technologies with forensic applications. The training sessions provided instruction and presentation of research data for Liquid Chromatography Tandem Mass Spectrometry (LC-MS\MS) for Forensic Toxicological analysis, Cedar Fox Questioned Document (QD) software for Handwriting analysis, Laser Microdissection in Forensic Biology applications, Clandestine Methamphetamine Analysis using Capillary Electrophoresis, and Polynomial Texture Mapping software for footwear and tire Impression examinations. The objective of each two day training session was to provide analysts with an overview of the theoretical and practical applications of the emerging technology. Laser Microdissection training was provided in two separate workshops with special focus for both analysts and laboratory managers.

The format for the workshop series was coordinated by a panel of NIJ staff, instructional designers, researchers, and laboratory staff. A primary directive given from the NIJ was to reach out to as many practitioners as possible to ensure that operational examiners may be aware of current research and technologies. This is somewhat limited with a classroom format and so it was decided that the series would be modeled on a blended approach. A classroom format was employed for each workshop with 12 to 16 practitioners in attendance. Each workshop took place in a recording studio set up at the NFSTC and was captured and edited to allow media based delivery. The edited workshop was made available via internet download together with instructional materials (curriculum, PowerPoint® lectures, and reading materials) for each workshop. This effectively allowed delivery free of charge to all interested parties.

Twelve to sixteen forensic examiners attended each workshop. Attendees were chosen by NIJ based on knowledge of intent to imminently incorporate the technology at hand into their laboratory protocols. While the primary objective was to make the information available as soon as possible, current instructional design principles were applied to the curriculum content. Instructional designers worked with each researcher to produce a detailed curriculum with corresponding objectives, reading material, and practical exercises. Each training workshop included theoretical lectures, demonstrations, practical exercises, and data interpretation exercises as applicable. Both classroom and laboratory activities were media captured. Training evaluation surveys were conducted at the conclusion of each training session, as well as three months after the training. The surveys were designed to assess the overall effectiveness of the training, the progress of individual laboratories in implementing the technology, and the impact of the workshop on laboratory implementation of the technology in question.

Initial evaluation responses obtained at the conclusion of each workshop indicated that attendees found it useful to learn of emerging technologies with potential for implementation in operational forensic laboratories. The majority of attendees indicated an interest in implementation, though with some modifications.

It is anticipated that this format will be used as a model to facilitate future technical transfer training at the National Forensic Science Technology Center and the National Institute of Justice. Experience has shown that this blended training format effectively bridges the gap between researcher and forensic practitioner.

Research, Training, Technology

D18 USB Portable Operating System and File System Circumvention Capability Analysis

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After attending this presentation, attendees will be familiarized with the functionality of portable operating systems and programs used on USB flash devices, as well as their file system circumvention capabilities.

This presentation will impact the forensic community and/or humanity by identifying residual data specific for USB portable operating systems.

The emergence and availability of personal computer technology has resulted in a broad spectrum of uses, ranging from the recreational to the criminal. Everyday computer use inherently leaves traces of residual data available for forensic analysis and identification. With the advent of solid-state data storage devices (e.g. USB flash media, memory cards), programs and/or operating systems can be made portable while essentially circumventing normal operating system artifacts. These removable storage mediums are becoming increasingly large in memory and small in size while their prices drop.

Even though a USB apparatus may be small and easily removed from a computer, it is not gone without a trace. Plugging in a thumb drive creates several identifiers in the registry, which can be used to help identify a particular device. The registry is made up of a series of files that is utilized by Microsoft Windows to store various computer configurations. There is

a lot of information that a digital investigator can ascertain such as: typed URLs, run command history, and user accounts. Once individual keys in the registry are identified, their last write times can be used to create a timeline of events.

Four programs/portable operating systems were used in this study to determine their operability and circumvention success; Flash-Puppy (portable version of linux), U3 (dual partition file system with start menu), MojoPac (virtual Windows XP), and Portable Apps (single partition file system with start menu). These were chosen to show a little variety in the route taken to achieve the company's stated goals while still using a removable storage device.

In order to ensure that only the changes to the host operating system were analyzed, an image of a basic installation of Windows XP was put onto a 40 GB, zero-wiped hard drive for each experiment. An initial image of the hard drive disk (HDD) was taken using EnCase. Then, the HDD was put into a computer, booted up, and the USB device was plugged in. Basic flash drive programs (such as Mozilla Firefox Portable, Open Office, Skype, and Trillian) were accessed and files were created and saved to the flash drive before ejecting the USB drive and shutting down the computer. After the experiment, the HDD was re-imaged to look for changes to the system. Of the four programs tested, Flash-Puppy returned the best results for someone who didn't want their tracks traced, followed by MojoPac, U3, and Portable Apps.

As removable storage media continues to increase in popularity and become more widely available, people begin to fear that any personal data which is stored on these devices may be intercepted or left behind after their use. In response, companies and developers have created programs which claim to make it appear as if you were never there. However, when a flash drive is plugged into a USB 2.0 Port, its unique information is imprinted onto the registry in many places.

Digital Forensics, File System Circumvention, USB Flash Drive

D19 Technical Overview and Application of 3-D Laser Scanning for Shooting Reconstruction and Crime Scene Investigations

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After attending this presentation, the attendees will gain an understanding of the principles, operation, and capabilities of 3D laser scanning as it applies to crime scene investigations.

This presentation will impact the forensic science community and/or humanity by describing the operation, application, and capabilities of 3D laser scanning as a forensic tool.

3D laser scanning for documenting crime scenes is a growing use for a measurement technology that has already gained wide acceptance with surveyors, engineers and construction professionals. 3D laser scanning involves deploying an advanced type of survey/measurement instrument that is used to remotely measure and document crime scenes with extraordinary accuracy, completeness and speed. It is already being used by police agencies in the United States and Europe and can also be used for crash investigations, fire scene reconstruction, failure analysis, vulnerability and threat assessment as well as modeling simulation and analysis of environments.

The benefits of 3D laser scanning for any type of investigation are:

- Scenes can be recorded exactly as the first responder found it without altering evidence
- Exact body positions and evidence can be captured in great detail to an accuracy of 6mm at a distance of 50 meters
- Scanning is an objective scene recording tool which minimizes the chance of overlooking key evidence due to human error
- Measurements can be made between any objects in the scene long after the scene has been released
- The scene can be viewed in 3D from any viewpoint
- The data collected can be used to create compelling 3D jury exhibits

This presentation will describe the operation, application and capabilities of this new forensic tool. Additionally, the accuracy, precision and validity of the technique will be examined by comparing data generated with standard crime scene measurement techniques to those collected with a Leica Geosystems ScanStation 3D laser scanner. Actual crime scenes that have been scanned will be presented as they were documented to demonstrate the advanced capabilities of 3D laser scanning in the areas of captured detail, completeness, and 3D visualization. A visually compelling and accurate 3D method of depicting trajectories will be presented. Data from 3D laser scanning will be compared to trajectory measurements taken using standard methods for comparison in the areas of accuracy and precision. This will be accomplished by firing known impact angle shots through various materials and comparing the measurements using standard methods and tools like protractors, plumb bobs, inclinometers and photographs to those computed from scanned data. The data collected from both the scanning technique and manual methods for this controlled experiment shall be tabulated and compared in order to show the accuracy and validity of this technique. As more and more animations and exhibits generated from 3D laser scanning make their way into courtrooms it is becoming apparent that a generation of jurors raised on 3D video games shall have greater expectations for the kind of exhibits placed before them.

The audience will gain an understanding that 3D laser scanning is a forensic tool that is with us to stay, and that it will only be a matter of time before it becomes the norm for crime scene investigation. At the conclusion of this presentation the audience will have a basic understanding of the principles, operation and capabilities of 3D laser scanning as it applies to crime scene investigation.

3D Laser Scanning, Crime Scene Investigation, Trajectory

D20 Criteria for Identification of Gunshot Events From Video Imagery: A Case Study

Philip N. Williams, BS, Federal Bureau of Investigation, Federal Bureau of Investigation Laboratory, Counterterrorism and Forensic Science Research Unit, Building 12, Quantico, VA 22135*

After attending this presentation, attendees will gain an understanding of the challenges, possible solutions, and minimum useful criteria for identification of possible gunshot events using crime scene surveillance video.

This presentation will impact the forensic community and/or humanity by establishing a common framework against which the criminal court system can evaluate the validity and admissibility of expert witness testimony concerning gunshot event determinations from video evidence alone.

With the prevalence of video surveillance systems in the United States, the chances of capturing criminal and police shooting incidents on video has increased significantly. One of the pertinent questions frequently raised during the investigation of these incidents is the actual number of shots fired. In many cases the usefulness of the video images in determining this critical issue is either overlooked or presumed to be of little value. One of the principal reasons for this relates to the difficulty of positively identifying probable gunshot events using the video images in isolation from other evidence, and the lack of validated criteria for establishing the occurrence of such events from video alone.

An approach to gunshot determinations from video will be presented that will set forth a series of criteria for determining which events evident in the imagery could or should be used in these determinations. In addition

to simple observation of isolated events, courts will also demand for admissibility purposes, some form of objective cumulative threshold criteria before a reasonable conclusion that a gunshot event has occurred can be reached. It is these criteria and methods for quantification of the results of the analysis that are critical in admissibility related hearings.

An actual forensic case study for this analysis, that was adjudicated in California will be presented.[1] In this case, analysis showed that a series of isolated events could be demonstrated to actually be connected within the context of proper temporal and spatial analysis, which lead to more or less decisive conclusions for each event as to their nature as gunshot events. In some cases, a series of isolated events, while still connected temporally, may be insufficient to reach a decisive conclusion, based on the nature and/or number of events and those issues will also be addressed. This analysis was used by prosecutors in support of firearms reports, and crime scene analysis, which combined, largely refuted the Defense contention that the accused had fired warning shots prior to shooting his intended victims.

The analysis will also show that it is possible to identify events shown in the imagery as falling into one of three categories. Category one, is events which meet the full range of criteria as to number, type, space and timing, and therefore may be reasonably classified as gunshot events. Category two, is events which meet certain criteria, such as a number of isolated events, temporal connection, or type, but are of insufficient number, type, or timing such that it is not possible to exclude event types other than gunshots. Category three events are isolated events that meet only one of the threshold number, type, or timing, criteria to be reasonable considered as having been the result of a gunshot, but are still consistent with an action sufficiently anomalous to draw attention for additional analysis.

It is anticipated that through the publication of this analysis a proper foundation may established sufficient to support broader acceptance by the Courts for video based gunshot evidence, and reduce evidentiary challenges for this type of evidence in the future.

Reference:

[1] The People of the State of California, Plaintiff, -Versus- Stuart Alexander, Defendant, Docket NO. 139527.

Gunshot, Video, Forensic Video Analysis

D21 The Boyd Case: Shooting Incident Reconstruction

Alexander Jason, BA, ANITE Group, PO Box 375, Pinole, CA 94564*

After attending this presentation, participants will gain an understanding of the methods and technology utilized to analyze a shooting incident.

This presentation will impact the forensic science community by demonstrating a comprehensive approach to shooting incident analysis and reconstruction utilizing 3D computer modeling, photographic analysis, bullet trajectory determination, and bloodspatter pattern interpretation.

The case presented in this paper resulted in a complex shooting incident reconstruction in which wound paths, shooting locations, bullet trajectories, fired casing locations, bloodspatter, and dynamic positioning of a body were all significant elements.

An attempted armed robbery and kidnapping resulted in a police pursuit of a vehicle. The suspect fired at the police car behind him during a six minute pursuit in heavily populated urban area. When the suspect finally stopped his vehicle in a narrow street, his vehicle was struck by several bullets fired by police officers. The suspect got out of his car without the handgun and variously held his hands up in a surrender position and then down to his side. He went back and forth into and out of the vehicle. At one point, he sat on the driver's side floorboard, reached under the seat and turned rapidly towards police officers nearby.

Believing the suspect was now armed and about to shoot, one officer fired three rounds in rapid succession. The suspect was struck by two of these bullets and was wounded fatally. When police officers tried to move the body away from the car, the decedent's legs separated from his torso: he had no legs below his knees and was wearing two prostheses.

Several of the witnesses reported that the decedent was shot while his hands were in the up, surrender position. Although the shooting was determined to be legally justifiable, a wrongful death/excessive force civil action was filed against the officers involved and their department.

A shooting incident analysis and reconstruction was performed to address the key issues in this incident:

1. The location, position, and orientation of the decedent when shot.
2. The position of the decedent's hands when shot.
3. Sequence of shots.
4. The location of the vehicle.
5. Distance from shooter to decedent
6. Dynamic wound paths
7. Bullet trajectory angles
8. What certain witnesses could and could not have seen from their observation points.
9. Speed of vehicle during pursuit

As part of the analytical process, a three-dimensional computer based model was created which contained the street and sidewalk surfaces, model objects representing the parked cars near the shooting scene, buildings, trees, and street markings. This digital 3D model was created from actual measurements of the scene along with numerous photographs documenting all physical features including colors. The digital model was useful both for analysis of the distances between objects and locations and as forensic trial exhibits which allowed witnesses to illustrate aspects of their testimony concerning observed movements and locations.

The decedent received three bullet wounds; however one wound – in the left hand – was determined at autopsy to be consistent with a re-entry wound. An examination of the decedent's vehicle revealed the presence of bloodspatter in a distribution and location consistent with the left hand being aligned with a perforating bullet wound in the decedent's left thigh.

This paper demonstrates a comprehensive approach to shooting incident analysis and reconstruction utilizing 3D computer modeling, photographic analysis, bullet trajectory determination, and bloodspatter pattern interpretation.

Shooting Reconstruction, Video Analysis, Audio Analysis

D22 Advancing the Process of Post Blast Investigation

Thomas G. Gersbeck, MFS, 127 Knight's Ridge Way, Mays Landing, NJ 08330*

After attending this presentation, attendees will recognize the value of applying laser-scanning technology to post blast investigations.

This presentation will impact the forensic community as well as the military and public safety bomb disposal communities by demonstrating a timely, highly accurate, and tactically safe means of documenting crime scenes; specifically the scene of a large explosion.

One of the most complex investigations is that of a large post blast scene. The actions of investigators on a Combat Zone (CZ) post blast scene are very different from those currently conducted within the United States. An investigation in a CZ, such as Iraq, is made more complex by insurgent activities and secondary devices that limit scene documentation and evidence collection to about 30 minutes, greatly compressing normal investigative timelines. An investigation within the United States, where insurgent activity is not a factor and secondary devices are rare, allow investigators an appropriate amount of time to process the scene. Once secured, investigators will photograph the scene, measure the shape and depth of the crater, plot the location with GPS, obtain soil samples, and locate anything that may have come from the device; such as, Radio

Control (RC) components, command wires, switches, power sources, wires, fragmentation from ordnance or improvised sources. All of the evidence is photographed, documented, collected, and additional photographs are taken of any unique damage observed at the scene. Any evidence overlooked during this hasty process may be lost forever unless it was captured in a photograph. Consequently, the ability to photographically document a scene during this hasty process cannot be understated and any evidence not collected or photographed is forever lost.

In 2000, Total Station Mapping equipment was used for the first time on a Vehicle Bomb Improvised Explosive Device (VBIED) during a Federal Bureau of Investigation (FBI) VBIED School and quickly became the standard for processing these incidents. However, by the year 2000 the Total Station had been employed by accident investigators for approximately 12 years. Today, Laser-scanning technology is slowly replacing total station for accident reconstruction, but it has not been employed on a post blast scene in a CZ, nor can the author cannot find any examples of it being employed on a post blast scene in the United States.

The use of terrestrial 3D Laser-scanning for forensic mapping has created a paradigm-shift in the way investigators can collect and later analyze data after an incident. Using high-speed laser scanners, investigators can digitize the post-blast environment quickly and easily by making millions of highly accurate measurements. The scanner captures a "point cloud" which can be viewed in 3D from any perspective and provides a compelling visual archive of the scene. Laser-scanning is a remote sensing technology that minimizes the amount of time investigators are on scene thereby decreasing their exposure to possible hazards. Two field tests will be used to demonstrate the application of this technique. The first test involves an FBI VBIED course that will show the applicability of this technique to this type of investigation. The second test involves an FBI Combat Zone Post Blast Course utilizing a VBIED, and will reinforce the applicability of this technique and demonstrate the speed in which 3D Laser-scanning equipment can be employed -as the on-scene portion of this test will be under 30 minutes.

Manual measurement methods employed at a CZ scene may result in 20 to 40 measurements being obtained. Employing Total Station Mapping equipment would be a significant technological jump and data capture may increase to 400 or 500 points, but the time on scene is significantly increased. However, by employing the appropriate 3D Laser-scanning equipment an investigator can capture up to four million points in less than 30 minutes, greatly increasing the possibility of capturing information that may be overlooked.

Post Blast, Laser-Scanning, Point Cloud

D23 To Sort a Fly: A Simple Apparatus Built From Ordinary Materials, Using Ice as a Coolant for Sorting Live Blow Fly Specimens

Neal H. Haskell, PhD, 425 Kannal Avenue, Rensselaer, IN 47978*

After attending this presentation, attendees will learn an efficient, easy and inexpensive way to sort hundreds of gravid female flies from wild collected multiple species assemblages from over carrion.

This presentation will impact the forensic science community by creating greater precision in time of death (postmortem interval) estimations by using the presented entomological sorting technique.

Forensic entomology researchers are revisiting and re-evaluating growth and developmental data from previous growth studies due to differences of preferred methodologies in analytical approaches to case evaluations. The multiple protocols used in the earlier growth studies have led to discrepancies in the understanding of what is actually being reported in these studies. For example, there have been discussions of differences between a study conducted by Kamal in the 1950 and another by Greenberg from the 1990s for the development tables of calliphorid (blow flies) species. These two studies cannot truly be compared with respect to the length of time between stadia (an insect stage duration) due to the fact that one study (Greenberg) assess the minimum time of development and the other (Kamal) looks at the mode duration. This is apples and oranges. However, some in the forensic entomology community are attempting to re-evaluate the development of the most common species of blow flies found in the forensic case records. To accomplish this, rearing protocols developed by Wells appears to be a sound and reliable methodology for this re-evaluation, but requires hundreds, if not thousands of eggs all being deposited within one to no more than two hours. Anesthetizing several hundred wild collected blow flies of multiple sex and species and then sorting only females of a single species is very difficult and requires expensive equipment (a cooling table). An inexpensive method is proposed here using houseware cake pans, an ice crusher (blender), a freezer, and a refrigerator. An inexpensive apparatus can be constructed from a few items in the houseware area at any department store. A rectangular cake pan, which is approximately 12"X22" with a plastic lid, will provide the base portion of the unit (Unit A). Use a square aluminum or steel cake pan (Unit B) for the inside element which has smaller dimensions (e.g. 9" X 9") and will fit into the larger rectangular cake pan (Unit A) with an inch or two of space around each side. Also, Unit A should have a greater depth than Unit B for space under the smaller unit. Cut a hole in the plastic lid of Unit A which Unit B will fit through (try to keep it a snug fit). Your coolant will be a mixed slurry of finely chopped ice (use an ice crusher rated blender) and water. Pour enough water into the ice so that it is slushy and will fill in the bottom and sides surrounding Unit B. This maintains a temperature which keeps the flies inert in Unit B. Unit B is your sorting tray and will be surrounded on the bottom, and all four sides with icy water. If buoyancy is a problem, Unit B can be weighted down with weights or two large rubber bands can be placed around Unit A and Unit B to hold the sorting pan down into the icy water. Pre-cool Unit B in the freezer for several minutes before placing into the ice bath. You will need additional temporary storage containers for the sorted specimens. A "small" "Mosquito Breeder" (BioQuip) with the collecting cone inverted into the base makes for quick placement of the specimens and the inverted cone prevents them from escaping back out once they regain flight. When testing the flies from your geographic area, you may find that the slushy ice water bath is not cold enough; you can add salt to lower the temperature of the ice/water mixture. If it works for ice cream, it will work for the flies, too.

The procedure will enable easy procurement of hundreds of gravid female blow flies of a selected species for obtaining thousands of eggs. These eggs can then be reared to different life stages for evaluating growth and development durations of any blow fly species. These data will then be used for greater precision in time of death (postmortem interval) estimations.

Forensic Entomology, Blow Flies, Sorting

D24 Paradigm Shift: Analog Film to Digital Media at the U.S. Army Criminal Investigation Laboratory

Carl R. Kriigel, BS, United States Army Criminal Investigation Laboratory, 4930 North 31st Street, Forest Park, GA 30297*

Upon the completion of this presentation, attendees will learn about the challenges and benefits of the journey to move from analog film based media to digital media and technology.

This presentation will impact the forensic community and/or humanity by sharing the various processes and decisions used to change the standard of using analog film and processing digital media by the United States Army Criminal Investigation Laboratory.

Many world events contributed to this paradigm shift. These included the fall of the Berlin Wall, U.S. Military reduction of troop strength and discontinued film development capabilities.

These challenged the U.S. Army Criminal Investigation Laboratory (USACIL) to explore new approaches to photography, film and video enhancement. As a result changes in technology enabled USACIL to develop more effective and efficient techniques for accomplishing a worldwide mission.

The USACIL underwent several phases when implementing digital technology. Some of the phases required considerable study and effort. Implementation of digital technology also met with resistance to change. These issues of change when moving to digital technology and some of the lessons learned will be covered.

Digital, Digital Technology, Film

D25 The Virtopsy Approach: Bridging Radiologic and Forensic Sciences

Michael Thali, MD, University of Berne, Institute of Forensic Medicine, Buehlstrasse 20, Berne, 3012, SWITZERLAND*

After attending this presentation, attendees will be aware of the newest developments in forensic imaging.

This presentation will impact the forensic science community and/or humanity by providing an overview and outlook of upcoming imaging technologies.

Forensic science has experienced revolutionary changes in different fields, such as genetics, crime scene investigation methods and toxicology. Forensic pathology, by contrast, still utilises the time-old, evidence-based methods introduced centuries ago, namely the dissection of a corpse and an oral description and written documentation of the findings obtained; this has been augmented in the past decades by photography. Although conventional X-rays have found their way into daily forensic practice, newer, clinically established methods, such as CT and MRI, seem to lag behind in their forensic implementation.

This conservative attitude towards new technologies is surprising in a field in which prosecutors and defence lawyers are, depending on the case circumstances, often eager to test novel methods. Regardless of these obstacles, many different institutions have implemented CT in postmortem forensic investigations.

In Switzerland, this revolution in forensic science started off in the mid-nineties, when the Institute of Forensic Medicine of the University of Bern started a project with the Scientific Service of the City Police of Zuerich. The aim was to document body and object surfaces in a three-dimensional fashion. A few years later, the Institute of Forensic Medicine again started a joint research project, this time with the Institutes of Diagnostic Radiology and Neuroradiology of the University of Bern. This project had the ambitious aim of detecting forensic findings of corpses using MSCT and MRI, and of comparing these results with autopsy findings.

This was the beginning of the Virtopsy® project. Later on, further methods and tools were added in addition to MSCT and MRI, so that now the project implements an ever expanding variety of imaging methods.
The transdisciplinary research project Virtopsy® is dedicated to implementing modern imaging techniques into forensic medicine and pathology in order to augment current examination techniques or even to offer alternative methods.

The project relies on three pillars: 3D surface scanning for the documentation of body surfaces, and both multislice computed tomography (MSCT) and magnetic resonance imaging (MRI) to visualise the internal body.

3D surface scanning has delivered remarkable results in the past in the 3D documentation of patterned injuries and of objects of forensic interest as well as whole crime scenes. Imaging of the interior of corpses is performed using MSCT and/or magnetic resonance imaging (MRI). MRI, in addition, is also well suited to examine surviving victims of assault, especially choking, and helps visualise internal injuries not seen at external examination of the victim. Apart from the accuracy and three-dimensionality that conventional documentations lack, these techniques allow for the re-examination of the corpse and the crime scene even decades later, after burial of the corpse and liberation of the crime scene. Virtual, non-invasive or minimally invasive approach will improve forensic medicine in the near future.

The Virtopsy approach is now used worldwide: The Office of the Armed Forces Medical Examiner (Armed Forces Institute of Pathology, Washington, DC, Dover, DE), which performs CT scans on military personnel killed in combat on a routine basis evaluated the usefulness of CT in the assessment of high velocity gunshot victims with promising results. Groups from the universities of Copenhagen (Denmark) and Linkoping (Sweden) have started CT scanning on corpses on a broad scale, here again with promising results. According to personal communication, every corpse delivered to the Victorian Institute of Pathology (Sydney, Australia) undergoes a CT scan prior to autopsy. Also dedicated to this novel approach, the Society for Autopsy Imaging in Japan was founded in 2003. CT scanning has also been introduced into forensic anthropology. A French group (Toulouse) actually obtained superior results when assessing the case a charred body with respect to anthropological aspects than with traditional methods.

In conclusion, the non-invasive or minimally invasive approach envisioned by postmortem surface scanning and MSCT as well as MRI has several advantages to current forensic examination techniques, namely:

- Precise, objective and clear documentation of forensic findings for the court
- Calibrated, 3D documentation of findings
- Quality assurance through digital data archivation and transfer
- Reduction of psychological trauma for the next-of-kin
- Improved judicature in cultures with low autopsy acceptance

In the talk the newest developments of the Virtopsy project will be presented.

Forensic Imaging, Virtopsy, Forensic Radiology

D26 Novel Method for 3-D Biometric Face/Head Total and Partial Comparison Through Scanner-Invariant Slicing

Leonid I. Rudin, PhD, Jose- Luis Lisani, and Jean-Michel Morel, Cognitech, Inc., 225 South Lake Avenue, Suite 601, Pasadena, CA 91101*

The goal of this presentation is to present new theory and algorithm for 3D based face/head comparison.

This presentation will impact the forensic science community and/or humanity by extending the understanding of the state of the art 3D based techniques for biometric identification and comparison.

The classical techniques to compare 3-D surface-shapes are either exploit numerical, e.g., least-square, matching of surface shapes[1], or the 3-D data is matched through registration of "landmarks," which are "meaningful loci that can be unambiguously defined and repeatedly located with a high degree of accuracy and precision."[2] These methods may be classified as a "local" 3-D registration techniques, since they are based on point-to-point comparison cumulative metrics. Most recently a new class of 'global' 3D shape comparison methods was pioneered in[3], which is based on comparison of coordinate-system invariant geodesic curves that connect pairs of surface points. The main advantage of this method is that under surface deformations which are area-preserving, the minimal length geodesics do not change. Thus it opens up a possibility to 'expression-invariant' face matching, as long as there is no shortening or stretching of the facial surface (as in opening and closing the mouth).

Neither of the above techniques is invariant with respect to the corresponding 3-D scanning method and machine which is used in collecting the 3-D data. It is well known that the scanning apparatus is

capable of introducing 3-D shape variations that are at least affine in nature. For example surface areas can get stretched and skewed. Therefore it is desirable to have a method that does not depend on the chosen 'extrinsic' coordinate system and is at least affine-invariant. Similarly, there is a need for a 'partial' comparison method that is able to identify matching shape parts, even if the rest of the shape is missing or distorted.

In this presentation, the theory for and demonstrate implementation of the new method for the matching and partial comparison of 3-D biometric Face/Head scanned data is proposed. The main idea is to "dissect" the 3-D shape of Face/Head 3-D scan into "invariant" slices. If such coordinates invariant slicing can be performed, the resulting "slice-curves" turn out to be also invariant, i.e., independent from affine transformations due to the scanner, and are independent of the selected coordinate system, which may vary for each scan, and each scanner. Then using affine-invariant methods of curve comparison, a matching criterion can be established for a whole or a part of the 3-D shape. The original affine-invariant 3-D surface-shape registration method was proposed by authors in.[4,5] It is based on a fundamental principle that geometric tangency is preserved by affine transformations, e.g., by zooming and skewing. Once the slicing curves are determined, the tangency condition can be used again on the 2-D "sub-manifolds" of curves. This results in parsing the 'slicing' curves into affine-invariant line-elements, which then can be coded and compared.

The traditional 3-D face matching methods will fail when very little 3-D complexity is present in the shape. Initially, the computational performance and stability of our method on the 3-D scanned database of "doll-heads" with affine variation of scanning parameters will be demonstrated. The significance of the doll-head bench mark data is that the examined shapes have very few significant 3-D features and no macro-textural information, unlike human faces which sometimes are easier to distinguish just by correlating local shape information. Several comparison examples with human Face/Head 3-D scans are also presented.

Furthermore, the 3D data are exploited to numerical matching of two surface shapes. The difference of two shapes are also visualized.

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3D Shapes, Shape Comparison, Scanner Invariant Slicing

D27 Remote Detection of Clandestine Mass Graves Using Field Spectroradiometer and Airborne Hyperspectral Data

Margaret Kalacska, PhD, and Lynne S. Bell, PhD, Department of Criminology, Simon Fraser University, 8888 University Drive, Burnaby, BC V5A 1S6, CANADA*

After attending this presentation, he attendees will gain an understanding of the fundamental concepts of remote sensing technology, and more specifically of hyperspectral data as it can be applied to forensic investigations such as the detection of clandestine graves.

This presentation will impact the forensic science community and/or humanity by demonstrating the utility of hyperspectral data with pattern recognition techniques to locate a mass grave by means of differentiating its spectral reflectance from the background in a tropical environment, going beyond simply locating "disturbance".

Remote sensing, in the form of field spectroradiometry and airborne and satellite imagery has been relatively untested as an investigative tool in the location of mass graves. This form of remote sensing examines the reflected solar electromagnetic energy from the Earth's surface with specialized sensors on the ground (i.e., field spectrometer), in the air (i.e., airborne imagery) or in space (i.e., satellite imagery). The unique manner in which different targets reflect the electromagnetic radiation over a series of wavelengths is referred to as a spectral signature. In this study, the focus is on examining the spectral signature of an experimental animal proxy mass grave from field and airborne hyperspectral data in a tropical moist forest environment. With over one hundred bands (narrow wavelength regions) recorded in the visible to the shortwave infrared wavelengths (i.e., 400-2,500nm) specific features in the reflectance data that may be characteristic of the spectral response of the grave in comparison to a variety of soil/ground disturbances from field data or land covers such as pasture, forest, etc. from airborne imagerycan be examined. The spectral response of the grave and a variety of soil/ground disturbances over a period of sixteen months from field spectra with a combination of standard machine learning techniques was examined. The airborne imagery, collected one month following experimental set-up was examined in *n*-dimensional space to isolate the spectral response of the grave. A clear separability between the spectra of the grave and the disturbed soils/ground throughout the sixteen month period was found. Distinct characteristics in the spectral response of the grave versus other targets in the landscape from the airborne imagery were also found. In addition, other observations show that vegetation regeneration was severely inhibited on the grave in comparison to disturbed soils. At the sixteen month period when the regeneration was sufficient to collect leaf samples, we examined in detail leaf-level spectra from grass growing on and off the grave with the same analysis techniques; the spectra were separable with minimal error and may be explained by differences in the chemical characteristics of the soil.

Remote Sensing, Cadaveric Decomposition, Spectrometry

D28 The Future of Professionalism in Digital Forensics

Carrie M. Whitcomb, MSFS, University of Central Florida, National Center for Forensic Science, PO Box 162367, Orlando, FL 32816-2367*

The goal of this presentation is to give the historical development of professionalism, explain where the profession is now, and explain where we need to be.

This presentation will impact the forensic science community by describing the professional organizations for digital forensic practitioners and individual certification are two cornerstones of professionalism.

When new types of tasks come into the work place and require technical skills, rapid growth groups of individuals with the appropriate talents focus on acquiring positions to do these specialized tasks can be seen. As the technology grows, the general population's need for the technology grows, and specialties within the technology begin to develop. People begin to focus their tasks in the given specialty and experts begin to develop. As experts develop they begin to be very independent. As time goes forward, they will make a mistake that draws attention from the community. At this point the community can decide to control these experts by investigations and litigations or the experts themselves decide to become self-regulating.

Today we are at the leading edge of self-regulating in the digital forensic areas through professional organizations, laboratory accreditation and developing professional certification boards for the various subspecialties in digital evidence.

In the future, the community will come together through these paths and will become very organized. So much so that they will develop forensic processes before the latest gadget is sold. At last we keep pace with the criminals!

Digital Forensics, Professionalism, Certification

D29 Application of Forensic Techniques to Data Preservation

John Tebbutt, and Douglas White, MS, National Institute of Standards and Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 20899-8970*

The goal of this presentation is to learn about an automated procedure for processing large numbers of files to extract forensic metadata and how this procedure is employed for two disparate purposes: to provide court admissible computer file identification information to law enforcement agencies for use in forensic examinations of computer systems; and to aid in data reduction, management and cataloging of a large document corpus.

This presentation will impact the forensic science community by describing a set of procedures used both for the production of data for use by computer forensics investigators and the automation of data reduction and management in a large data collection.

Attendees will learn how the National Software Reference Library processes larges numbers of files to extract forensic metadata and how this same process can be applied to aid in data reduction, management and cataloging of any large corpus of files. Application to the collection managed by the National Archives and Records Administration is given as a specific example.

This talk will demonstrate that procedures originally developed for the production of forensic metadata can be successfully applied in the automation of data reduction and management in a large data collection.

The National Software Reference Library (NSRL) of the National Institute of Standards and Technology (NIST) is studying the application of techniques initially developed to aid computer forensics examiners in the investigation of mass storage devices to assist the National Archives and Records Administration (NARA) in its mission to preserve the records of government until the end of the Union.

With the increasing use of information technology, successive administrations are producing correspondingly more data to be archived. For example, the archives has estimated that the amount of data from the George W. Bush administration to [date] is on the order of [X] TB. The automation of data preservation, management and cataloging becomes ever more vital to the NARA's mission.

The NSRL routinely collects and generates metadata associated with large numbers of files. The process by which file metadata are derived is largely application agnostic and can be applied to any large corpus of digital files. As with any sufficiently comprehensive dataset, they can be mined for purposes other than that for which they were originally intended. By applying the NSRL process to the NARA dataset, we can assist with data reduction, management and cataloging.

At the file level, the metadata collected include "hard" data, such as file name, file size, and routine cryptographic hashes of the file content - useful for uniquely identifying individual files - and "fuzzy" hash values, which are based on analysis of the structure of file contents and are useful in the detection of files which are similar but not identical. At the sub-file level, the metadata consist of cryptographic hashes of a file's constituent blocks.

Data reduction is achieved by comparing the "hard" metadata of every file in the corpus and using the information to detect and discard duplicate files, replacing them with references to a single (or a very small number of) master copies. This process is totally automated and does not require input from or supervision by an archivist.

Once exact duplicates have been discarded, the remaining unique files are compared using the "fuzzy" metadata and block-level metadata and compiled into clusters of similar files. The cluster data is available for inspection by archivists and to aid in data management and cataloging.

Metadata, Data Preservation, Data Reduction

D30 Virtual Machines in Computer Forensics Research

John Tebbutt, and Douglas White, MS, National Institute of Standards and Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 208998970*

After attending this presentation, attendees will learn about some of the ways in which virtual machines can be used in computer forensics research to expedite the research process while providing more detailed information on the machines under observation.

This presentation will impact the forensic science community by showing how virtual machine technology is a significant addition to the toolkit of computer forensics researchers, facilitating adherence to the scientific model by enabling high-resolution capturing of machine states for investigation.

Virtual machines (VMs) are increasingly used by computer forensics investigators because they offer numerous well-documented advantages over physical machines. Computer forensics researchers also have found virtual machine technology to be of great use, for somewhat different reasons. Principal among these are the potential to create small (4GB or less) virtual drives; the ability to freeze or snapshot these drives while the machine is in a particular state; the ability easily to store such snapshots indefinitely (e.g. on a DVD); and the ability to investigate several such VMs simultaneously and over time on a single physical workstation.

VM technology has been helpful in the observation of changes in system characteristics as a result of specific actions. A snapshot of a machine in a known state is taken, an action performed, a second snapshot, taken and the two snapshots are compared in order to determine the consequences of the action. It is then a simple matter to return to the known state, perform different actions, and identify any patterns which may exist. The NSRL has used this approach primarily to examine changes occurring as a result of software installation: which existing files are changed, and how; which files are added; and what is the effect on the Windows™ registry?

VM technology is used to obtain coverage statistics for the NSRL data set. The NSRL derives its reference data directly from installation media, which raises the question as to the utility of the reference data when compared with files installed on computers. Using VMs, it is possible rapidly to quantify the coverage of the NSRL data set with regard to real systems. Beginning with a "bare metal" install in a VM, it was possible to investigate which operating system files are not found in the NSRL data set, progressing to known applications, and so on. Previously it had been necessary to attempt coverage estimates using arbitrary machines operating in everyday environments and with incompletely known installation histories.

Finally, VMs are occasionally used in the production of the NSRL reference data. For example, a new operating system is installed into a VM with a 4GB virtual hard drive, the VM is shut down, and the virtual hard drive is written to a DVD. The virtual hard drive can then be processed in the same way as an installation disc to obtain file hashes for inclusion into the NSRL data set. It can then be stored together with the installation media, rendering the process repeatable and verifiable. While this approach is labor intensive, there are circumstances in which it can be useful, for example, when files are stored in unknown proprietary archive formats on the installation media and would thus otherwise be unavailable for processing.

Virtual Machine, Machine State, Computer Forensics

D31 Internet Café

Jeffrey Barefoot, Department of Defense, Computer Forensic Laboratory, 911 Elkridge Landing, Suite 300, Linthicum, MD 21090*

After attending this presentation, attendees will understand how a suspect of a crime, without eyewitnesses, can be determined through the use of digital forensic tools and examination of computer data remnants.

This presentation will impact the forensic community by showing that digital forensics can provide valuable leads to a crime even when similar cases have failed or eyewitness testimony is not available. This presentation can also increase awareness that administrators of Internet cafés, that provide computers, should implement robust user management techniques to deter misuse of their resources.

Jeff Barefoot has been a computer forensic examiner at the Department of Defense Computer Forensics Laboratory (DCFL) for approximately four years. In August 2006, a follow-on examination to a Project KIDS (PK) case for additional analysis of media seized from an Internet café computer was initiated and assigned to Mr. Barefoot. Most case requests provide a subject and allegations of a crime. In the follow-on examination, the subject was unknown. Initial analysis revealed only one user profile that was identified as a generic Internet café account. Individual accounts are generally not created on Internet cafés because of the high volume of users. Mr. Barefoot's previous cases attempting to correlate a user associated with a computer crime on an Internet café had been unsuccessful. The forensic analysis was aimed at searching the media for chat or email messages during the timeframe of four images of suspected child pornography that had been recovered in the previous case.

Forensic analysis recovered creation times of the four images, where two of the images were found in a folder on the desktop and the other two images were found in a folder in the recycle bin. While no temporary Internet history records were recovered, there were four Yahoo!® Messenger chat messages that corresponded to the same creation times of the recovered picture files. In a review of the chat messages, one chat dialog revealed a Yahoo!® user account name and a connected Yahoo!® buddy icon picture to the username were revealed. This particular chat dialog displayed an individual chatting to a purported 15 year-old-girl. The entire timeframe of the chat session occurred during the creation times of three of the suspected child pornography images. During further examination of HTML files found in web cache, Jeff was able to connect the Yahoo!® user account to a nickname and the last name of an individual. While reviewing recovered emails, Mr. Barefoot was able to connect a "Classmates" email that addressed the subject's first name, thereby now correlating the individual's first and last name.

Based on the files of the suspected child pornography recovered from the analysis, it was determined that the images originated from a web-based photo storage site named "Photobucket." During analysis of five web page files from "Photobucket" photos, two filenames corresponded with the filenames of the recovered child pornography pictures. Additionally, a larger picture appearing to match the individual in the Yahoo!® buddy icon picture was identified.

After forensic analysis of the submitted media, the case agent was provided with the first and last name of the individual, the Yahoo!® buddy icon picture, and the larger picture retrieved from the Photobucket website. Subsequently, the case agent went to the personnel office and was able to successfully pull the individual's ID card, which revealed a perfect match to the information provided by DCFL. When confronted and interrogated, the subject confessed to viewing child pornography on the submitted Internet café computer and an additional café computer. An addition Internet café computer and the subject's personal computer was later sent to DCFL for forensic analysis, and additional images of suspected child pornography were recovered.

Yahoo!® Messager Chat, Buddy Icon Picture, Photobucket Website

D32 Tracking Computer Use With the Windows™ Registry Dataset (WiReD)

Douglas White, MS, National Institute of Standards and Ttechnology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 20899-8970*

After attending this presentation, attendees will have a basic understanding of issues involving Windows™ Registry forensic investigation.

This presentation will impact the forensic community by presenting a rigorous procedure and data set to support investigation of Microsoft Windows(tm) computer systems.

The NIST Windows Registry Dataset (WiReD) contains the changes to the Windows™ Registry caused by application installation, de-installation, execution or other Registry modifying operations. The applications are chosen to be of interest to computer forensic examiners.

WiReD is currently an experimental prototype. NIST is soliciting feedback from the computer forensics community to improve and extend its usefulness.

There are two tools associated with the WiReD effort which will be discussed. One tool generates a XML-based difference between two Microsoft RegEdit-generated Registry patch files. The other tool creates the WiReD dataset from difference files generated from the XML. The tools are currently implemented in Ruby (1.8.4) and were tested in Mac OS X 10.4 (Tiger). Portability to other BSD-style operating systems will be discussed. Documentation for the tools and associated libraries will be provided.

Future directions of the WiReD prototype will be outlined. Limitations of using RegEdit to generate Registry dumps and handling problematic Registry entries will be discussed. The task and prioritization of identifying, acquiring and processing software for inclusion in the dataset will be discussed.

It is envisioned that the current prototype as only a small step in a much larger scheme that includes an XML database for managing the Registry difference files. This will allow for the efficient query and manipulation of acquired Registry data. Another goal is acquisition and cryptographic hashing of all files installed or modified by an application of interest. Expansion of Registry modification detection to beyond just application installation to include all phases of an application's life cycle on a given machine is the long term forensic information we seek.

Microsoft Windows, Registry, Registry Forensics

D33 Identification and Reconstruction of Deleted, Fragmented DNA Digital Files

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The objective of this case study is to describe a methodology to identify, reconstruct, and validate deleted file fragments. This methodology is predicated on a thorough understanding of the content structure of the file format and file-system level structures.

This presentation will provide the forensic community with details about a process used to identify and recover files from a reformatted drive by using file structure and file-system characteristics, which in turn were utilized to develop a programmatic and elegant solution to a challenging and complicated task. The case presented involved not only identifying the file fragments of the deleted file, but also reconstructing the history of the drive, including the file-system structure of the drive before it was reformatted.

Identification and reconstruction of deleted, fragmented files is a time consuming and often difficult process but it can be worth the effort, particularly when the results are a matter of life or death. The case study presented will detail the identification and recovery of deleted files from a

hard drive that had been re-initialized with different volume parameters from the original drive format. The recovered files contained the DNA analysis results of a crime scene sample that were relevant to a multiple homicide investigation and death penalty trial.

Traditionally, identification of deleted files has been most successful when plain text content is searched for in unallocated space. Documents such as word processing documents, spreadsheets or Internet HTML files may be identified with relative ease in unallocated space, even in fragmented form. Nevertheless, in only a few cases is an original file able to be reconstructed from recovered file fragments.

This case study provides an example in which only the first fragment contained a searchable keyword. Fragmentation on the drive made it impossible to reconstruct the files using available tools. The existence and location of the first file fragments were identified through keyword searches formulated by researching the file format and the standard nomenclature used by the laboratory that had analyzed the original DNA samples. One method available to identify the remaining associated file fragments would require a manual "trial and error" approach to combine random clusters and attempt to validate the combined file.

Instead, the authors developed, and will present, an alternative method using a customized program to search for and identify the associated file fragments that relies upon the characteristics of DNA digital files and individual attributes of the specific, relevant files. The program searched through every cluster of the relevant hard drive for the associated second file fragments, and returned only one hit for each deleted file fragment. The file fragments were reconstituted, and the resulting files tested and validated with DNA analysis software.

Fragmented Files, Reconstruction, Deleted Files

D34 Built for Speed: Using Bloom Filters for File Identification

Douglas White, MS, National Institute of Standards and Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 20899-8970*

After attending this presentation, attendees will understand some principles of storing, accessing and sharing digital file identification data in Bloom filters.

This presentation will impact the forensic community by calling attention to the Bloom filter as a storage mechanism; a probabilistic algorithm to quickly test membership in a large set using multiple hash functions into a single array of bits.

A list of cryptographic hash values from NIST's NSRL RDS 2.13 was mapped 16-byte (MD5) and 20-byte (SHA-1) integers and concatenated them to form a binary file. This is the most compact form we have found that preserves order and allows perfect matching. The binary file can be used to determine if an MD5 or SHA-1 is known in the NSRL.

At this time, the Bloom filters with which we are experimenting are stored in 512MiB files. The files have a header, a 2^32 bit (512MiB) Bloom bit map section, and may contain data after the bit map.

Tools for manipulating the bitmap data will be discussed. The implementation varies in the number of Bloom vectors used - 16 vectors for MD5, 20 vectors for SHA-1. The effects of changing the Bloom key size, vector count and number of inputs will be explained.

There are benefits and pitfalls to both Binary tree and Bloom filter search methods, which will be covered in this discussion. Our math shows that a Bloom filter with 35-bit keys, using 20 vectors can store 1,000,000,000 SHA-1 values with a 1-in-100,000,000 false positive rate, and be stored in 4GiB. Other speed, storage and distribution benefits of Bloom filter use will be shown.

Bloom Filter, File Identification, Digital File Storage

D35 Hashing of File Blocks: When Exact Matches Are Not Useful

Douglas White, MS, National Institute of Standards and Technology, 100 Bureau Drive Stop 8970, Gaithersburg, MD 20899-8970*

After attending this presentation, attendees will understand some principles of eliminating benign information from investigations of computer systems, based on cryptographic hashes of files and partial files.

This presentation will impact the forensic community by introducing the rigor of cryptographic digital file identification at a granular level which supports statistical identification of objects.

Use of cryptographic hashes or "digital fingerprints" to automatically identify files is absolute when applied to a file as a whole; the file is unambiguously categorized. When dealing with morphing digital objects, such sorting leaves many files to be dealt with by manual review.

Block hashing is a method of applying the cryptographic algorithms to smaller-then-filesize portions of the suspect data. In this case study, the portions align with the blocks of the computer's hard disk. The aggregation of the unambiguous block hash values allow statistical probabilities of identification of suspect files, taking the dynamic nature of digital objects into consideration. This is parallel to the use of latent fingerprints from a few of a suspect's fingers rather than a complete tenprint set for identification.

Examples of practical applications of this technique, along with preliminary error rates will be presented.

Automated Investigation, File Hash, File Fingerprint

D36 Using Hashing to Improve Volatile Memory Forensic Analysis

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After attending this presentation, attendees will understand how information extracted from known files can improve volatile memory analysis and they will have insight into how automated tools can be built that leverage this information.

The presentation will impact the forensics community by demonstrating new methods of forensic volatile memory analysis, discussing how to derive trust in the data extracted from a potentially compromised system, and finally introducing a new resource being made freely available to the digital forensic community to support volatile memory analysis.

By extending hash databases to include immutable code sections of known executable files, an investigator can greatly augment the current techniques used for analyzing the volatile memory. This information can be used to automatically identify known aspects of the system's runtime state, thereby reducing the areas of volatile memory that need to be analyzed during the investigation. Since these immutable sections are compiler generated text, they can also be used to evaluate the runtime state of a potentially compromised system. This can be accomplished by evaluating the in-memory code sections of critical system executables that should not change if the system is in a trusted state. Also, by leveraging these static sections of code as anchors of trust, the investigator can evaluate the control flow integrity of the system at the time the memory image was acquired using a notion of transitive trust. This allows investigators to detect common mechanisms used to undermine the integrity of the system and compromise the integrity of the data collected

from the system. By automatically identifying these changes to critical sections, it can also provide an investigator the mechanism to quickly triage the system and, if necessary, focus their attention on the time-intensive effort of determining the intent of the modifications.

This work will also discuss why the information currently stored in hash databases is inadequate to support the needs of the volatile memory community. It will also provide insight into the challenges associated with collecting this information. Outlines of the procedures that are needed to normalize the data extracted from the known files and of the procedures that need to be followed to extract and normalize the immutable code from volatile memory will also be presented.

A major goal of this effort is to provide freely available standard reference data, to support the needs of digital investigators and tool makers that are currently using this type of information. By leveraging the National Institute of Standards and Technology (NIST) National Software Reference Library (NSRL) it was possible to augment the Reference Data Set (RDS), a freely distributed collection of digital signatures for known applications, to include hashes of these immutable sections of data which will provide a valuable resource to the volatile memory analysis community.

Finally, the results of a number of experiments performed on both laboratory and real-world systems will also be presented. These experiments will attempt to demonstrate the impact of leveraging these techniques to improve volatile memory analysis.

Volatile Memory Analysis, Identification, Trust

D37 Potential Anomalous Results - Calculation of One-Way Cryptographic Hashes in Universal Serial Bus Devices

Mark Pollitt, MS, J. Philip Craiger, PhD, Chris Marberry, BS, and Paul Burke, BS, National Center for Forensic Science , University of Central Florida, PO Box 162367, Orlando, FL 3281*

After attending this presentation, attendees will develop an understanding of the interplay between USB storage devices and cryptographic hashing tools.

This presentation will impact the forensic science community by. As a result of attending this session, examiners may be able to avoid incorrectly interpreting the results of hashing algorithms and will be able to develop protocols which will prevent obtaining incorrect results.

One-way cryptographic hashes (or 'hashes' for short) are mathematical algorithms applied to digital media. A common use of hashes in forensics is to demonstrate that digital media has not changed (i.e., not been tampered with subsequent to seizure). The application of a hashing algorithm to a piece of digital media (a file, a forensic image, etc.) should always result in the same unique number, typically of size 128 or 160 bits depending on the particular hashing algorithm used. Change of a single bit on the digital media will result in a significant change to the resulting hash, indicating that the contents of the media have changed.

While developing simulated forensic evidence for teaching purposes, anomalous hash values were noted using certain combinations of imaging tools and Universal Storage Bus (USB) storage devices. The differences noted were limited to instances where the imaging tool was attempting to obtain an image of the "physical" drive.

One significant difference in the data structures for USB devices is that they normally lack a partition table. It is therefore possible that imaging software may make erroneous assumptions concerning the size of the media resulting in an image that is either the incorrect size or the included data bytes are different from what is read by another imaging tool.

Storage drives which utilize "autoplay" technology are becoming very common. Initial examination of these reveals that they may contain applications which change information on the USB drive, which could result in an altered hash value.

Given the increasing number, size and importance of USB devices, it is important to ensure that complete and accurate images are created from the original evidence.

Digital Forensics, Cryptographic Hash, Universal Storage Bus (USB)

D38 Acquisition Techniques of Mobile Devices and Associated Media

Richard P. Ayers, MS, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8970, Gaithersburg, MD 20899-8970*

The goal of this presentation is to provide an overview on mobile device forensics and suggested procedures during the acquisition phase of GSM devices and associated media.

This presentation will impact the forensic science community by providing a brief overview on mobile device forensics and suggested procedures during the acquisition phase of GSM devices and associated media.

Mobile devices incorporating cellular capabilities are ubiquitous and contain a wealth of personal information useful in criminal cases, civil disputes, employment proceedings and recreation of incidents. Data acquisition performed on cellular devices operating over Global System for Mobile Communications (GSM) and non-GSM networks has proven not only frustrating but extremely tedious due to the rapid rate of new cellular devices appearing on the market. Software vendors specializing in cellular forensics are forced to continuously provide updates to software and associated hardware in order to maintain support and provide examiners with solutions for the latest technologies. Multiple hardware and software solutions exist which provide acquisition solutions for various makes and models of cellular devices and associated media. Forensic examination of mobile devices is a small part of computer forensics, in general. Consequentially, tools possessing the ability to acquire data from these devices are slowly maturing and continually expanding. This paper provides a brief overview on mobile device forensics and suggested procedures during the acquisition phase of GSM devices and associated media.

Introduction: Cellular devices continue to expand in storage space (on the order of gigabytes) via associated removable media (e.g., Multi-Media Card [MMC], Secure Digital [SD], memory sticks) and internal hard drives allowing mobile devices to double as mp3 players and personal organizers. Additionally, the intelligence of these devices continues to advance. Personal Information Management (PIM) applications provide functionality comparable to those present on older desktop personal computers. The combination of ever-increasing storage capacities, built-in camera and video functionality alongside faster processing and Internet ready devices, provide users with the ability to store an abundance of personal information. Consequentially, the advancement in technology has escalated the richness of data contained on cellular devices. Therefore, cellular devices are often the key component to solving an incident or bringing justice to involvement in criminal activity.

Data acquisition of mobile devices entails availability of appropriate hardware and associated drivers used to establish connectivity with a software application capable of interpreting and presenting acquired data in a human readable format. Forensic manufacturers are challenged with producing new hardware (i.e., data interface cables) and software (i.e., drivers) which provide forensic examiners with an acquisition solution for emerging technologies. Unlike hard disks whose interface (e.g., Advanced Technology Attachment [ATA], Serial Advanced Technology Attachment [SATA], Small Computer System Interface [SCSI], Universal Serial Bus [USB], Firewire [FW400/800]) standards are nominal, cellular devices do not have a pre-defined interface standard and vary based upon manufacturer and specific models. Non-standardization of mobile device interfaces often times forces examiners to borrow cables from another source (i.e., mobile device acquisition toolkit) in order to acquire the

device. The worst-case scenario forces examiners to physically "thumb" the device while recording the process via video camera, where screenshots are used to create a finalized report.

The evolution of forensic software and associated hardware capable of acquiring data from cellular devices is continuous, due to the turnover rate of mobile devices available on the market today. A lack of interface standards often times leads to acquisition complexities involving multiple toolkits yielding a successful acquisition. Therefore, quality control and rigorous testing of mobile device acquisition tools is paramount, in order to provide examiners with a sound application.

Characteristics: Forensic examiners, specialists and associated team members involved with the task of investigating mobile devices should encompass a general understanding of the mixed variety of architectural layouts contained within low to high end cellular devices, smart phones and PDAs (Personal Digital Assistants) embedding cellular technology. Knowledge of mobile device design architecture plays a significant role in device management throughout the life cycle of the investigation or incident. The type of memory present in a device is quite significant in terms of data preservation related to power conservation during transportation to a protected laboratory setting. Generally, mobile devices are comprised of the following elements: a micro-processor, memory, radio-module, digital signal processor, microphone, speaker and a variety of hardware keys that provide application functionality.[3] However, differences in memory layout between low to high-end cellular devices compared to smart device determine the seizure and transit techniques minimizing the possibility of data loss.

Cellular devices (i.e., low to high-end cell phones), designed with the primary purpose of placing and receiving calls, maintain data in flash memory. Typically, the first part of flash memory is filled with the operating system and the second part is allocated for user data. Due to the design of these devices the conservation of power is not as critical as it is for smart devices. Cellular devices that maintain data within non-volatile memory are not subject to data loss via battery depletion. While the criticality of power maintenance is lessoned, low to high-end cellular devices face the possibility of data loss via network connectivity overwriting recoverable deleted data or the possibility of a key-chord acting as a device restore feature.

The internal memory of smart phones is classically divided into two regions: Flash Read Only Memory (ROM) and Random Access Memory (RAM). Data stored in Flash ROM, such as the operating system (OS) and pre-loaded applications supplied by the manufacturer are hard-coded and protected against erasure during the event of a hard-reset or battery exhaustion. RAM is generally divided into two areas, program memory and an object store. Program memory (used for program execution, loading drivers, and storage for processing information) is cleared much like RAM on a personal computer. The object store retains data during active and quiescent states, but risks data loss in the event of battery exhaustion or a hard reset. Manufacturers may provide users of smart devices with an allocated safe-store folder for sensitive data that the user would like to protect against erasure in the event of a hard reset or battery depletion. Additional sources of memory storage present on high end devices are external memory (e.g., Secure Digital [SD], MicroSD, Multi-media Card [MMC], Memory Sticks) cards which provide users with a non-volatile storage solutions. Smart phones are high maintenance during transit to a protected laboratory setting due to the memory configuration and must be either shut down or powered while protected in a radio-isolated bag lessening the chance of data modification.

SIM Characteristics: The Subscriber Identity Module (SIM), a smart card that contains a processor, read only memory (ROM) and random access memory (RAM), is an essential element combined with the Mobile Equipment (ME) providing users the ability to authenticate and gain access to subscribed services for devices operating over a GSM network. In addition to providing users with extended non-volatile memory storage for personal information SIMs provide users with the ability to port their identity to multiple devices.[3] The GSM 11.11 standard provides useful information related to SIM characteristics, protocols and data elements. The SIM is approximately the size of a postage stamp and is typically located in the battery cavity area of mobile devices. Often times, multiple SIMs are used with a single device, therefore, it is important to carefully search surrounding areas and confiscate all related media or devices. Devices found without the SIM present may cause difficulty in acquiring the internal memory of the related device. Fortunately, tools exist that provide specialists with the ability to create an access card that allows internal memory acquisition to be completed without interruption.

SIMs provide subscribers with a layer of security via a 4-8 digit Personal Identification Number (PIN). Proper authentication is essential for network connectivity. Three incorrect successive authentication attempts lock the card forcing the correct PIN Unblocking Key (PUK) to be entered; if ten consecutive attempts are entered incorrectly the SIM is rendered useless. Therefore, it is advantageous for SIM acquisition tools to present the number of authentication attempts remaining if examiners are forced to attempt to crack the PIN. SIMs are generally pre-programmed with a default PIN, often documented on the manufacturers' site, which may serve as a starting point when alternative means of PIN discovery are not available. Acquiring the contents of the SIM are extremely limited without proper authentication, therefore knowledge of the PIN is invaluable. An abundance of useful information is stored on the SIM such as Abbreviated Dialing Numbers (ADNs), Last Numbers Dialed (LND), Short Message Service (SMS) messages, Enhanced Messaging Service (EMS), subscriber information (i.e., IMSI), and location (i.e., LOCI, GPRSLOCI) information providing additional data separate from the internal memory acquisition of the ME.

A number of forensic software tools have emerged that deal exclusively with SIMs independently of their handsets. The SIM must be removed from the phone and inserted into an appropriate reader (e.g., Personal Computer/Smart Card [PC/SC] reader) for acquisition. The majority of SIM only tools concentrate on a subset of data (e.g., subscriber information, Abbreviated Dialing Numbers [ADNs], Short Message Service [SMS] text messages, call logs, location information [LOCI]) considered most useful as forensic evidence. Tools have begun implementing support for the creation of a radio-isolation card providing examiners with the ability to acquire devices without network interruption, via writable SIM cards. The ability to create an access card of a SIM provides "radio silence" during acquisition eliminating incoming data overwrites of potentially recoverable deleted information. Additionally, the creation of radio-isolation cards or access cards provides examiners with the ability to acquire the internal memory of GSM devices found without the SIM present.

Currently, Universal Subscriber Identity Modules (USIMs) are on the rise. The third generation (3G) card carries out the same functions as it 2G cousin (i.e., SIM) and offers users with greater bandwidth allowing for enhanced multi-media, communication, wireless Internet access and strengthened security mechanisms.

State of the Art Snapshot: The variety of cellular technologies present on the market today has given rise to a multitude of forensic toolkits providing forensic specialists with the ability to acquire data present on various makes and models of mobile devices and related removable media. A considerable number of software tools and toolkits exist, but the range of devices over which they operate is typically narrowed to distinct platforms for a manufacturer's product line, a family of operating systems, or a type of hardware architecture. Although, the majority of toolkits support a full range of acquisition, examination, book-marking and reporting facilities, some tools focus on a subset that provide examiners with the ability to only acquire and produce a final report. Information present on a cell phone may vary depending on several factors such as the capabilities of the phone implemented by the manufacturer, network services subscribed to, or modifications made to the phone by the service provider and/or the user.[1]

Tools capable of acquiring data from cellular devices may provide examiners with the ability to perform both a logical and physical acquisition. Often times this is dependent upon the device being acquired. Physical acquisition implies a bit-by-bit copy of an entire physical store

(e.g., a memory chip), while logical acquisition implies a bit-by-bit copy of logical storage objects (e.g., directories and files) that reside on a logical store (e.g., a file system partition). Physical acquisition has advantages over logical acquisition, since it allows deleted files and any data remnants present to be examined, which otherwise would go unaccounted. A logical acquisition, though more limited than a physical acquisition, has the advantage that the system data structures are normally easier for a tool to extract and provide a more natural organization to understand and use during examination. If possible, doing both types of acquisition is preferable – a physical acquisition before a logical acquisition.[2] Additional features of various mobile device forensic tools often protect case files or individual files from modification via encryption or SHA/MD5 hash functions.

Digital Evidence: The amount and richness of data contained on mobile devices varies considerably dependent upon device type and personal usage. Higher end devices such as smart phones or PDAs doubling as cell phones provide users with enhanced applications, capable of storing multiple file types while providing enhanced network connectivity. However, a core set of user data can be defined that remains somewhat consistent on all device types (i.e., low to high-end cellular device vs. smart devices) with cellular capabilities. GSM devices provide two areas of data storage, the internal memory of the device and the SIM. The following data elements stored on the SIM provide useful investigative or incident-solving information.

- Service Provider Name (SPN): The SPN provides examiners with the name of the provider useful for contact information in the event of needing additional SIM assistance.
- Integrated Circuit Card Identifier (ICCID): The ICCID (useful for obtaining the Pin Unlocking Key [PUK]) is the SIM serial number, which is imprinted on the outside of the card or can be acquired with the use SIM acquisition tool.
- International Mobile Subscriber Identity (IMSI): The IMSI is a unique number that identifies the phone/subscription to the GSM network.
- Mobile Subscriber International ISDN Number (MSISDN): The MSISDN is a number that identifies the phone number used by the headset.
- Abbreviated Dialing Numbers (ADNs) – ADNs are phone book entries that may contain a contact name in addition to the phone number.
- Last Dialed Numbers (LDN) – LDNs are a log of the last numbers dialed from the handset.
- Short Message Service (SMS) – SMS or text messages contain incoming messages sent to the device.
- Enhanced Message Service (EMS) – EMS messages are text messages over 160 characters or messages that contain either Unicode characters or a 16x16 to 32x32 black and white image.
- Location Information (LOCI) – LOCI information provides information relative to cell towers communicated with on the network.
- General Packet Radio Service (GPRS) location – GPRSLOCI contains the routing area information for data communications over the general packet radio service.

The following data elements stored in the device's internal memory provide useful investigative or incident-solving information.

- International Mobile Equipment Identifier (IMEI) – A unique 15-digit number that serves as the serial number of the GSM handset useful for determining statistics on fraud or faults.
- Personal Information Management (PIM) data – Data that is associated with the Address book (e.g., name, phone number, email address, address, website) and Calendar entries (e.g., details such as contact name, time, and address, relating to previous and upcoming appointments), To-Do lists, Memos, etc.
- Call Logs – Incoming and outgoing calls in addition to the SIM are found in the internal memory of the device.
- SMS text Messages – Depending upon the device or user setup SMS messages may be stored on either the internal memory of the device or the SIM. Often times, once the maximum limit has been reached for incoming SMS messages on the SIM they will be stored on the internal memory of the device. Additionally, dependent upon the device and user-setup, outgoing messages may be stored in the devices internal memory in a sent folder.
- Multi-media Messages (MMS)/email – MMS messages/email messages are found in the internal memory of the device and have an audio, graphic or video clip associated with them.
- File Storage – Files types such as audio (.mp3), graphic (.jpg) video clips (.avi) are often supported for many cellular devices (mid-level to high-end) and provide an excellent investigative source to examiners.

Preservation: Proper evidence preservation techniques must be strictly observed lessening the chance of data modification or deletion during the life cycle of the examination (i.e., initial seizure to final reporting). Maintaining the present state of mobile devices during transit to a laboratory setting can be problematic and challenging. For instance, a disposable or portable battery charger for the specific make and model of the device seized must be readily available. Maintaining power to the device eliminates the possible triggering of authentication mechanisms and loss of data contained in volatile memory as discussed earlier in Section 2.

Live devices require eradicating network connectivity via a radio-isolated container or radio-isolation card protecting against incoming or outgoing communication with the network. Incoming data alters the state of the device and potentially may overwrite recoverable deleted data. Additionally, any exposed cables used for maintaining power must be completely isolated to counteract the cable acting as an antenna negating the effect of the radio-isolated container. The Netherlands Forensic Institute (NFI) has developed in-depth flow chart of preservation techniques when transporting seized mobile devices.

Data Acquisitions: Retrieving data from cellular devices and associated media must be approached methodically following specific techniques in order to preserve data present on the device. As mentioned earlier, cellular devices must be contained in radio-isolated containers or simply turned off during transit to eliminate the possibility of overwriting potentially recoverable deleted data. Turning off the device may trigger authentication mechanisms and prolong the acquisition process, therefore, use extreme caution when using this technique if radio-isolation is not optional. Deleted data elements such as: address book, calendar entries, text messages, and MMS messages can be recovered from the internal memory of the cellular device dependent upon the tool and type of allowable acquisition (physical vs. logical). Furthermore, data elements stored on the SIM are recoverable if proper seizure, transit and acquisition techniques are strictly followed. Contact with the network can potentially destroy data stored either in the internal memory of the device or data stored on the SIM. Tools that traverse and report data stored on the SIM during internal memory acquisition have been noted to change the status of text messages. For instance, one traversal of the data present on the SIM will report an unread SMS message as unread; the second read due to the first traversal changes the status to read. The slight modification could have significant bearing on resolving an incident or criminal activity. Therefore, a thorough understanding of proper acquisition techniques and operations will lessen the chance of modifying existing data. Additionally, data elements that need to be handled carefully to defend against modification or deletion are the call logs (i.e., last numbers dialed). The SIM should never be removed from the phone before internal memory acquisition and additional SIMs found should not be inserted into the target device. Switching out SIMs alters the data stored in the internal memory of the device.

Conclusions: Forensic examination of cellular devices is a growing subject area in computer forensics. Therefore, cell phone forensic tools are a relatively recent development and in the early stages of maturity. Acquisition of data contained on mobile devices is effected by numerous

variables such as the type of device being acquired (i.e., low-end versus high-end) and the techniques used during seizure, transit, acquisition, and storage throughout the life-cycle of the investigation or incident.

The goal of this paper is to provide a brief overview of variables and situations to consider when acquiring a mobile device and associated media. Accurate acquisition techniques and methodologies must be adhered to, yielding optimum results. Moreover, continuous education of executing proper forensic techniques and possessing a profound understanding of the examined mobile device and associated application is paramount when handling digital evidence tied to an incident or criminal investigation.

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3 Jansen, W. Ayers, R. 2006, Forensic Software Tools for Cell Phone Subscriber Identity Modules, Conference on Digital Forensics, Association of Digital Forensics, Security, and Law (ADFSL), <URL: http://csrc.nist.gov/mobilesecurity/Publications/JDFSL-proceedings2006-fin.pdf.

Mobile Device Forensics, Cellular Forensics, Digital Forensic Tools

D39 Smart Unpacking Research: Using Mathematics to Unpack More

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After attending this presentation, attendees will learn new methods, developed by author, to elicit as well as validate structure and content using mathematically-based techniques. Attendees will not only learn the details of the methods, but also their development and use to date for accomplishing the objectives of the NSRL – to provide more file-identifying information and to validate the accuracy and completeness with which that information has been extracted.

This presentation will impact the forensic community by introducing new methods for analyzing and thinking about the issues of content analysis, data extraction, and measurement of these operations.

This work presupposes that digital content can be characterized and classified according to mathematical properties and structures. How this can form the basis for new kinds of analyses as well as a foundation for validation and measurement of the structures discovered will be discussed.

The idea of unpacking content from within another structure is a very general notion. It encapsulates a large portion of the activity in computer forensics to date.

The National Software Reference Library (NSRL) Project was formed to reduce the workload of investigators as they sought to separate what files constituted evidence of user activities and what files did not. The NSRL provides databases of file-identifying information (FII) for the purposes of reducing the number files that must be investigated, among other things. A large portion of the work involved in providing this data is performed by unpackers – tools and methods utilized to extract embedded files from compound files such as archives, compressed files, and so forth. Extracting such files increases the amount of file-specific information that may be provided.

The rate of appearance of new compound structures often exceeds that of corresponding unpacking methods. This is largely due to the fact that most unpacking is performed by pre-written tools that understand these structures and can extract their contents for processing. This problem also reflects a more general problem in forensics: accurate comprehension and/or extraction of embedded content in a timely manner. This problem is often addressed in a largely manual, time-consuming manner by those who create unpackers. In addition to the time lag introduced by these methods, there are few, if any, methods for validating the accuracy or completeness of their unpacking functions. Thus, users are often left to settle for whatever is provided to them.

Smart unpacking research was born to address these issues in a new way. The problems are addressed mathematically by identifying and locating the invariant meta-patterns of digital content. This allows the characterization and extraction of embedded content without necessarily requiring pre-written unpackers. These methods are also utilized to form measurements as to the completeness and accuracy of a given unpacking method for a given compound file or meta-structure.

This research, although new, has yielded some very promising results that suggest not only the soundness of the concept but perhaps a new approach to these problems in general. This talk presents the findings to date and demonstrates their use in practice.

Mathematical Content Analysis, Data Measurement, Content Validation

D40 Computer Forensic Tool Quirks Uncovered During Testing

James R. Lyle, PhD, National Institute of Standards and Technology, 100 Bureau Drive, Mail Stop 8970, Gaithersburg, MD 20899*

After attending the presentation, attendees will be made aware of several unexpected behaviors exhibited by computer forensic tools used in the acquisition of digital evidence. The practitioner can then either avoid the conditions that generate the behavior or take steps to mitigate the results.

The presentation will impact the forensic community by increasing awareness in the community of some tool behaviors that are unexpected and may have implications for examination of digital data and presentation of results.

The Computer Forensics Tool Testing (CFTT) project at the National Institute of Standards and Technology develops methodologies for testing computer forensic tools. The authors have applied the developed test methodologies to several tools in the areas of disk imaging and write blocking.

Disk imaging involves acquiring an image of either a physical hard drive or a disk partition, also called a logical drive. A disk imaging tool functions by reading each sector from the drive to be examined and creating either an image file or a clone of the original on a similar device. An image file contains all information to exactly reconstitute the original hard drive. While an image file may be stored as a bit for bit copy of the original, it is usually compressed in some way to save space. During testing of disk imaging tools it was observed that under the correct conditions for some tools the following behaviors:

- a tool incorrectly determines the size of a hard drive to be acquired,
- the last sector of a hard drive is not acquired,
- the last sector of a partition (logical drive) is not acquired,
- a few sectors near the end of an NTFS partition are acquired incorrectly,
- hidden areas of a hard drive are not acquired,
- a tool tries alternate read instructions if a faulty sector is encountered,
- readable sectors adjacent to a faulty sector are not acquired, and
- a restored hard drive is not identical to the original acquisition.

Write Blocking is used to protect original digital data from modification during acquisition or preliminary inspection to determination relevance to an investigation. A write blocking tool functions by inserting itself between the data to protect and the application accessing the data.

Any operations that might change the data are intercepted and blocked. Write blocking can be implemented either in hardware or software. While there are advantages and disadvantages to both, hardware write blocking devices are more widely used. Usually access to digital data from a storage device is by a command set that implements some access protocol. Typical examples are BIOS commands, ATA commands and SCSI commands. These command sets usually implement several read and several write commands. During testing of write block software and hardware we have observed the following:

- blockers are designed in one of two ways: either (1) to block any write commands and allow any other commands, or (2) allow any read commands and block anything else, access protocols change over time and new commands are introduced, and some blockers may allow acquisition of protected data but, an operating system may not be able to mount a file system from a protected drive and hence a preliminary examination may not be possible.

Digital, Software, Testing

D41 Behind Armor Blunt Trauma Injuries in Law Enforcement From Ballistic Impact: Body Armor Assessment

Sarah E. Stojsih, BS, and Cynthia Bir, PhD, Wayne State University, 818 West Hancock, Detroit, MI 48201*

During this presentation, attendees will gain knowledge of the different types of injuries caused by ballistic impacts to the armor-protected regions, the injury mechanics, and the effects to end users. The types of injuries that occurred, the extent of the injury, and the lasting effects will be discussed for key cases.

The data that is yielded by this research project will help the forensic science community by better protecting the law enforcement officers that protect the citizens. This research will provide valuable insights that will ultimately drive new standards of officer care, provide recommendation for changes to the current certification standard, allow for validation of current research models and improve the collection and analysis of vests that have protected officers from a ballistic impact.

Over 3,000 police officers have been saved due to utilization of a bullet proof vest.[1] The International Association of Chiefs of Police (IACP) and DuPont have joined together to capture these cases in one database. The IACP/DuPont Survivors' Club database provides a means for examining this group of case studies using specific criterion such as threat and region of impact. The goal of the current research effort is to assess the types of injuries caused by ballistic impacts to the armor-protected regions as well as the potential mechanisms of injury.

Prior to commencement of the study, approval was garnered from the Wayne State University Human Investigation Committee. Permission to access this database was granted for this project by IACP, DuPont, and "third parties for the purpose and enhancement of law enforcement officer safety." The information regarding each injury was acquired from three different sources. First, consenting members of the Survivors' Club were asked to complete a questionnaire via a telephone interview, which was adapted from the current version of the Survivors' Club application. Second, the participants were asked to release medical records related to the injury including records from both the initial emergency room visit and follow-up medical treatment. Finally, the police records for each of the participants' cases were requested to enhance the information obtained through the phone interview and medical records.

A total of 453 letters were mailed to those identified in the IACP/DuPont Survivors' Club database fitting the criteria. A second letter was sent in December 2006 to remind officers about the study. A total of 56 officers agreed to participate. Medical records were procured from 36 of the survivors and follow up interviews were conducted with 29 of the survivors. Of the 56 cases, 29 of them exhibited remarkable examples of the behind armor blunt trauma (BABT). BABT occurs when a high velocity low mass projectile, such as a bullet, strikes the body armor and causes an injury. Minor injuries that coincide with a BABT include superficial or severe bruising, abrasions, and some superficial lacerations. According to the Abbreviated Injury Scale (AIS) 2005, 10 of the cases were considered AIS 410402.1, which indicates that these cases were mild contusions to the thorax region. Three of the cases were considered a combination of both AIS 410402.1 and AIS 410602.1 with both mild contusion and laceration to the thorax region. Two cases were considered AIS 510402.1 denoting mild abdominal contusions.

A few notable cases present with more serious injuries from BABT. The first case involved severe bruising with approximately one inch in diameter of skin necrosis in the thorax region. This is uncommon and more research is needed to determine the exact cause of the injury. A second case involved an injury that is becoming more common due to the increase flexibility of newly developed armor. This injury has been referred to as a backface signature injury or "penciling" and involved a one inch open wound in the abdomen. Two of the cases involved rib fractures due to the blunt force trauma. The final notable case involved a bullet hitting within 1/16 of an inch from the edge of the vest and penetrating the vest. These select cases will be presented in detail.

The data that is yielded by this research project will help humanity by better protecting the law enforcement officers that protect the citizens. This research will provide valuable insights that will ultimately drive new standards of officer care, provide recommendation for changes to the current certification standard, allow for validation of current research models and improve the collection and analysis of vests that have protected officers from a ballistic impact.

Reference:

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Behind Armor, Backface Signature, Wound Ballistics

D42 The Importance of Forensic Photography in Domestic and International Forensic Operation

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After attending this presentation, attendees will have an increased understanding of the important role of forensic photography in domestic and international forensic operations.

Detailed photographic documentation is part of any forensic work. Specialists from many different fields often rely heavily on photographs to illustrate their work processes and results. Photos are acknowledged to be a very powerful tool in presenting forensic evidence to a non-scientific audience of law professionals and jury members in court. Despite the almost universally recognized and accepted importance of photography in forensic investigation, the photos are most often taken by insufficiently trained law enforcement personnel or by the forensic scientists themselves.

The reason for that is the common but misguided belief that anyone can take good photographs. A belief that has been recently been strengthened be the arrival of digital and therefore instantly reviewable photography. This has lead to far more images being taken but certainly had no positive effect on quality levels.

It is true that most people can take photographs and most of those will be acceptable. But to take good photographs, which can illustrate and accurately document evidence and processes, proper, standardized training

and experience is necessary. In this, forensic photography is no different to any other profession. To acknowledge that forensic photography with its often challenging light and environmental conditions is a specialized field that needs equally specialized and appropriate training, is the first step in the right direction.

This presentation will show several different aspects to and roles of photography in forensic operations. It emphasizes the benefits the judicial system can experience if photography is not just limited to simple evidence documentation and how a more comprehensive approach to forensic photography can strongly support other forms of documentation and therefore strengthen the legal process. The presentation will highlight a few key principles of forensic photography and how proper standards can be achieved.

Through a number of examples, the presentation will show how beneficial photography can be to prosecutors' offices and the courts, as well as demonstrating how insufficient photography can leave the expert witness in the difficult position of not being able to demonstrate their work and results to its optimal potential. Every forensic practitioner must be aware that a photograph not taken or taken badly is a missed opportunity, which can very rarely be rectified. Many forensic processes happen only once and can not be repeated.

It will also be demonstrated how non-forensic, humanitarian missions can enjoy the same benefits from high quality photography.

Although the importance of good photographic evidence is obvious, operations with limited budgets may be reluctant to commit to employ a full time photographer. This difficult and understandable position many teams find themselves in will be addressed and possible solutions presented.

Forensic Photography, Evidential Photography, Methodological Documentation

D43 Impact of Forensic Evidence on Solvability in Child Abduction Murder Investigations

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The goal of this presentation is to assist police investigators more timely and efficiently identify forensic evidence which will contribute to the solution of child abduction murder cases.

This presentation will impact the forensic science community by improving the efficiency and effectiveness of the investigation process in child abduction murder cases.

There is a paucity of research which addresses the role forensic evidence plays in murder investigations of abducted children. Only two researchers, Hanfland et al. (1997) and Brown (2005) present descriptive statistics about the types of forensic evidence found in murder investigations of abducted children. Unlike murders in general, in which weapons are collected as evidence in almost 40% of cases, weapons are collected as evidence in only 17 to 20% of child abduction murder investigations (Hanfland et al., 1997; Brown, 2005). The most common evidence collected in these types of investigations is hair (26.1%) followed by weapons (20.0%) (Brown, 2005). Brown (2005) found that finger and shoe prints (18.0%), semen (17.2%), fibers (15.9%) and blood (14.3%) were found in investigations in substantially the same percentages as Hanfland et al (1997).

In addition to evidence that was left behind by the offender at the crime scene, Brown (2005) examined whether or not the offender deliberately discarded evidence after the murder. Discarded evidence was found by police in 24.2% of child abduction murders (Brown, 2005). This was a slight increase from 21% in a previous study (Hanfland et al., 1997). Of that discarded evidence, 36.0% was found along the roadway on which the killer traveled in the course of the murder, body disposal, and escape (Brown, 2005). This is a decrease from the 50% previously found in the Hanfland et al. (1997) study. Brown (2005) found that evidence was found along the roadway within one-mile of the Body Recovery Site in 56.5% of cases. This statistic was slightly less than the 59% reported by Hanfland et al. (1997). This statistic has important investigative implications for child abduction murder investigations because an investigator is likely to find evidence discarded by the offender within a one-mile radius of the body recovery location (Hanfland et al, 1997; Brown, 2005).

These studies provide valuable information to police investigators on the probability of certain types of evidence to be recovered at the murder incident component locations. However, to date, no researcher has addressed the impact of forensic evidence on case solvability in murder investigations of abducted children. This is surprising considering the increasing impact of forensic evidence in the solvability, clearance and conviction of offenders. This presentation will address the impact of physical evidence left by an offender on case solvability in murder investigations of abducted children. In particular, the impact of hair, weapons, finger, foot or shoe prints, semen, fibers, firearms, bite marks, tire tracks, trace evidence, blood and fluids evidence will be examined.

Forensic Evidence, Child Abduction Murder, Solvability

D44 DNA Typing From the Recovery of Latent Body Print Residue From Visual Substrates

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This presentation is focused on the ability to recover DNA from smears and unknown body prints at crime scenes which have been deposited onto various substrates commonly located within crime scenes.

This presentation will impact the forensic community by reporting results of research conducted by Army and Air Force Special Agents, with a Fellowship at the Office of the Armed Force Medical Examiner, and through the assistance of the Armed Forces DNA Identification Laboratory (AFDIL). Significant full and mix sample loci were recovered from various samples made to replicate objects normally located within a crime scene, after a "subject's" face and/or forearm came in contact with various substrates after a simulated struggle.

The process of identifying persons responsible for the commission of crimes relies upon the detection and recognition of individualizing characteristics that can only be attributed to one suspect. The two most common methods of definitively identifying criminals from evidence recovered at crime scenes are fingerprint and DNA identification.

Advances in DNA analysis have allowed for the detection of trace DNA within fingerprints found at crime scenes, though the chances of recovering a complete DNA profile do not yet justify the destruction of a usable fingerprint. There are, however, numerous latent prints deposited by areas of the body, beyond the fingertips, that are left at the scenes of many violent crimes. In fact, non-fingerprint latent body prints constitute approximately 35% of the latent impressions left at the scene. To date, these items of evidence have been a relatively untapped resource, as there has been insufficient interest and study of these prints in the United States.

A common complaint about using non-finger body prints for identification is a lack of standards that denote what constitutes identification, and a lack of body print databases to house reference samples. Further, the origin of various body prints and smears made by skin surfaces, other than fingerprint and footprint, may not be recognizable as originating from a specific part of the body. But the DNA is there.

With advances in trace DNA analysis there is now a use for non-finger body prints and smears recovered from crime scenes. Because the impressions deposited by various body surfaces are comprised of the same contaminates from which DNA has been extracted from fingerprints, namely sweat and sebum, there exists a realistic probability that swabs of latent body prints will yield a sufficient amount of DNA-containing epithelial cells to allow for the generation of a suspect DNA profile.

Methods and results of research conducted will be presented with the Armed Forces DNA Identification Laboratory to share and stress to the forensic community the need to collect unidentifiable latent body smears or prints identified at crime scenes for comparison to suspect DNA samples.

Prints, DNA, Residue

D45 Detection of Air Gun Pellet Wipe Using Digital Infrared Photography

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After attending this presentation, attendees will understand: (1) a procedure for recording digital infrared images of air gun pellet wipe patterns on dark and multi-colored fabric, and (2) the advantages and disadvantages of using digital infrared photography to enhance pellet wipe images.

This presentation will impact the forensic community and/or humanity by discussing the detection of pellet wipe on dark colored fabrics using digital infrared photography in a way that will enlighten those who investigate crimes involving the discharge of air guns.

The purpose of this presentation is to present the results of a study for recording digital infrared images of air gun pellet wipe patterns on dark and multicolored fabrics. When lead or lead alloyed air gun pellets perforate fabric, they produce a discolored area around the pellet hole margin. The discoloration is similar to bullet wipe; however; pellet wipe does not contain any cartridge components such as propellant residue, prima residue, soot, or bullet lubricant compounds. Pellet wipe produced from air guns discolors fabric with residue from traces of the pellet and oil residue from the pellet gun barrel. With an estimated 3.2 million air guns purchased annually in the United States, the media reports an increasing number of incidents involving air guns. Approximately 50% of these air guns have a muzzle velocity between 500 and 930 fps. Air guns with these muzzle velocities in this range have the potential to cause tissue damage and in some cases serious injuries or death. Understanding pellet wipe patterns can assist investigators in analyzing and reconstructing events in accidental or intentional pellet gun discharges. Investigators can evaluate the pellet wipe pattern to determine if the pattern is consistent with other physical crime scene evidence and statements from witnesses.

A study was conducted to evaluate the consistency of pellet wipe patterns when pellets are fired perpendicular into fabric targets at a known distance. A Winchester model 600X air rifle was used to conduct the test on twenty-five fabric samples. The Winchester air rifle is a spring piston type air rifle with an overall length of 105 cm (41.5 in), barrel length 45 cm (17.7 in), and weight 2.7 kg (5.9 lbs). The air rifle manual reports the muzzle velocity at 600 fps with 6.2 ft lbs of muzzle energy. A chronograph was used to test the muzzle velocity based on 10 shots. The average velocity was 600 feet per second. The range of velocity was 595 to 605 feet per second. Ten fabric samples were 100% cotton fabric, nine were 100% polyester, and six were 70% wool and 30% nylon blend.

Pellets used in the study were .177 (4.5 mm) caliber Benjamin Sheridan domed diabolo styled lead pellets. The average pellet weight was 7.8 grains based on a sample of 20 pellets. The pellet weights ranged from 7.5 grains to 8.0 grains. Square cardboard targets approximately 11.43 cm by 11.43 cm (4.5 in x 4.5 in) in size and .64 cm (.25 in) thick were prepared and covered with fabric. The pellets were fired into the samples at a distance of 1.52 m (5 ft). One target covered in white fabric was used as a standard for detecting a visible pellet wipe pattern. Digital infrared images were photographed with a 35 mm Nikon D-70 camera with an 18-70 mm f 3.5 – 4.5 G ED-IF AF – S DX Nikkor lens and a 67 mm #87 infrared Tiffen filter. The lens to object distance was 22.86 cm (9 in). The average exposure time was 8 seconds. Pellet wipe was visible in 22 (88%) of the twenty-five fabric samples. Of the 100% cotton samples, pellet wipe was visible in 7 out of 10 samples, and in the 100% polyester samples, pellet wipe was visible in 9 out of 10 samples. Pellet wipe was visible in all of the samples of the blends of 70% wool and 30% nylon. Recording a digital infrared image is an effective method to enhance pellet wipe patterns on dark and multi-colored fabrics. It does not alter the pellet wipe pattern and results are obtained right away. When infrared images fail to produce pellet wipe patterns, sodium rhodizonate, a chemically specific test for lead, can be used to test the margin for lead or lead alloyed particles around the pellet holes.

Pellet Wipe, Digital Infrared Image, Air Gun

D46 The Use of Liquid Latex to Remove Soot From Arson Scenes to Facilitate Further Forensic Examinations - A Case Study

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After attending this presentation attendees, particularly arson and major crime scene investigators will learn of the development, implementation, and use of a method to remove soot from arson scenes and exhibits. Removal of soot from such scenes and exhibits allows further examination to locate, enhance and recover fingerprints and the location of bloodstaining.

This presentation will impact the forensic community and/or humanity by providing a easy, fast, reliable, and cheap method to remove soot from arson scenes and exhibits to facilitate further forensic examinations, particularly the examination for fingerprint evidence and the recovery of DNA based evidence types. The effective removal of soot from arson scenes has been an on going problem to the forensic community, and the development of this technique has removed up to 90% of soot from surfaces within arson scenes and exhibits recovered from arson scenes.

In June 2005, a murder inquiry was commenced by the Metropolitan Police Service, Specialist Crime Directorate (SCD) following the discovery of the dismembered remains of a human body, floating in a canal in northwest London. Over 120 pieces of flesh were recovered from black plastic bin bags which were also found floating in the canal. The upper half of the deceased's torso was found in a shopping trolley type bag, wrapped in black plastic bin bags that had been tied with bicycle gear/break cables to a set of gymnasium weights. Approximately one week after the location of the body parts, the head of the deceased male was also found in the canal in a black plastic bin bag. The lower half of the deceased torso, arms, and legs were never located.

Investigations by detectives of the SCD led the investigative team to a 5th floor flat in a housing estate, near to the canal where the body parts were located. The flat had been the subject of an arson attack approximately two days prior to the location of the body parts. The flat was identified as being rented by a male, who was later arrested and considered a suspect in connection with this offence. The suspect made statements to the investigating police officers, stating that this flat was often used by persons known and unknown to him and that one of these people must have been responsible for any criminal activity that may have taken place in the flat.

The flat was examined and four seats of fire were determined. Blood was spattered on the living room doors and doorways, on a hallway cabinet and bloodstaining was also present on surfaces within the bathroom. Due to the statements made by the suspect, it was necessary to examine the crime scene for the presence of fingerprints.

Preliminary examinations for fingerprints on suitable surfaces were unsuccessful due to the levels of soot present which affected the location and identification of fingerprints. The soot also interfered with light source examinations due to the contamination of the surface.

A solution of liquid latex was applied to surfaces within a homicide scene to remove soot from surfaces to allow further fingerprint examinations. Once applied, the latex was allowed to dry and when peeled from the surfaces up to 90% of soot was removed. Numerous fingerprints were located within the address, some of which were identified to the suspect, the victim and to persons of interest in this case. Further chemical enhancement of fingerprints could also be undertaken and, in addition, further bloodstain pattern examinations could be undertaken.

The development of this technique has now been adopted within the Metropolitan Police Service to examine arson homicide scenes and also items recovered from arson scenes. Items submitted to the laboratory can be treated with liquid latex to remove soot and further fingerprint and DNA recovery examinations can be undertaken. Liquid latex does not affect subsequent light source and chemical enhancement techniques, nor does it affect DNA analysis. This is a cheap, fast, and very effective method for soot removal and in the author's opinion is an easier soot removal technique than the use of sodium hydroxide solutions.

This presentation will explain the use, application and effectiveness of this technique as used on criminal casework within the Metropolitan Police Service.

Soot, Liquid Latex, Fingerprint

D47 The Probabilities Associated With the Matching of Impression Evidence

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The goal of this presentation is to provide a method to evaluate the statistical probability associated with an impression evidence match.

This presentation will impact the forensic science community by demonstrating a new approach to impression evidence matching.

The unique correspondence between two impression marks is something one hears about all the time but the reasoning behind this assertion is conspicuously absent in the literature and would seem to be problem that is worth paying some attention to. Although the matching of impression evidence modified by irregular wear patterns or defects is certainly indicative of a unique history in the broad sense it doesn't automatically follow that what remains as evidence can be treated in the same way. The elimination of general features or class characteristics as a justification for unique correspondence is certainly a good first step and certainly the greater the number of matching features the more unlikely is the correspondence is due to chance however one is on dangerous ground if it is simply left as that. A good example of random marks is scratches and these can be overlaid onto a suspect pattern to reveal a match. The probabilities for this kind of pattern matching can be calculated based upon the detail that most people can resolve and so limits the possibilities of coincidence. This is equivalent to partitioning the scratches into component lines about 0.5 mm wide, which is the separation at which most people can distinguish line pairs and so when one is evaluating an array of scratches across a width *w,* either by eye or through a microscope*,* then the probability that we will find a particular line at a specific location in the array is $P = \frac{r}{w}$. For an array in a half inch wide space for example the chances of finding a line at a particular place is $P = \frac{r}{w} = \frac{0.05}{1.27} = 0.039$ meaning that in this case where there are 25 discernable line positions (*w/r*) on the pattern and any particular line that happens to be involved in a match to any other will be found in one of these locations.

The number of different ways that a sequence of *n* lines can be distributed over the *w/r* locations is given by $\varpi_n = \frac{w/r!}{n!(w/r - n)!}$ since the number of ways that N objects can be arranged in j subsets is $\varpi = \frac{N!}{n_1!n_2!n_3!...n_j!}$ where $N = \sum_{i=1}^{i=j} n_i$ and for the case of 15 matching lines out of a pattern of 20, for example, when there are 25 discernable line positions $\varpi = \frac{25!}{15!10!} = 3,268,760$ that is to say there are over three million different ways to construct sets of 15 lines and the probability of finding any specific one of them is one in 3.3 million which seems pretty convincing. That is of course until one realizes that there are actually going to be 15,504 patterns of 15 lines on the subject evidence which reduces this probability to 1 in 210. The presence of 15 lines amongst 25 is another matter however if they happen to form an uninterrupted sequence because the probability for this occurrence is

$$P_c = \left(\frac{n!(w/r - n)!}{(w/r)!}\right)^2 \left(\frac{(w/r)!}{n!(w/r - n)!} - \frac{N_1!}{n!(N_1 - n)!} + (N_1 - n + 1)\right)(N_2 - n + 1)$$

or 1 in half a million which is certainly less likely but still hardly unique. Had the pattern of scratches been spread over a 1 inch span rather than half an inch however the patterns would have been unique.

Probability, Evidence, Toolmarks

D48 The Quantification and Time Effects of Bruises Created Using a Drop Mass System

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The goal of this presentation is to educate attendees on the effects that mass and impact velocity have on the duration and color of bruises created on the forearms of volunteers.

The impact of this research to the forensic community lies in its ability to build a scientific basis for a bruise classification and a better understanding of bruising biomechanics. These findings will assist emergency room physicians in determining cases of possible physical abuse.

Existing literature contains conflicting information regarding the color changes in bruises with respect to time. There is general agreement that the first colors seen are usually deeper reds, black and blue. Yellow is generally not seen for the first 18-24 hours, but after that, any color may be present. It follows that deeper tissue bruises will remain darker, longer. It is hypothesized that a lighter, faster impactor will create a bruise that will begin to resolve more quickly and the colors will be lighter.

The relationship between mass, velocity and bruise characteristics has not been explored in any published literature. Specifically of interest is the affect that impact velocity has on bruise area and bruise color when the impact is controlled for constant impact energy. It is hypothesized that a faster lighter impactor will create a bruise with a larger surface area than a slower heavier impactor.

Preliminary data was collected using a drop mass system. Seven healthy adult volunteers age 23.3 +/- 3.2 years completed an initial questionnaire to screen for bleeding disorders and blood thinning medications. Informed consent was garnered and each subject had both forearms photographed (Canon EOS Digital Rebel XT, Lake Success, NY.). Prior to impact, tri-stimulus light reflectance was also measured using a commercially available colorimeter (model CR-400, Konica Minolta, Mahwah, NJ.) Tri-stimulus light reflectance was reported using the three dimensional CIE 1976 (L*, a*, b*) color space, where L* represents

luminance (0 = black, 100 = white), a* represents the shift from magenta to green (green is indicated with negative values, red with positive values) and b* represents the shift from yellow to blue (blue is indicated with negative values, yellow with positive values).

The drop mass system was designed to deliver a constant 19.6 Joules of energy by dropping a steel mass down a PVC tube onto an impactor resting on the forearm of the subject. Two conditions were tested: low velocity, high mass and high velocity, and low mass. The low velocity, high mass consisted of a 2 kg mass being dropped from 1 meter resulting in a velocity of 4.4 m/s. The high velocity, low mass consisted of a 1 kg mass being dropped from a 2 meter height resulting in a velocity of 6.3 m/s. A load cell (model SPL 7187, Syscon Instruments Private Ltd., Bangalor, India) was placed under the volunteers' forearms to measure the amount of force transmitted through the forearm. Load data was collected at 10000 HZ using TDAS (Diversified Technical Systems, Seal Beach, Ca.) and displacement of the impactor was measured using high speed video at 1000 frames per second (model HG 100K, Redlake Inc., Tucson, AZ).

Volunteers were subjected to both impacts, one to each arm, based on randomization. Photographs were taken and light reflectance was measured immediately following the impacts and then every 24 hours for 96 hours. Each day, all three values of the tri-stimulus were recorded for both arms and compared to the pre-test values. Observation showed the forearms were visibly more red immediately following low velocity impact and this was confirmed by higher a* values for the low velocity impact between the pre-test and immediate post-test scans. Values at 72 and 96 hours for the a* values were significantly lower or more green (9.68 +/- 1.24, and 8.82 +/- 1.59 respectively) than the pre-test values (10.08 +/- 1.36) for the same arms ($p<0.05$). The initial increase in red comes from the inflammation response with the increase in green due to the metabolism of bilirubin, a metabolite of hemoglobin which is found when blood cells are lysed.

Table1 – a* values measured every 24 hours

Test Condition	Pre-test	0 hours	24 hours
Low Velocity	10.08 +/- 1.36	11.02+/-1.05	10.04 +/-1.25
High Velocity	9.61+/-1.49	10.42+/-0.87	9.52+/-1.35
Test Condition	48 hours	72 hours	96 hours
Low Velocity	9.85+/-1.28	9.68+/-1.24†	8.82+/-1.59†
High Velocity	9.61+/-1.14	9.33+/-1.57	9.01+/-1.15

† Statistically significant compared to pre-test values ($p<0.05$)

Bruising, Contusion, Impact Velocity

D49 The Ball's in Your Court: Castration as a Form of Extreme Body Modification in America

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The goal of this presentation is to introduce the forensic community to the world of extreme body modification (EBM), specifically castration, through several case studies.

The presentation will impact the forensic community by providing awareness that an illegal castration attempt may be the possible cause of a patient reporting to medical personnel with bleeding in the groin region.

Every forensic scientist should have at least one out of the ordinary, memorable case. In February 1999, such a case was brought into the Indiana State Police Crime Laboratory serology section in Fort Wayne, IN. This case introduced the unusual world of extreme body modification (EBM). The case involved a man, Edward Bodkin, who was arrested for castrating numerous men in Huntington, Indiana. Bodkin was brought to the attention of police by an ex-roommate, who reported that Edward was performing the castrations on willing men in the kitchen of his apartment. A search of Edward's home yielded 9 glass jars containing what appeared to be human tissue found next to his refrigerator. Knives, other instruments and video tapes of the procedures were also collected. Forensic examination later confirmed that the jars did in fact contain human testicles. A trial was averted when Edward Bodkin admitted to "surgical procedures" – practicing medicine without a license.

This case seemed to be an isolated incident until a case in Michigan made the news several years later. In August 2002, a 29-year-old man was arrested for performing a castration on a 48-year-old "willing victim." A pair of severed testicles was found in a plastic storage container in the suspect's refrigerator. The similarities with the Bodkin case made it appear that this procedure was more common than originally thought. One year later, another castration case came to light in Pennsylvania. Since that time, illegal castrations continue to make the news. While none of the participants in these procedures have died, there has been excessive bleeding and injury.

Cursory knowledge of this EBM subculture will enable forensic experts to be more aware of it when it crosses their area of expertise. For example, unusual injuries on a victim may not be the result of attack, but may in fact be a voluntary modification.

A search on the internet has found an entire network of people who alter their bodies for many different reasons. From the simple tattoos and piercings to the removal of body parts, the world of EBM can present itself in many forms. Who are the willing participants in the castration procedure? What makes them want to remove that particular body part? Why would someone risk imprisonment to perform this medical procedure in their kitchen? Why would someone video tape the "surgery?" This paper will discuss these issues as well as delve into the strange world of EBM on the Internet.

Castration, Extreme Body Modification, Internet

D50 Mass Graves as a Waste Disposal Solution?

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After attending this presentation, attendees will understand the nature of the dilemma faced by the UK Government regarding the preparation for and anticipation of a national influenza pandemic. Such a scenario could create "excess deaths" that would exceed the capabilities of existing burial, cremation, and funeral facilities. The use of mass graves in different contexts will be examined, with special reference to their value as a modern "waste" disposal solution. They will be compared to animal burial sites used for control of the spread of disease as an analogue for human "collective" burials in a pandemic situation. Participants will be able to understand the impact of such graves on the environment, in terms of landscape issues, alteration of vegetation, and any chemical and biological interactions between the infill and the surroundings. In addition, they will be able to recognize the social and economic effects of such graves on the local and wider communities.

This research brings together three significant and timely themes increasingly relevant in the UK today. Mass fatality incidents and environmental issues are at the forefront of the Government's agenda. This presentation will impact the forensic science community by addressing the potential impact of mass graves on the environment, and is unique in its approach from the joint perspectives of forensic and environmental science. This research examines the options open to the United Kingdom government if it is faced with "excess deaths" caused by a national pandemic, and evaluates the most effective disposal methods available. It takes into consideration the effect that such collective burials may have on the environment, economy and social framework of communities. It will

demonstrate how the Government is being pro-active in addressing environmental issues, and how well the United Kingdom's unique spatial and geographical circumstances are being tackled. It is hoped that the results of this research could inform and influence Home Office policy on the most environmentally, socially and economically efficient method of mass body disposal.

In light of the increasing threat of an avian flu pandemic in the UK, the Home Office have been investigating a range of methods for managing the potential problem of excess deaths that could exceed the capabilities of existing burial and funeral facilities.[1,2] There is currently unprecedented pressure on the Government to find an environmentally, ethically, socially and economically sound solution to the problem of disposal of bodies.

This paper aims to examine the nature of the problem faced by the government, and assess the value of mass graves as a modern 'waste' disposal solution. This study will investigate the possible alternatives to mass graves, such as cremation and individual burials, in response to pandemic situations. It will also evaluate and compare mass graves to landfill sites and the mass animal burial sites typified by the Foot and Mouth Crisis of 2001-02, with reference to minimizing the impact on the environment. This research will lead the way for further development of a twenty-first century 'waste' disposal solution model for the United Kingdom's specific geographical and spatial dilemma; as well as demonstrating the government's commitment to finding solutions whilst incorporating environmental 'best practice' as a key driver.

References:

1 Stones, A (2006) 'Mass Graves Planned if Bird Flu Pandemic Reaches Britain', www.telegraph.co.uk.

2 Cabinet Office (2006) 'Contingency Planning for A Possible Influenza Pandemic: Version 2', www.preparingforemergencies.gov.uk/emergency/.

Mass Graves, Waste Disposal, Environment

D51 A Better Mouse Trap: A New Technique for the Collection, Preservation, and Examination of Trace Evidence

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Upon completion of this workshop, participants will learn a new method of finding, collecting, preserving, and examining trace evidence using an inexpensive gripping material that is readily available in any local supermarket. Participants will further discover that the use of this gripping material for trace evidence recovery include easy examination options without having to disturb collected evidence; superior gripping ability and ease in handling lifts that include better resiliency and contort-ability; greater collection of materials that may often go undetected; and easy storage of the lifts and little or no damage to the evidence itself.

This new trace evidence collection technique will reduce many of the obstacles faced by investigators in the intricate task of collecting and examining trace evidence. Therefore this presentation will have a substantial impact on both the forensic science community and on jurisprudence as it allows crime scene investigators not only a better way to collect evidence, but it also permits better preservation and examination of the evidence without necessarily having to remove, damage or alter evidence from the collected surface. This in turn will increase the validity, understanding and use of trace evidence presented at trials. Evidence that can be preserved may then be made available for defense experts to examine and for juries to personally view during pertinent testimony. Also, preserved trace evidence lifts that can remain intact on a collected surface and still examined under a microscope and/or by using common digital computer software such as Adobe Photoshop® will permit more sensitive and through examination of recovered trace evidence and provide a time-saving tool for backlogged laboratory examiners.

Trace evidence often consists of very small quantities and/or may be very small in physical size and may be easily overlooked for a number of reasons, including human error, distractions and/or adverse conditions at the crime scene, one or all of which may lead to leaving behind extremely valuable crime scene evidence. This may be particularly true in cases where investigators cannot remain at the scene as long as necessary to complete a thorough search for evidence if for example there are structural or chemical hazards, inclement weather or where there is on-going violence. The already difficult task of finding trace evidence may also be hindered when investigators are processing crime scenes that have dark colored floors, plush carpeting or patterned areas with very busy backgrounds, surfaces that make evidence recovery much harder, particularly on the human eye. This technique not only permits recovery of trace evidence on surfaces such as tiles, carpets, rugs and floors, but it also permits successful recovery on such odd, uneven, textured or irregularly contoured surfaces as loose dirt, stuffed animals, soles of shoes. It may even be employed to successfully remove evidence from paper without tearing it. The technique is nearly identical to that which is used to tape lift fingerprints. Thus, a well trained and experienced investigator does not need to undergo additional training to use this technique, or the material, at crime scenes; it is more a matter of practice.

Trace, Collection, Evidence

D52 Photographic Differences Between the Colposcope and SLR Digital Camera With a RAW File

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The goals of this presentation are to list several qualities of a good picture, define and visualize depth of field between a colposcope and a digital camera SLR, and visualize the difference between similar pictures and resolution of the pictures.

The presentation will impact the forensic science community by demonstrating how forensic photography for the sexual assault examiner includes body pictures as well as pictures of the genital area looking for injury, no injury or evidence of pre-existing medical conditions.

Forensic photography for the sexual assault examiner includes body pictures as well as pictures of the genital area looking for injury, no injury or evidence of pre-existing medical conditions.

In the past, one of the tools that the sexual assault examiner has used has been the colposcope. Today the trend is moving toward digital photography. Common facts about digital picture quality that most people will agree on are that the picture:

- be in focus
- not to light or too dark
- aligned and not twisted
- represent the subject matter
- not be compressed too much
- has enough image resolution

3D can be defined as giving the illusion of depth. "Depth of Field" in a picture is the distance range in front of and behind the center spot in the picture. As an example, if close up picture displays the center area "in focus" and the outer areas out of focus, the picture has a limited depth of field.

Magnification plays a major role in determining the size of this depth of field range. Generally, the higher the magnification, the lower the depth of field. Using a colposcope, the ocular lens must be adjusted in order to see clearly the separate areas of focus.

This presentation will compare the depth of field, clarity, and all the picture facts for quality of a good photo between a picture taken using a colposcope and a digital camera. Several images similar in subject matter will be displayed for visualization of the difference in resolution and quality of picture. The participant will be able to observe and compare these different technologies and apply the information to their own sexual assault practice.

Many concerns about using digital pictures in court room are often expressed as well, not only by health care professionals but district attorneys. Additionally, the court of law may not be comfortable with secure digital imaging or have concerns that the pictures were not altered or changed.

Digital x-rays, digital sonograms and digital ultrasounds are used every day to make life and death medical decisions in every part of the country and it has been that way for years. These "digital pictures" have been used as legal evidence in medical suits and other such legal cases. That means that the standards for "digital" in the courtroom have already been set.

U.S. Federal Customs Agents capture digital headshot pictures, digital fingerprint pictures, and digital retina scans everyday at every border crossing today. These digital pictures are used to track and identify people, and legally deny undesirables into the county. The U.S. customs agents that interview citizens as they re-enter the country all have digital cameras and fingerprint scanners right at their desks.

This presentation will help the participant review and provide concrete examples for using digital pictures at your hospital or programs. Communication and education of the community will be an important first step to understanding what digital photography can do for evidence that can be brought to a court of law.

Forensic Photography, Colposcope, Sexual Assault/Child Abuse

D53 Gunshot Wounds in Police vs. Civilian Homicides: Analysis of Entrance, Trajectory, and Numbers

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After attending this presentation, attendees will be able to distinguish the pattern of injuries from police shootings versus civilian shootings. The goal of our study is to aid future crime scene investigations in distinguishing between justifiable homicide in the line of duty and criminal homicide.

The information provided by this study may impact the forensic science community by potentially helping to establish the position of the shooter in relation to the victim or the activity of the victim in controversial homicides involving police. Furthermore, the compilation of this data may prove useful as feedback information in the training of law enforcement officials.

Police or officer involved shootings (OIS) are a frequent part of containing a difficult and volatile situation, which may result in a homicidal death of a civilian or even law enforcement personnel. Frequently, the police respond to calls involving an armed individual and multiple shots may be fired. The manner of death in these cases is classified as homicide with the distinction of criminal homicide in cases involving only civilians or justifiable homicide in cases of police officers as the shooter acting in an appropriate manner.

Proper crime scene investigation as well as careful forensic post-mortem examination is necessary to establish the number of shooters, numbers of shots fired, the type of ammunition used, the cause of death, the extent of injury to the decedent, characterization of the gunshot wounds as well as the position of the shooter in relation to the victim. Currently, no research has been published which evaluates the difference in these variables between police and civilian shooters.

In the last five years, the Medical Examiner's Office of the City of St. Louis, Missouri has compiled over 500 cases of homicides from gunshots, some of which have involved police as the shooters. The study retrospectively analyzes homicides involving police officers versus civilian only homicides in relation to the number of shots fired, where the entrance wounds are located on the body (i.e., posterior, extremities, etc), and the bullet trajectory. Attempts were made to closely match the victims by age, sex, and race. In addition to recording demographic information, the victims will be divided into 2 categories: (A) officer involved shootings, and (B) civilian homicide. In each case, the following variables will be collected: (1) the number of entrance wounds, (2) the location of the entrance wounds, (3) the trajectory of the shots, (4) the type of ammunition used, and (5) the range of shot as characterized by the appearance of the gunshot entrance wound.

The hypothesis is that the officer involved shootings have fewer entrance wounds overall and thereby the gunshot wounds at the hands of law enforcement, although fewer in number, involve predictably lethal parts of the body such as the chest or head. In addition, it was found that gunshot entrance wounds in officer involved shootings are more often found on the anterior aspect of the body as most "face-off" situations—including "suicide by cop" —place the police officer in direct confrontation with the offender. In the cases of civilian only homicides, higher numbers of gunshot entrance wounds located on the posterior or lateral portions of the body and higher numbers of gunshot wounds that are not life threatening compared to homicides involving the police were found.

Officer Involved Shooting (OIS), Homicide, Gunshot Wound

D54 Analysis and Characterization of Children's Latent Fingerprint Residues by Infrared Microspectrometry and Gas Chromatography/Mass Spectrometry

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Upon completion of this presentation, attendees will understand the chemical changes that occur in children's latent fingerprints as a function of time and temperature.

The presentation will impact the forensic science community by demonstrating how an understanding of the chemical changes that occur in children's latent fingerprints over time may lead to improved methods for collection of children's fingerprints from crime scene investigations.

Latent fingerprint residues from pre-pubescent children have been observed to disappear form crime scenes faster than those of adults. Therefore, a study was initiated to determine the chemistry of children's skin surface residues. Latent fingerprint residues were collected from fifty-seven children, ranging in age from one to eleven years. The fingerprints were deposited onto aluminum-coated glass slides and analyzed by infrared microspectrometry. The data suggest that there are three consistent classes of compounds present in the latent fingerprint residues of pre-pubescent children: protein, esters, and carboxylic acid salts. While a spectrum of pure squalene was not obtained, an unsaturation peak at approximately 3100 cm^{-1} was routinely observed in many of the latent fingerprint residues and is attributed to the presence of squalene in the residues. The time study, discussed below, was initiated to further understand the changes in the chemical composition of the fingerprint residues as a function of time.

To determine the stability of the compounds over time, data were collected every twenty-four hours, using the same experimental parameters, over a period of ninety-six hours. The percent change in the

absorbance of both the salts and esters was recorded. The results suggest that the esters disappear more rapidly form the fingerprint residues of children relative to the salts. After a period of ninety-six hours, the percent change in the absorbance of the esters was approximately ninety-five while the percent change in the absorbance of the salts was approximately five. These results suggest that children's latent fingerprints have been historically difficult to recover because the salts were not being targeted by the developing agents. Additional analysis of the infrared data revealed that the unsaturation peak that was consistently observed at approximately 3100 cm^{-1} disappeared from all spectra after approximately two weeks while a second carbonyl peak appeared. These results are indicative of squalene oxidation and mass spectrometric analysis will be performed to confirm this supposition.

To further characterize the changes that occurred in the latent fingerprints as a function of time, gas chromatography with mass spectrometry experiments are currently being performed. The latent fingerprint residues that were collected on the glass slides will be extracted and analyzed to gain a better understanding of the complex chemical changes that were observed from studying the residues by infrared analysis. The mass spectrometry data will be discussed in the context of the chemical changes that occurred in the latent fingerprint residues after the residues were kept at ambient temperature for a period of more than four years. After completion of the mass spectrometry experiments, the data will be analyzed to gain a better understanding of the compounds that remain in children's fingerprint residues over extended time periods. The ultimate goal is to develop a better method of targeting the specific compounds in children's latent fingerprint residues so that the fingerprints can be recovered in crime scene investigations.

Latent Fingerprints, Infrared Microspectrometry, Gas Chromatography/Mass Spectrometry

D55 Gunshot Suicides in the Island of Crete

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The primary goal of this study is to present the characteristics of gunshot suicides in the region of Crete between January 1999 and December 2006.

This presentation will impact the forensic community and/or humanity by raising awareness and evoking interest to the serious health and community burden represented by gunshot suicides.

Data was collected from the records of the Department of Forensic Sciences, Faculty of Medicine, University of Crete. Furthermore, data was cross-checked with the records kept in the Police Departments as well as the Public Prosecutor orders per case in each prefecture. Any discrepancy was discussed with the Head of the Department of Forensic Sciences.

Crete lays in the Mediterranean Sea, is geographically isolated from the Greek mainland and constitutes the southernmost part of Greece with approximately 600,000 inhabitants. The island of Crete has been inhabited since prehistoric times. Nowadays, it is no secret that in the notoriously trigger-happy island most Cretans, by tradition, own guns. Road signs are easy targets and you will see many of them that resemble swiss cheese after some shooting practice.

Gunshot suicides were reviewed in the island of Crete for a eight year period (1999-2006) with respect to age, sex, type of firearm, anatomical location of the entrance wound, alcohol use, location of the event, and the presence of a suicide note. In the present study, which is the first relative study for a part of the Greek population, comparison was made with available data from a nationwide study of suicide (data period 1980-1995) and from the Epirus region, South-West Greece (data period 1998-2002). There were a total of 323 suicides during the period 1999-2006 in Crete. 19.5% of all suicide cases (n=63) used firearms, the third most frequent used method in the island, while the second favored method nationwide and in Epirus region. In contrast, firearm related suicides were the most common mode of suicide in the United States with a percentage of 60.9, between 1990 and 1995 years. When compared with European countries, firearm usage makes up 21.2% of the suicides in Finland, 24.7% in France, 10.4% in Germany, 18.3% in Austria, and 28.9% in Norway. Firearm suicides were more common in males and their frequency decreased as age increased, though is the less common means for women (n=1). In the majority of cases the suicide victims used shotguns (hunting rifles) and the shooting distance was contact or near contact. Most of the entrance wounds were located in the head and chest region. The number of gunshot suicide victims leaving a suicide note in this study is consistent with the observation that the majority of all suicide victims fail to leave such a note. With respect to the location of the event, the majority of gunshot suicide victims preferred to commit suicide in familiar surroundings, particularly the home or adjoining property. These findings are in accordance with other countries.

In Greece according to the national law 2168/1993 firearm acquisition requires the purchaser to obtain a firearm acquisition license. In order to obtain such a license, the applicant must be 18 years or older, have not been convicted of a crime in the last five years, to have a medical certificate of good mental health (provided from a psychiatrist, neurologist, or pathologist in a state hospital), and wait approximately a month before purchase. According to the Greek authorities there are more than million-and-a-half illegal guns in the country and they estimate that some 600,000 are in the island of Crete, the largest center of the arms trade in Greece. It is well known that availability of means to commit suicide has a major impact on actual suicides in any region; nevertheless Cretans seem to have a discreet gun culture. Despite the convenience to possess a firearm-legally or not-, gunshot suicides makes up in Crete a less common used mode compared with available data from a nationwide study of suicide and from the Epirus region, South-West Greece.

Suicide, Gunshot, Crete

D56 Homicide or Suicide? Unusual Death of Man Suspected of Sexual Harassment in Family Context

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The goal of this presentation is to describe the shame and the social stigma related with pedophilia and how it led a man to suicide by fire.

This presentation will describe a particular case of a carbonized corpse, found in his burnt-out car in an isolated Palermo's west suburban zone.

The external examination revealed burns of IV degree, "pugilistic attitude", "partly-cooked" muscle, brittle greyish-white splinters bone, loss of skeletal structures, and the absence of hands, limbs and feet. The radiological findings, made before the dissection, excluded the presence in the body of bullets or metallic splinters. Autopsy findings showed the presence of soot in trachea mucus, partial cooked viscera, the presence of fluid blood in the cardiac chambers, of urine in urinary bladder and the absence of marks of cranial and neck trauma.

Biological samples were used for toxicological analyses that showed high level of carboxyhemoglobin.

The DNA analysis on blood spot samples, compared with daughter's blood sample, showed that the body was a 64-year-old Caucasian male, gone away, alone and spontaneously, eight hours before his finding after a

quarrel in which he was accused of not verified sexual harassments in family context. Circumstantial data evidenced that he expressed the will to commit suicide.

According to the autopsy finding, toxicological results, and circumstantial data, suicide was presumed as the cause of death for this man, without pre-existent psychiatric pathologies, in which shame and the social stigma related with pedophilia led him to suicide by fire self-burning.

Suicide, Self-Burning, Sexual Harassment

D57 A Particular Case of Suicide Committed With a Double-Barreled Shotgun

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The goal of this presentation is to illustrate a particular case of suicide of a 17-year-old Caucasian boy, who was found dead on the floor of his bedroom with a large shotgun contact wound on his head.

The weapon at the scene used for committing the suicide was a shotgun, calibre 12 mm, regularly used by his father. This weapon was fixed with electrical tape on two perpendicular planks, which were laying on the floor near the head of the boy. On the vertical plank, a hand drill with a screwdriver was fixed. The body was in a supine position, a motorcycle helmet strap was found on his neck, and a small electronic box was in his right hand.

This box was connected to the hand drill by a small electric cable that passed over the trigger of the gun. The gun barrel was fastened to the strap of the motorcycle helmet by electrical tape and rested against his right temple.

At the external examination, there were devastating injuries with large gaping tears of the scalp and ejection of brain tissue; no other injuries were found.

Near the body, fragments of skull, brain tissue, and of motorcycle helmet were found, and near the left part of his trunk, there was a sheet of paper in which was written "***donate my organs***". Blood stains and fragments of brain tissue were found on the walls. There were no drugs in the room. On his writing desk numerous drawings representing violence scenes between father and son were found.

The legal authorities decided to not perform the autopsy, because the cause of death was evident. This particular case shows a serious and deep depression of a boy and the difficult father-child relationship.

Juvenile Suicide, Shotgun Contact Wound, Suicide

D58 Strangulation in Sexual Assault: A Case Study

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After attending this presentation, attendees will recognize physical indicators of strangulation in the course of sexual assault, methods of documentation, and barriers to evidence collection and prosecution.

This presentation will impact the forensic community by highlighting the need for multiple forms of documentation of strangulation in sexual assault for best victim and investigation outcomes.

Strangulation is frequently used as a means of power and control in sexual assault. Obstruction of the airway and major vessels of the neck may lead to disorientation, unconsciousness or death of the victim. After an incident of strangulation the victim may be unable to clearly articulate the events which took place during the attack, describing symptoms such as headache, hoarseness, vomiting, a perception of throat swelling or closure, and shortness of breath. In addition, perceptions of symptoms may also be altered by ingestion of alcohol or drugs. Although a ligature or other device can be used the most common form of strangulation occurs with the hand or forearm. Symptoms result from a combination of how much force the attacker applies, the location on the neck and the surface area over which the force is applied as well as the amount of the applied force. Strangulation can result in no visible injury or may produce hematomas and abrasions of the neck, petechiae of the conjunctiva, skin surface, and mucous membranes, and subconjunctival hemorrhage of the eyes. The amount of time that passes between the assault and the forensic examination can make a difference in being able to document visible injuries.

In April of 2007 a 29 year old female reported being strangled during the course of an attempted sexual assault to the San Diego Sheriff's Office in Encinitas, California. The victim, who had been out drinking with a friend, was attacked at her vehicle where the assailant strangled and beat her, resulting in multiple trauma and vomiting. Prior to the forensic examination the patient was taken to a local Emergency Department where she was medicated with Ativan, treated for her injuries, and a laceration below her eye was sutured. She was then transferred by the Sheriffs Department to Pomerado Hospital in Poway, California for a forensic evidentiary examination.

During the course of the forensic interview the victim stated that penile-vaginal penetration had occurred and that the assailant used his hands to grab her throat. While holding her by the throat he shook here by the neck and told her he could kill her. The victim denied loss of consciousness and thought she may have had some memory loss but here memory was returning post-assault. During the course of the investigation it was learned that the suspect was in the United States illegally, spoke little or no English, and was a previously deported felon.

Documentation of the victim's injuries was performed with a digital 35 mm camera, a colposcope, and written documentation on the California Office of Emergency services from 923. Hematomas were noted to the neck bilaterally, as well as multiple bruises to the upper back, both arms right leg, and face. Black debris was found intra-vaginally.

This presentation will show the multiple documentation techniques employed in this investigation and discuss the challenges in a forensic examination of strangulation in sexual assault.

Strangulation, Sexual Assault, Forensic Examination

D59 Case Report of an Unusual Gunshot Suicide Inside a Grave

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The primary goal of this study is to present the case of a 66-year-old man who was found dead inside a grave with two gunshot wounds to the head. The results of the scene investigation, the ammunition used, and the autopsy and toxicological findings are described.

This presentation will impact the forensic community by presenting a case of an unusual location of a suicide event as there is no mention of gunshot suicide in a grave in the English-language literature. The majority of gunshot suicide victims prefer to commit suicide in familiar settings with privacy, particularly in the house or adjoining property.

Data was collected from the records of the Department of Forensic Sciences, Faculty of Medicine, University of Crete.

In September 2003, a 66-year-old man, recently retired, visited his village, approximately 42km from the city of Chania, as he would do normally. He had a telephone conversation with his children and a second one with his wife, who was on vacation outside the country. The next day none of the family had seen him. He was reported missing by his son as he recently had suffered a cerebral stroke and a huge search started immediately. The next day, police investigators found his body inside a grave that has been recently purchased by the victim. While entering the village cemetery everything looked normal and the grave slabs were in position except one that seemed slightly moved. Investigators then decided to move the grave's slab and have a closer look inside. The 66-year-old man was found sitting on a cement parapet; his left shoulder was lying on the inner side while having a 9-mm Luger pistol still in his right hand. The scene investigation showed no evidence of a struggle. In the interior, investigators found: (1) three fired cartridges (the two in the victim's feet), (2) two live cartridges in the chamber, (3) one live cartridge in the clip and another one out, (4) fourteen live cartridges in a paper bag, (5) a knife 28cm in length, (6) a hand lens and a battery, (7) two pairs of glasses, (8) a rubber cement tin and four silicone tubes, and (9) a metal device used for the silicone. The deceased had apparently used the silicone to seal the grave's slabs from inside before committing suicide. A multiple page suicide note was found in a knapsack in the victim's car trunk, parked outside his home, while a second one was found inside the grave.

Autopsy examination revealed two typical contact gunshot entrance wounds in the head. The first entrance wound was located in the right temple and the exit wound in the left parietal. The course of the bullet was right to left. The second entrance wound was located in the middle line of palate inside the mouth with upper jaw and mandible smashed. The course of the bullet was upward. One deformed bullet was found smashed in the fractured left zygomatic bone parts and beneath the skin. Gunpowder residues were detected in the right hand in the subsequent chemical detection in Crime Lab. Toxicological analysis showed a 0 g/l blood alcohol and it was also negative for other drugs.

Multiple contact suicidal gunshot wounds to the head have been not at all unusual in the every day medicolegal practice. Nevertheless, it is important to keep in mind that scene investigation, including the position of the body and gun, the pattern of blood splatter, past history of the victim, questioning of the members of the household, and the existence of a suicide note, is evident of suicidal intent or not in the medicolegal investigation.

Gunshot Wound, Suicide, Crete

D60 Human Trafficking: Implications for Forensic Nursing Practice

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The goals of this presentation are to (1) describe types of injuries and illness that trafficking victims often acquire, (2) identify forensic evidence that could be gathered by the forensic nurse to aid in the investigation of crimes of human trafficking, and (3) discuss implications for forensic nursing practice concerning detection, intervention and prevention of this violent crime against humanity.

The presentation will impact the forensic science community by demonstrating how "trafficking in persons" is a crime against humanity and an act of modern day slavery.

Approximately 900,000 persons are trafficked around the world every year and it is estimated that half of these victims are children. Following the illicit drug trade, trafficking in persons is tied with firearms trafficking as the second most lucrative business among organized crime groups. Unlike drug and firearms trafficking, however, human traffickers can continue to exploit their victims long after the initial point of sale.

Victims may be hidden underground as laborers or servants while others are sold into the sex trade. Through the use of force, fraud or coercion victims are often beaten, tortured, raped, or drugged into compliance. To their captors, trafficked persons are commodities whose value diminishes when they become injured or sick. Victims overcome by illness or injury may be escorted by their captors or a designee to seek treatment at healthcare facilities. The forensic nurse may be the trafficking victim's first point of contact in the healthcare system. Through comprehensive nursing assessment, forensic nurses may detect evidence that points to the crime of human trafficking. Musculoskeletal injuries, patterns of injuries in various stages of healing, sexually transmitted infections, HIV/AIDS, malnutrition, and drug addiction are common health problems often acquired by trafficking victims.

Similar to the profile of a domestic violence victim, persons who have been trafficked live in fear of being further harmed or have been threatened that their loved ones would be killed if they were to report their situation to anyone. Victims feel that they cannot trust anyone and will be reluctant to disclose information about where they live or what has happened to them. Bio-psycho-social needs of the trafficked are like those of domestic violence victims in that they require a plan for safety, shelter, health care, mental health services and legal assistance.

Victims who have been trafficked from foreign countries fear that they will be arrested, incarcerated or deported by immigration authorities. For some, returning to their country of origin may be more dangerous than if they remained with traffickers. Personal documents such as birth certificates, passports, insurance information are likely not in possession of victims because they have been confiscated or destroyed by the traffickers. Sometimes victims are issued false documents.

Forensic nurses must be aware of the crime of human trafficking and have knowledge of laws, protocols for reporting, and resources for referring victims in the venues where they practice. This presentation will provide the audience with awareness of the prevalence of human trafficking, describe types of injuries and illness that trafficking victims often acquire, identify forensic evidence that could be gathered by the forensic nurse to aid in the investigation of crimes of human trafficking and discuss implications for forensic nursing practice concerning detection, intervention and prevention of this violent crime against humanity.

Human Trafficking, Forensic Nursing, Evidence

D61 Hymen Injury in Elderly Consensual Partners

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The goals of this presentation are to (1) review the physiology of the genitalia of the post-menopausal female, (2) present a case study of a 65-year-old female following consensual intercourse, and (3) to discuss the implications for complaints of rape in elder victims.

Injury to the female vulva and hymen has historically been the capstone for validation of rape. This presentation will impact the forensic science community by demonstrating how a case where there was injury following consensual intercourse has implications for the investigation of rape.

Injury to the female vulva and hymen has historically been the capstone for validation of sexual assault. This presentation is a case study that reviews the physiology of aging and the effect on male and female genitalia. The case is a 65-year-old Caucasian female who finds "new love" after the death of her husband of 40 years. She had not had any type of intercourse for over 10 years, due to the husband's illness. The 70-year-old partner used a lubricated condom. The client reported foreplay that included digital stimulation only. The patient reported that there was some "burning" upon penetration, but the pain diminished with continued activity. The next morning, the patient complained of pain and appeared at the clinic where permission was secured to photograph and present for educational purposes.

Rape, Sexual Assault, Elder

D62 Evidence Collection for Suspect Examinations

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The goals of this presentation are to name two basic items that are collected in a suspect examination for evidence, (2) list two examples of potential evidence collection in a suspect examination, and (3) state two barriers in obtaining suspect examination.

It is not uncommon to see sexual assault cases in which evidence is only collected from the victim. Hazelwood, (2001). There are three crime scenes in a sexual assault: the victim, location, and the suspect. Evidence should be collected from all scenes. Too often the suspect crime scene is often overlooked. Frequently there are no standardized procedures or protocols that deal with suspect examinations. The suspect examination may even be the best source of probative evidence in the case. These are the barriers that many communities face. This presentation will impact the forensic science community by reviewing basic examine and documentation components as well as providing key points and recommendations for suspect examinations.

It is not uncommon to see sexual assault cases in which evidence is only collected from the victim (Hazelwood, 2001). There are three crime scenes in a sexual assault. They are victim, location, and the suspect. Evidence should be collected from all scenes.

One source of evidence that is critically important but all too often overlooked in a sexual assault investigation is the suspect examination. Most sexual assault teams, or law enforcement agencies have failed to establish appropriate policies and procedures for obtaining comprehensive forensic examinations for sexual assault suspects which is unfortunate, given the potential for recovering probative evidence from the body as well as the clothing of suspects (Archambault, 2007).

The purpose of this presentation is to make the case for the importance of suspect examinations, to explore some of the reasons why they often are not done, and to provide concrete recommendations for overcoming these barriers and using suspect examinations effectively in your community.

When evaluating potential sources of evidence, the focus is anything that might have transferred from the alleged suspect to the victim; thus, forensic examinations of the victim are seen as critically important. However, keep in mind that any evidence that could potentially be transferred from the suspect to the victim may also be transferred from the victim to the suspect. Therefore, depending on the type of contact involved in a sexual assault offense, the suspect's body may actually be a better source of probative evidence than the victim's.

For example, in the case of a digital penetration of the victim's vagina, the suspect's fingers will often be the best source of probative evidence.

Results of suspect kits analyzed SDPD revealed the following:

- In cases involving an adolescent victim, 44% of the suspect's rape kits that were examined by a criminalist identified the victim's DNA. In fact, DNA analysis of epithelial cells found on penile swabs of the known suspect were the most common pieces of suspect evidence associated with victim identification.
- In the cases with an adult victim, as many as 30% of the suspect's rape kits that were examined by a criminalist identified the victim's DNA. Again, DNA analysis of epithelial cells found on penile swabs of the known suspect were the most common pieces of suspect evidence associated with victim identification.

Even beyond DNA evidence, the suspect examination is important because it can provide documentation of the suspect's clothing, appearance (e.g., shaven or unshaven), and other characteristics that may become important later on during the course of an investigation and prosecution.

Clearly, the decision to obtain a suspect examination should not be based solely on an understanding of how long trace and biological evidence might be available on the suspect's body. Recommendations for a forensic examination of the suspect should be conducted any time (1) the suspect is arrested shortly after the sexual assault, (2) the law enforcement investigator believes that the suspect has not bathed since the sexual assault (however, keep in mind that depending on the type of assault, an exam may still be warranted even if the suspect has bathed), or (3) if there is reason to believe there might still be evidence of injury to the suspect.

Barriers to suspect exams:

1. Communities fail to see the importance of suspect examines.
2. No established protocols
3. Untrained, examiners.
4. Funding for payment of these examinations.

Sexual Assault, Suspect Examinations, Evidence Collection

D63 Evaluation of Fatal Sexual Violence Against Women: Collaboration Between Forensic Clinical Nurse Specialist and Body Donation Program

Sharon R. Crowley, RN, MN, 122 Emeline Avenue, Santa Cruz, CA 95060; and Charlotte A. Wacker, MS, University of California, Davis, Donated Body Program, 4800 Broadway, Suite 100, Sacramento, CA 95820*

The goals of this presentation are to (1) describe the forensic research partnership between a body donation program and a Forensic Clinical Nurse Specialist, via studies to provide a theoretical framework for the medical evaluation of fatal sexual violence, (2) describe the sample population of female cases from a body donation program, which serve as controls for the study of fatal sexual violence in women, and (3) describe a few of the myriad opportunities available to forensic scientists through collaboration with body donor programs.

This presentation will impact the forensic science community by (1) improving the diagnostic acumen of the forensic nurse examiners in postmortem anogenital examinations, (2) facilitating the development of a theoretical framework for medical evaluation of fatal sexual violence against women, and (3) facilitating knowledge and awareness within the forensic community of the capacity for future forensic research endeavors through donated body programs.

There are 112 whole body donation programs associated with medical schools or other academic entities, within the United States. In 2004, Wacker and Schmitt (AAFS, 2004) discussed both the traditional use of whole body donors, as well as the potential application to several areas of the forensic sciences. Traditional utilization of such donor specimens is found daily in medical education and research venues that incorporate surgical trials, biomechanical research, emergency procedures, and techniques for anatomic dissection (Wacker and Schmitt, AAFS, 2004).

The University of Tennessee, at Knoxville (UTK), is a well-recognized leader in forensic research. Every year, UTK utilizes approximately 50 human bodies for forensic anthropology studies (Wacker and Schmitt, AAFS, 2004). A non-exhaustive list of forensic professions with whole body donor application potential include anthropology, pathology, botany, entomology, and odontology. Now, that a successful liaison has been established, forensic nursing has been added to that list.

The Donated Body Program, at the University of California, at Davis, accepts donation of more than 100 bodies annually, for use in research and education, by individuals, and institutions. The stated goals of the Program in this regard are:

- Assist in education and continuing education of current and future health care practitioners, anatomists, forensic scientists, and mortuary technicians.
- Biomedical, forensic, and other scientific research that will assist in the development of procedures and/or products with general intent of improving the human condition." (Donated Body Program, UC Davis, CA, 12 February 2007).

In an effort to accumulate baseline cases for the study of the nature and appearance of the anogenital tissues during the postmortem interval, an IRB proposal was submitted and accepted by the University of California Davis Donated Body Program. Initial examinations on female cases commenced in March, 2007, and are ongoing.

In addition to contagious diseases, some of the general medical conditions that bar acceptance for medical study include obesity, extensive, metastasized cancers, diseases associated with muscular atrophy (e.g., muscular sclerosis), recent surgery, autopsy, traumatic injury, and certain diseases, e.g., arterial/vascular processes that impede either instruction of "normal" anatomy or specimen preservation.

Materials and Methods: This observational study is conducted on female whole body donors, ≥18 y.o. For this project, specimens are fresh, or fresh frozen, vs. embalmed. The majority of cases are received by the Sacramento County Coroner's Office Morgue within 24 hours of death. Cases are tested for Hepatitis A, B, and HIV. Available, non-identifying demographic data is collected and cases for the current project are assigned a unique identifier for entry into a modified *Sexual Homicide Database* (Crowley, AAFS/1998; 2000; JFS/2004). Some of the variables include age, ethnicity/race, cause of death, date of death, interval from date of death to receipt by Program, concomitant medical processes, examination methods, photography, and examination adjuncts.

Crowley's mobile system of technology for the examination of postmortem genital examinations with colposcopy is used on these baseline cases, which are examined at the Sacramento County Coroner's Office Morgue (JFS, 2004). Eleven anatomic sites of the anogenital anatomy are routinely inspected and photographed. Comparison photographs are made with a digital single lens reflex (SLR) camera and a colposcope at 7.5, 15X magnification, or both. The genital examination also incorporates speculum insertion and anoscopy. In select cases, the 1% nuclear stain, toluidine blue, is applied and appropriately decolorized, in order to evaluate the efficacy of this adjunct as a tool in the postmortem examination.

In addition to the photographs from the SLR camera and the colposcope, a *postmortem worksheet* was developed to document the salient findings of the examination.

Discussion: Due to expertise with living sexual assault victims, forensic nurses and other experts are increasingly called upon to assist the forensic pathologist/medical examiner with the evaluation of select homicide cases to help determine concomitant sexual assault. The overall goal of this study project is to incorporate representative samples of natural, accidental, suicide, and non-sexual homicide. The Davis Donated Body Program provides excellent samples of natural death. One variable that may be unique to the Program sample is the greater age of the sample population thus far. In and of itself, this has been a valuable contribution. Traditionally, the number of reported postmenopausal living sexual assault victims has always been small, in comparison to younger victims. Thus, there has been a dearth of information about normal genital anatomy obtained via colposcopic examination of living victims in this age group. The opportunity to examine numerous cases of postmenopausal women that died a natural death is yielding extremely valuable data.

Whole body donors are received in a timely manner and appropriately stored in the coroner's morgue, consistent with the standards for storage of human remains. The incorporation of cases from the Donated Body Program has provided an unprecedented opportunity to study both in great detail and in a timely manner, the nature and appearance of the anogenital tissues in the postmortem interval. Depending on concomitant medical and/or gynecological conditions, the anogenital tissues are in excellent condition and offer unparalleled opportunity to study early postmortem changes.

The generous donation of these individuals has afforded a needed research opportunity. On a larger scale, their gift has helped to provide a framework from which we can begin to understand the traumatic changes that occur in the aftermath of fatal sexual violence against women.

Fatal Female Sexual Violence, Body Donor Program, Forensic Clinical Nurse Specialist

D64 Sexual Assault: Clinical and Forensic Management a Virtual Practicum to Train Sexual Assault Forensic/Nurse Examiners

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The goals of this presentation are to (1) demonstrate the learning strategies utilized to develop a virtual practicum on the evaluation of sexual assault, and (2) reinforce the strategies and evidence documented in "A National Protocol for Sexual Assault Medical Forensic Examinations" developed by the Violence Against Women office in the Department of Justice.

Education of health care providers and the inter-professional team has been unique to each community and based on a variety of resources and beliefs. This virtual practicum utilizes the most recent evidence to demonstrate mentor/apprentice learning strategies standardized in the "National Protocol for Sexual Assault Medical Forensic Examinations." This presentation will impact the forensic science community by helping to disseminate this important document to the forensic specialists charged with this type of evaluation.

The Interactive Media Laboratory (IML) at Dartmouth Medical School has developed a computer based learning program primarily for health care practitioners who may perform sexual assault medical forensic examinations and the inter-professional team members who have interest in the forensic medicolegal evaluation. The program applies IML's Virtual Practicum model and methodologies to disseminate the concepts and procedures contained in *A National Protocol for Sexual Assault Medical Forensic Examinations* (National Protocol). This protocol was developed by the Office on Violence Against Women, U.S. Department of Justice, under the President's DNA Initiative. OVW is a co-sponsor of this project with the National Institute of Justice. Dr. Henderson was the Project Director and Dr. Speck was a Content Expert.

The Virtual Practicum incorporates mentor/apprentice learning strategies, patient-based learning via rich-media virtual patients, lectures, computer-based activities, interviews with patients and practitioners, and role-modeling by experts, all in a graphically integrated learning environment. Drs. Speck and Henderson will describe this project and demonstrate the capabilities of the Virtual Practicum for the participants.

SANE, SAFE, National Protocol

D65 Mapping the Literature in Forensic Sciences: A Bibliometric Study of North American Journals From 1980 to 2005

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The goal of this presentation is to describe the evolution of forensic literature in North-American journals over more than twenty-five years. More precisely, it will draw a picture of our literature and describe developments and trends regarding numbers of author(s) per article, represented countries and international collaborations, fields of forensic sciences, types of articles and use of the scientific method.

This presentation will impact the forensic community and/or humanity by providing new insight into forensic science literature. This better knowledge of our body of literature as a whole could help us assess our strengths and weaknesses, and to position ourselves on literature ethical issues.

Introduction: Bibliometric studies have increasingly being used over the last years. Those studies are useful to understand the evolution of literature or trends in particular fields or within a geographical area. However, in forensic sciences, bibliometry has barely been used yet. As a matter of fact, the few bibliometric analyses of forensic science literature that have been performed were mainly focused on most highly cited articles, most prolific authors, and impact factors.

Methods: The two North-American leading journals in forensic sciences were selected: the Journal of Forensic Sciences and the American Journal of Forensic Medicine and Pathology. All articles published in those journals in 1980, 1985, 1990, 1995, 2000 and 2005 were retrospectively analyzed, excluding editorials, guest editorials, tributes, and book reviews. For each article, the following features were compiled: number of author(s), author's country and international collaboration, related field of forensic sciences, and type of article. Furthermore, it was assessed if the article was using or not the scientific method, with testing of hypotheses by statistical analysis. A total of 1693 articles were examined from 1980 to 2005 at a 5-year interval: 1252 articles from the Journal of Forensic Sciences and 441 articles from the American Journal of Forensic Medicine and Pathology. The SPSS 15.0 software was used to perform statistical analyses at a threshold of significance of 5%. Mean values were compared using analysis of variance, while proportions were compared through Chi-square tests.

Results: Over the last twenty-five years, the number of articles per year has doubled. Meanwhile, the average number of author(s) per article has passed from 1.9 to 4.0, significantly increasing by more than twofold ($p=0.000$, $p<0.05$). The relative contribution of other countries in comparison to the United States has significantly increased from 19.5% to 70.8% ($p=0.000$, $p<0.05$), and articles from international collaboration have passed from 1.6% to 10.4%. Articles in the fields of anthropology, ballistic and biology/DNA have significantly increased over the years ($p<0.05$), while articles concerning questioned documents significantly decreased ($p<0.05$). No significant differences were noted for the progress of articles in the fields of chemistry, odontology, pathology and legal medicine, psychiatry, and psychology. As for the types of articles, technical note was the only type of articles showing a significant increase ($p<0.05$). Historical overviews, letters to the editor and review articles demonstrated a significant decrease ($p<0.05$), whereas no statistical differences were observed for case reports, case series and original studies ($p>0.05$). Finally, the number of studies using the scientific method has also significantly increased through the years, passing from 10.53% to 40.73% ($p=0.000$, $p<0.05$).

Conclusion: Forensic literature in North-American journals has expanded and enriched over the last quarter of century. As a matter of fact, the number of articles has increased, so did non-US contributors, international collaborations, and number of studies using the scientific method. However, the significant growth of the average number of author(s) per article could raise some ethical issues.

Forensic Sciences, Literature, Bibliometrics

D66 Don't Blame the Forensic Scientist!

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After attending this presentation, attendees will learn how efforts to improve forensic science go wrong when critics play a blame game after errors are discovered. They will learn that improvements in forensics can be made, but only if we stop blaming forensic scientists and start thinking about improved organizational structures.

This presentation will impact the forensic science community by addressing an issue that forensic lab directors are always concerned about, namely human error and quality control. Error rates and their relationship to structural redundancy will be discussed with a view toward enhancing laboratory administration.

Critics of forensics have seized on sensational cases of error in a way that has put forensic science under siege. The unfortunate result has been a tug-of-war between the critics of forensic science who call for oversight and regulation and the defenders of forensic science who wish to preserve their legitimate autonomy. This tug-of-war has grown into an increasingly urgent public dialogue on the reliability of forensic science. Reform is coming. It is vital that such reforms make things better, not worse. The forensic science community must act effectively to ensure not only the continued validity of forensic science, but also continued public trust in the most vitally scientific element of our criminal justice system. To ensure a good result, forensic scientists should emphasize the role of organizational structures in quality assurance.

A properly designed system of redundant testing ("structural redundancy") in forensic science would reduce both error rates and the direct money costs of administering the criminal justice system. As in other areas such as research science and information theory, structural redundancy is necessary for error correction. Structural redundancy reduces the costs of administering the criminal justice system because wrongful convictions are costly. Costs of incarceration are so high (over $20,000 a year for each prisoner) that even when errors are rare, the costs of redundant testing are swamped by the savings they produce in the costs of incarcerating the wrongly convicted. In this sense, forensic tests are cheaper than prisons. Cost estimates based on public documents reveal that greater funding of forensic science is economical because forensic science is a bargain for the criminal justice system.

The presentation explains how the research team uses experimental techniques to study the connection between error rates and structural redundancy. Results so far suggest a strong connection and the possibility of reducing error rates through an improved organization of forensic science. The latest experimental results reveal that improvement comes from the benefits of structural redundancy and not from any improvement in the performance of individual examiners in the system. Thus, it is a mistake to blame individual forensic scientists when things go wrong. Instead we should look for better organization. In particular we should look for ways to put the principle of structural redundancy into place.

The project described will have a great impact on forensic science by helping to eliminate the blame game and by revealing both the correct principles and fine details of how to institute structural redundancy in forensic science. Reducing error rates in forensic science will benefit society by improving justice. Mistakes in the criminal justice system are costly. The project will benefit society as a whole by lowering incidence of such mistakes and thus their cost. It will also reduce the costs of administering the criminal justice system, which helps to justify an increase in the funding of forensic science.

Blame, Structural Redundancy, Error Reduction

D67 Morgue Operations in the Aftermath of Hurricane Katrina: A Radiology Perspective

Nancy S. Adams, BS, 202 Milford Street, #155, Tupelo, MS 38801*

After attending this presentation, attendees will have a better understanding of the morgue operations conducted by the Disaster Mortuary Operational Response Teams (DMORT) following Hurricane Katrina.

This presentation will impact the forensic community and/or humanity by demonstrating the three generations of morgue operations and

the contribution of radiology and the radiographer in victim identification, providing insight into the interactions between the morgue components, specifically radiography, pathology, and anthropology.

On August 29, 2005, the worst national disaster to ever strike the United States occurred at 6:10 AM when Hurricane Katrina made landfall along the Gulf Coast. In its wake, it left an area larger than Great Britain in ruins; over 90,000 square miles of total devastation stretching from Florida to Louisiana. Hundreds were dead or missing and 1.5 million people were displaced. In the aftermath of this historic event, the DMORT teams from regions 4 and 6 deployed to begin the search, recovery and identification of the victims left behind by this horrific storm.

In the days following the initial deployment, the DMORT teams had to set up operations and provide team members with basic life support under conditions never before encountered: no power, no running water, no toilet facilities, no lodging, and extreme heat and humidity. The first generation of morgue operations was set up utilizing the DPMUs (deployable portable morgue units); fully equipped morgues palletized and ready for deployment via rail, truck or air. Region 4 set up in tents inside a damaged hangar in Gulfport, Mississippi, while region 6 set up under similar primitive conditions in a warehouse just outside Baton Rouge, Louisiana. The Gulfport operation was designated DMORT East, and the Baton Rouge operation DMORT West. For the initial deployment, the Radiography section had to work with the old equipment from previous deployments. This included battery-operated portable units, and conventional film and processing. Since darkrooms were required for film development, black visqueen was duct-taped to walls and ceilings to provide the light-tight environment needed for image processing. The heat, humidity, lack of ventilation, and strong chemicals necessary for processing presented an additional hazardous environment for the technologists and personnel assisting with film processing. Radiation safety was another factor that had to be taken into consideration. The primary factor for safety was distance, requiring that the x-ray units were contained within a perimeter of at least 6 feet from any other area. This meant that the darkroom had to be established outside the 6-foot limit to prevent image fogging and to protect unexposed film, which entailed carrying heavy cassettes some distance for processing. Lead aprons were provided for personnel operating the equipment, but due to the working conditions, it was almost impossible to wear the aprons. Instead, improvised shielding using folding chairs with lead aprons draped over the back provided a means of protecting personnel. On September 14, 2005, the new computed radiography (digital imaging) systems were delivered and put into operation. These systems meant that the conventional darkrooms and the associated problems could be eliminated. It also meant that image storage was no longer a problem, as the digital images could be stored on CD or on backup computers.

The first generation morgue at Gulfport was disassembled and personnel evacuated on September 22, 2005 when Hurricane Rita headed for the Gulf Coast. Once Rita had passed through, the second generation morgue set up under much better conditions on the water park at Gulfport. The environmental conditions were much better, and DMORT personnel were housed in an area hotel that was able to provide accommodations. During this phase, radiography proved to be a valuable resource in the identification process, working closely with pathology and anthropology in evaluating ante- and postmortem images, and reproducing antemortem images for comparison purposes. In November, 2005, DMORT East completed its work and began to phase out operations. During this period, a new facility, to be called the Victim Identification Center, was constructed on the site of a former leper colony at Carville, Louisiana, near Baton Rouge. Destined to become the largest morgue in the world and called the finest of its kind by some experts, it provided the third generation of operations in the aftermath of the hurricanes.

The Victim Identification Center sits on a secure 37-acre compound. Included within the fenced facility are dormitory-style buildings capable of housing 300 personnel along with a huge tension fabric structure that contains a complete kitchen with dining area, recreational and laundry facilities, warehouse, administrative offices, and overflow sleeping accommodations for an additional 186 staff. The morgue, an 18,720 square-foot facility, contains ten separate analysis stations and is capable of processing up to 150 victims per day; however, the fadiology section would need at least two units in operation if full-body x-rays are required. If the bodies are victims of an attack using explosives or ordinance, a portable C-arm unit, or perhaps an airport-type E scanner would be necessary for preliminary scanning to detect shrapnel or unexploded devices. The entire compound contains everything needed to perform up to 800 forensic examinations as well as casketing and re-casketing operations. In this final phase of operations, the radiology computer was interfaced with the pathology and anthropology computers, and all three sections were in adjacent bays, allowing the technologist to provide immediate images for viewing to the other areas. The pathologist and anthropologist had immediate access to the technologist for any assistance with image comparison or image manipulation. The configuration also allowed the technologist to provide training to the other sections on the features of the computed radiography software, including long bone measurement, magnification, annotation, image reversal techniques, and image retrieval. The computerized radiography system provided excellent quality images, whether the remains were soft tissue or skeletonized. In April, 2006, the third and final generation of morgues completed operations, and the facility went into stand-by status. Throughout operations, the radiology component proved its worth in both identification and cause of death.

Morgue, Radiology, Katrina

D68 Crimes Against Humanity and War Crimes in Colombia (1978-2005): In Pursuit of Forensic Evidence for Missing Persons

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After attending this presentation, attendees will gain an understanding of forced disappearance situation in Colombia and the current application of forensic sciences, especially anthropology and archaeology to solve these crimes.

Crimes against humanity and war crimes are being investigating in a social, legal and forensic perspective around the world (Roberge, MC, 1998). Countries such Argentina (Doretti, 2003) Iraq, the Former Yugoslavia, Guatemala, and Rwanda (PHRUSA, 1994), are receiving all the interest from forensic teams attending the United Nations (UN) and the International Committee of the Red Cross (ICRC) calls. This is not the case in Colombia. Every year from 1988, UN, ICRC and international Non-Governmental Organisations (NGOs), such Amnesty International or Human Rights Watch, produces annual reports about the critical situation of Human Rights and International Humanitarian Law in this South American country. National NGOs also reports these crimes but forensic investigations are limited for security, social, political, and economical reasons and especially because the internal armed conflict still remains.

As a result of the pressure from Civil Society, especially Human Rights NGOs and relatives of forced disappearance's victims, from 2000, the Colombian State had been working on the creation of laws (leyes) to judge the offenders (ASFADDES, 2003) as well as the implementation of two Truth Commissions. Both the National Search Commission of Missing Persons" (Comisión Nacional de Búsqueda de personas desaparecidas) and National Reparation and Reconciliation Commission" (Comisión Nacional de Reparación y Reconciliación) (PPDHDIH, 2004) are charged with the search for missing persons. Both Commissions will use forensic sciences, specially archaeology and anthropology in order to achieve their purposes.

Through this presentation the problem of forced disappearance in Colombia (1978-2004) is analyzed from several points of view: historical, legal, cultural, geographical, and forensic. Information comes from NGOs and some governmental institutions as the National Institute of Legal

Medicine, the Ombudsman Office (Defensoría del Pueblo) and the Inspector's Office (Procuraduría General de la Nación). Three cases will be exposed. Some of them are already finished with the location and identification of the victim but others are still being investigated.

Forensic Anthropology, Forensic Archaeology, Human Rights - Colombia

D69 Coping With Changing Legislation: Learning Lessons From the United Kingdom, Reducing the DNA Backlog, the Role of Facilities in Addressing Crime, Use of Robotics and Expert Systems in Forensic Science

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The goal of this presentation is to help attendees understand lessons learned from the United Kingdom to help reduce DNA backlog.

Coping with changing legislation: learning lessons from the United Kingdom: Legislation such as proposition 69 in California is an example of the way that the United States is transforming its approach to the use of forensic science. It is set to have a major impact upon both convictions and upon domestic security. But as legislation changes, there is a growing need to develop capabilities and services to respond to the changing needs of the sector. By drawing upon some of the world's most respected and established scientific technology, the United Kingdom is able to work in partnership with bodies across the United States and further afield to address issues such as DNA backlogging and terrorism

Reducing the DNA backlog: Even as far back as 2005, data from the Bureau of Justice Statistics in the States referred to a "disturbing trend of increased cases and increased backlog in all disciplines of forensic science." The facts certainly present a pressing case for change. Interestingly, the current plight of the US backlog follows a similar pattern to what has already occurred in the United Kingdom. The challenge now is to translate the knowledge and best practice learned, across the pond and to use it to assist the States in tackling the backlog, efficiently and effectively. When it comes to DNA processing, the figures in the United Kingdom are impressive, with over 0.5 million samples processed a year, each within a three to five day timeframe. Additionally, as analyzed samples have increased, staff numbers have dramatically decreased. But it hasn't always been that way. How has the United Kingdom done it and what lessons can the United States learn?

The role of facilities in addressing crime: When it comes to forensics, the building itself is just the shell – what is critical is the technology incorporated within, and its ability to integrate with existing systems and procedures. The need for a temporary structure can be triggered by a number of factors – for some organizations it's about providing an adjunct to an existing facility in order to cope with immediate issues such as backlogging. For others, there's a need for an interim facility whilst a permanent solution is found, for some just a commercial desire to find out whether a forensics laboratory will reap benefits for their bottom line. Whatever the trigger, it is clear that a "quick fix," non-custom facility simply will not do. The United States currently do not have enough facilities to cope with growing demand triggered by legislation such as Proposition 69. The United Kingdom has been through this and come out the other side thanks to advanced temporary facilities.

Use of robotics and expert systems in forensic science: Automation and the use of expert systems present one solution that the Unites States is beginning to investigate, and it's a path that is well trodden in the United Kingdom. Over the last ten years the United Kingdom has worked to develop robotics and wider technology to ensure that we are able to manage whatever level of samples we are presented with. From this experience we have learnt a valuable lesson: it's not about the technology but about how you integrate it with the rest of the process, and feed it efficiently. Using technical robotic instruments to remove mundane duties for staff has proved hugely successful. It is human nature that after processing hundreds of samples every day, people get tired, distracted and they make mistakes – robots, on the other hand, do not. The use of robotics represented a real leap of faith for forensics teams in the United Kingdom. Quality of programming is critical, and although existing systems were used, considerable time and resources were spent designing protocols for them that instructed the machines to extract DNA, measure, and amplify it as required. As a result however there has been an increase in the number of samples processed and in turn improving match rates. By catching even those criminals committing minor offences, as the statistics show, the United Kingdom's populace are saved from a whole host of future potential crimes.

DNA Backlog, DNA Processing, Crime Reduction

D70 The Role of the Radiographer in Forensic Medical Investigation

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After attending this presentation, attendees will understand range of diagnostic imaging procedures used in support of forensic investigation and the key role played by the radiographer or radiologic technologist.

This presentation will impact the forensic community by highlighting the need for core standards and guidelines in forensic radiography, supported by training programs for radiographers.

Purpose: A review of the role of the radiographer in support of forensic medical investigation in South Africa, Australia, Argentina, the United States, and the United Kingdom.

Materials and Methods: Two to three university centers of Forensic Pathology were visited in each country between December 2005 and March 2006, as part of a Winston Churchill Traveling Fellowship. Through observation, discussion, and semi-structured interviews with radiography service users, service providers, and educators, the following aspects in each center were assessed:

- Service philosophy and scope of practice
- Use and availability of technologies
- Organizational roles and responsibilities of those undertaking forensic radiography examinations; and
- Current training programs

Relevant published literature was also reviewed.

Results: Marked differences in utilization and availability of services between countries, and lesser differences between centers within each country, were evident. The perception of the importance of radiography as a tool of the forensic investigator are influenced by differing levels of violent crime, degree of involvement of radiographers and radiologists, available resources, and differences between education systems for radiographers and pathology technicians. Access to advanced imaging techniques is at present limited to those centers attracting research funding or where cultural issues are significant, but many practitioners report an increasing use of and interest in forensic medical imaging.

Conclusions: Radiographers play an increasingly important role in forensic medical investigation. Core standards and guidelines in forensic radiography should be formulated and supported by training programs for radiographers.

Radiography, Radiology, Education

D71 The Issue of Computer Generated Images in Child Pornography Cases

Amanda Broyles, MAM, Federal Bureau of Investigation, Building 27958A, Quantico, VA 22135*

After attending this presentation, participants will have an understanding of the legal basis for the need to demonstrate that children depicted in pornographic images are real victims and not computer-generated, or virtual, children. Also, participants will be made aware of a recent ruling which expressed the opinion that an expert is not always necessary to demonstrate the reality of victims. Certain often misused terms will be discussed relevant to this issue. The participant will be given an overview of several techniques employed by CG artists to render a virtual person, including a discussion of the difficulties and the shortcomings of these techniques. Lastly, methods of investigation will be discussed. These include the need for identifying any known victims and the evaluation of the image properties. Examples of properties that can be evaluated are photographic properties, such as lighting and shadows, and human properties, such as skin texture and details of the hair. Students will also learn the advantage of having videos or image series, multiple images depicting the same objects, people, or settings, as evidence when the reality of the images and scenes is questioned.

This presentation will impact the forensic science community by educating the audience as to the relevant issues surrounding the prosecution of child pornography in the post-Ashcroft v. Free Speech era. The issue of showing that the individuals depicted represent real children, as opposed to computer-generated children, potentially impacts every case involving child pornography in the United States. While it is not a point of contention in every case, investigators and prosecutors need to understand the state-of-the-art and be prepared with general knowledge and case citations if the issue is challenged. A correct understanding of the issues leads to better case preparation.

This lecture will begin with a description of the impact of the 2002 ruling of Ashcroft v. Free Speech on child pornography cases in the United States. The lecture will address the question, "How easy is it to create a virtual child?" The state-of-the-art in CG (computer-generated or computer graphics) technology will be discussed, as well as the feasibility of rendering a virtual child. With the state of the current technology in mind, characteristics will be discussed that would allow one to distinguish between the real and the virtual.

Virtual, Pornography, Computer Generated

D72 The Detection and Authentication of Real Digital Photographic Images in Light of Ashcroft, Attorney General, et al. vs. Free Speech Coalition

Michael J. Salyards, PhD, DC3/DCFL, 911 Elkridge Landing Road, Linthicum, MD 21090*

The goals of this presentation are to (1) report current state-of-the-art in Computer Graphics (CG) technology, (2) report current legal precedence including Ashcroft v. Free Speech Coalition and subsequent cases, (3) provide an explanation of the JPEG image structure, (4) describe artifacts found in real (i.e., non-CG) digital images, and (5) describe artifacts found in CG digital images

In ASHCROFT, ATTORNEY GENERAL, et al. v. FREE SPEECH COALITION (April 16, 2002) the Supreme Court of the United States decided to overturn parts of the Child Pornography Prevention Act (CPPA) of 1996. Specifically the Court ruled that in order to prosecute child pornography cases, the Government must prove that a real child was harmed. This presentation will impact the forensic science community by demonstrating how since this decision, this "virtual child pornography" defense has been frequently used by accused parties, and has been a challenge to address.

The Department of Defense Computer Forensic Laboratory (DCFL) Image Authentication Process (IAP) has shown that real (non computer generated) digital photographic images contain numerous detectable artifacts.

In ASHCROFT, ATTORNEY GENERAL, et al. v. FREE SPEECH COALITION (April 16, 2002) the Supreme Court of the United States decided to overturn parts of the Child Pornography Prevention Act (CPPA) of 1996. Specifically the Court ruled that in order to prosecute child pornography cases, the Government must prove that a real child was harmed. Since this decision, this "virtual child pornography" defense has been frequently used by accused parties, and has been a challenge to address. Confounding the issue, many fact witnesses (investigators, support councilors, etc) who are currently able to testify to victim identity are aging and in some cases passing away.

The Department of Defense Computer Forensic Laboratory (DCFL) Image Authentication Process (IAP) has shown that real (non computer generated) digital photographic images contain numerous detectable artifacts.

The process consists of four major steps. First, a unique mathematical "fingerprint" of the image called the message digest version 5 (MD5) value is calculated and compared against values stored in the National Center for Missing and Exploited Children (NCMEC) database. Each picture in the NCMEC database contains an identified known child victim.

Second, the metadata contained in the image is extracted and analyzed for artifacts of origin. This includes both metadata that is statically available such as camera make and model as data in the image and metadata that is calculated from the properties of the picture file itself.

The third step in the process is to extract and analyze the image quantization table for artifacts of origin. Each JPEG image contains a quantization table that is generated during the second of three compression steps (discrete cosine transform, quantization, Huffman coding). This table varies from camera to camera and program to program.

During the fourth and final step a discriminatory examination of the Red, Green, and Blue (RGB) values for each pixel is mapped and incorporated into a number of mathematical equations. These equations compare each pixel to its neighbors in order to detect such things as flatness, lighting differential and human skin depth.

Data produced by the process shows that there is a significant, quantifiable difference between real and computer generated (CG) images.

Computer Graphics, Child Pornography, Image Authentication

D73 Digital Image Forensics

Hany Farid, PhD, Dartmouth College, 6211 Sudikoff Lab, Hanover, NH 03755*

After attending this presentation, participants will learn about cutting edge techniques in digital image forensics and how they can be applied in real-world settings.

This presentation will impact the forensic science community by describing the new and important field of digital image forensics with implications to the Law, Media, Science, and Society.

Today's technology allows digital media to be altered and manipulated in ways that were impossible twenty years ago. The impact of this technology is being felt in nearly every corner of our lives, from the courts to the media, politics, business, and science. As this technology continues to evolve it will become increasingly more important for the science of digital forensics to keep pace. This presentation will describe state of the art techniques in digital image forensics.

Digital watermarking has been proposed as a means by which an image can be authenticated. This approach works by inserting at the time

of recording an imperceptible digital code (a watermark) into the image. With the assumption that tampering will alter a watermark, an image can be authenticated by verifying that the extracted watermark is the same as that which was inserted. The major drawback of this approach is that a watermark must be inserted at precisely the time of recording, which limits this approach to specially equipped digital cameras.

In contrast, recent advances in digital forensics operate in the absence of any watermark or specialized hardware. With the assumption that tampering disturbs certain underlying statistical properties of an image, these forensic techniques can detect specific forms of tampering.

Air-brushing or re-touching can be detected by measuring deviations of the underlying color filter array correlations. Specifically, virtually all digital cameras record only a subset of all the pixels needed for a full-resolution color image. Instead, only a subset of the pixels are recorded by a color filter array (CFA) placed atop the digital sensor. The most frequently used CFA, the Bayer array, employs three color filters: red, green, and blue. Since only a single color sample is recorded at each pixel location, the other two color samples must be estimated from the neighboring samples in order to obtain a three-channel color image. The estimation of the missing color samples is referred to as CFA interpolation or demosaicking. In its simplest form, the missing pixels are filled in by spatially averaging the recorded values. Since the CFA is arranged in a periodic pattern, a periodic set of pixels will be precisely correlated to their neighbors according to the CFA interpolation algorithm. When an image is re-touched, it is likely that these correlations will be destroyed. As such, the presence or lack of these correlations can be used to authenticate an image, or expose it as a forgery.

A digital composite of two people can be detected by measuring differences in the direction to the illuminating light sources from their faces and body. By making some initial simplifying assumptions about the light and the surface being illuminated, we can mathematically express how much light a surface should receive as a function of its position relative to the light. A surface that is directly facing the light, for example, will be brighter than a surface that is turned away from the light. Once expressed in this form, standard techniques can be used to determine the direction to the light source for any object or person in an image. Any inconsistencies in lighting can then be used as evidence of tampering.

Duplication or cloning is a simple and powerful form of manipulation used to remove objects or people from an image. This form of tampering can be detected by first partitioning an image into small blocks. The blocks are then re-ordered so that they are placed a distance to each other that is proportional to the differences in their pixel colors. With identical and highly similar blocks neighboring each other in the re-ordered sequence, a region growing algorithm combines any significant number of neighboring blocks that are consistent with the cloning of an image region. Since it is statistically unlikely to find identical and spatially coherent regions in an image, their presence can then be used as evidence of tampering.

These and other image forensic techniques will be described. In addition, demonstrations of their use in exposing digital tampering will be provided.

Image Forensics, Image Tampering, Digital Forgeries

D74 Skin Tone Detection for Contraband Image Analysis

Marc Rogers, PhD, Abhishek Choudhury, and William B. Gillam, MSc, Purdue University, 401 North Grant St, Knoy Hall of Technology Room 255, West Lafayette, IN 47907-2021; and Keith Watson, and Richard P. Mislan, ABD, Purdue University, PO Box 2165, West Lafayette, IN 47907*

The goals of this presentation are to provide an overview of skin tone filters for contraband image analysis and to obtain feedback from the community on the development and application of a novel approach.

The development of the skin tone detection filter greatly enhances the ability to isolate those images that have a high probably of depicting child pornography. This presentation will impact the forensic science community by bringing practitioners up to speed with the latest developments in digital evidence.

After attending this presentation, attendees will more aware of some of the developments in contraband image analysis algorithm development.

The presentation discusses the development of a skin tone detection algorithm to be used by first responder digital forensic tools such as File Hound developed at Purdue University. File Hound is a "field analysis" software that is currently being used by over 100 law enforcement agencies worldwide. It is mainly used in forensic investigations to search for and identify pornographic images from a storage device. Ever since the conception of File Hound several steps have been taken to improve its performance and expand its features. One such feature added is a skin tone detection filter that can identify images with a large skin count. This filter was developed based on the theory that there is a strong correlation between images with a large skin count and images that are pornographic in nature. A novel skin tone detection filter was developed for these purposes and this filter was tested against images obtained from the Compaq Image database for skin tone detection. The filter was successful at identifying skin tone across races and differing illumination.

Digital Evidence, Computer Forensics, Skin Tone

D75 Blind Verification of Image and Video Authentication Examinations

Richard W. Vorder Bruegge, PhD, Federal Bureau of Investigation, Operational Technology Division –Forensic Audio, Video and Image Analysis Unit, Building 27958A, Pod E, Quantico, VA 22135*

After attending this presentation, attendees will learn how image analysts authenticate images and videos as depicting real people and events. They will also learn of multiple instances in which subsequent investigation verified conclusions reached by FBI examiners.

This presentation will impact the forensic science community by documenting instances in which the results of image and video authentication examinations have been verified after the fact, thus meeting the *Daubert* criterion that this technique be tested.

Blind verification is recognized by the forensic science community as an excellent way to demonstrate that examiners and laboratories – as well as specific forensic techniques and processes – produce results that are accurate and reliable. Blind verification is particularly relevant to many image and video authentication examination requests handled by the FBI's Forensic Audio, Video and Image Analysis Unit (FAVIAU). FBI personnel have been conducting authentication examinations of images for decades.

This paper will describe how the results of multiple FAVIAU image and video authentication examinations have been confirmed through investigative work performed after the examinations were completed. Included among these confirmations are: (1) authentication of a beheading video as real (confirmed through the subsequent recovery of the victim's headless torso and head), (2) identification of a "snuff film" as a forgery (confirmed by disclosure of the forgery by the creator as a demonstration of his ability in the realm of special effects), and (3) authentication of multiple child pornography images and videos as being real (confirmed by the subsequent identification of previously unidentified victims depicted as real children). It is proposed that such confirmations effectively constitute "blind verification," thereby demonstrating the validity of not just the individual examinations, but the validity of the techniques and processes used in these examinations, as well. Furthermore, such a demonstration provides a direct way of addressing the *Daubert* criterion regarding whether a technique has been tested or is capable of being tested.

The Scientific Working Group on Imaging Technology (SWGIT) describes forensic image authentication as "…the application of image science and domain expertise to discern if a questioned image or video is an accurate representation of the original data by some defined

criteria….Questions involved…include issues of image manipulation, image creation, and consistency with prior knowledge about the circumstances depicted."[1] This type of authentication differs from the necessity to authenticate evidence as a precondition to acceptance in court (e.g., testimony from a fact-witness that a photograph is a "…true and accurate depiction of the scene at the time the photograph was taken…"). Likewise, image and video "authenticity" should not be confused with image and video "integrity," which specifically addresses whether an image or video recording has been altered or modified from its original state, regardless of whether such alteration changes the intrinsic meaning of the recording.

The question raised in forensic image authentication exams effectively comes down to "Did the events depicted occur as they appear in the picture or pictures?" Currently, FAVIAU is most frequently asked to perform image authentication examinations in cases involving child pornography. In such instances, the defense may claim that the images or videos charged in the case do not, in fact, depict real people and events. This may include the suggestion that the images or videos are computer-generated (CG) or that images have been manipulated in some way to make it appear that children were engaged in sexually explicit behavior, when they actually were not. For example, it might be suggested that the face and/or body of a minor was inserted to replace that of an adult in a sexually explicit scene that originally involved only adults.

Another type of case in which image authentication exams are requested involves purported executions or murders depicted in videos. While execution videos have become something of a staple on the Internet as a propaganda tool of terrorists, there remains a subset of videos known as "snuff films" that have nothing to do with terrorism, per se. In either case, investigators are anxious to determine whether a real crime is depicted in the video, or whether the video is merely an attempt at misdirection or some other purpose.

The process by which such images and videos are examined to determine authenticity can involve multiple tasks. As SWGIT notes, "…[t]hese tasks include…evaluation of image structure and content."[2] Evaluation of image structure may include observation of detailed characteristics of an image to detect artifacts of manipulation, or it may involve analysis of metadata to determine the source or provenance of an image, such as camera make and model, or date and time information. Content evaluation may involve observation to detect manipulation in continuity, or specific characteristics of the content, such as staging or features that are out of place or time. For example, when conducting an examination to determine whether a human being depicted in an image or video is real and not CG, there are specific characteristics of human beings that are known to be difficult to recreate in a CG depictions. Such features include fine details of the skin, eyes, and hair.

This paper will describe some of the specialized software tools used to assist in the detailed examination of the images and videos, including those used to examine the metadata and structure of individual digital files. Finally, the criteria used to establish authenticity will also be discussed.

References:

1 SWGIT, "Best Practices for Image Authentication", available on line at theiai.org/guidelines/swgit/guidelines/section_14_v1-0.pdf.

2 Ibid.

Image Authentication, Image Manipulation, Blind Verification

D76 Examination of Digital Video Formats Such as MPEG-1, MPEG-2, MPEG-4, 3GP, and AVI

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The goals of this presentation are to describe what kinds of video formats exist, explain what to do if a format is not playable, describe how to repair broken video streams, and to discuss integrity.

This presentation will impact the forensic science community by describing methods to repair a broken video stream with provided software.

Nowadays many video streams arrive in the laboratory for examination in digital format. Questions range from analysis of integrity, to finding and repairing fragmented or otherwise damaged video files. The number of digital CCTV-recordings is expanding due to security concerns. In many places surveillance cameras are present that can record crimes scenes. Furthermore, more people have phones with cameras in them.

The formats that are widely used on the market range from MPEG-1, MPEG-2, MPEG-4, 3GP and AVI. Many more formats exist, and sometimes they are also proprietary. Often CCTV-manufacturers have proprietary formats.

For forensic examination of damaged files it is important to know in detail on byte-level how a video file format is built up. The different standards of the file formats describe in detail how the file should be composed. Also manufacturers might implement the video file formats slightly different from the standard, such that regular players of video do not show the files correctly.

Damaged files might be found in unallocated clusters and slack space of hard drives and other data carriers. Also, one may find damaged or fragmented files in drives with a corrupted file system, or when analyzing internet interception data.

For analysis, we have developed the open source software tool DEFRASER, which can be downloaded from http://defraser.sourceforge.net. In this software it is possible to read in files that might include video streams. Also images of hard drives can be searched for video information in them. The different formats: MPEG-1, MPEG-2, MPEG-4, 3GP and AVI are supported. It is expected that other commonly used formats will follow. The software will reduce work that is needed otherwise since the specifications of the formats are included.

Simple actions such as using a header from another video file from the same camera is possible. Also more in-depth analysis of the separate data blocks is possible. It is also possible to write plug-ins for this software to analyze different formats.

In this presentation some examples are given of wiped video files which should be recovered. The software also keeps logs in order to know later how a file has been recovered. It should be combined with the use of regular hex editor, for the final forensic analysis. Hidden data such as date and time-stamps in the video files are important for investigation of integrity.

The tool itself is made open source such that it is easily possible to store and exchange knowledge of file formats for analysis.

Video, Formats, CODECS

D77 Digital Video Forensics

Hany Farid, PhD, Dartmouth College, 6211 Sudikoff Lab, Hanover, NH 03755*

After attending this presentation, participants will learn about cutting edge techniques in digital video forensics and how they can be applied in real-world settings.

This presentation will impact the forensic science community by describing the new and important field of digital video forensics with implications to the Law, Media, Science, and Society.

Popular websites such as YouTube have given rise to a proliferation of digital video. Combined with increasingly sophisticated users equipped with cell phones and digital cameras that can record video, the Internet is awash with digital video. When coupled with sophisticated video editing software, we have begun to see an increase in the number and quality of doctored video. This technology is impacting nearly every corner of our lives, from the courts to the media, politics, business, and science. As this technology continues to evolve it will become increasingly more important for the science of digital forensics to keep pace. This presentation will describe state of the art techniques in digital video forensics.

Digital watermarking has been proposed as a means by which a video can be authenticated. This approach works by inserting at the time of recording an imperceptible digital code (a watermark) into the video. With the assumption that tampering will alter a watermark, a video can be authenticated by verifying that the extracted watermark is the same as that which was inserted. The major drawback of this approach is that a watermark must be inserted at precisely the time of recording, which limits this approach to specially equipped digital cameras.

In contrast, recent advances in digital forensics operate in the absence of any watermark or specialized hardware. With the assumption that tampering disturbs certain underlying statistical properties of a video, these forensic techniques can detect specific forms of tampering.

The MPEG video compression scheme has emerged as a virtual standard. This lossy compression scheme introduces specific spatial and temporal correlations into a compressed video. When a video is edited and re-compressed, static and temporal artifacts are introduced that are distinct from an originally recorded MPEG video. These double compression artifacts can be used to determine that a video was, at a minimum, subject to some secondary processing after recording.

Most video cameras do not simultaneously record the even and odd scan lines of a single frame. Instead, one-half of the scan lines are recorded at time T, while the other half are recorded at time T+1. In an interlaced video, these scan lines are simply combined to create a full frame. While this approach allows for better temporal sampling, it introduces spatial "combing" artifacts for quickly moving objects. In order to minimize these artifacts, a de-interlaced video will combine the even and odd lines in a more sensible way, usually relying on some form of spatial and temporal interpolation. For de-interlaced video, the correlations introduced by the camera or software can be quantified, and deviations of these correlations can be used as evidence of tampering. For interlaced video, the motion between fields of a single frame and across fields of neighboring frames should be equal. Deviations of this motion are used to detect tampering.

Sophisticated video editing software allows for objects and people to be added to complex and dynamic scenes. The camera motion can be estimated from individual objects or people in a video and any inconsistencies in camera motion are evidence of tampering.

These and other video forensic techniques will be described. In addition, demonstrations of their use in exposing digital tampering will be provided.

Video Forensics, Video Tampering, Video Forgeries

D78 Measurement of Lighting Conditions at a Police Traffic Stop

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After attending this presentation, the attendees will become familiar with the testing program being developed by NIST and used by IACP.

The presentation will impact the forensic science community by serving as the basis for a testing program being developed by NIST and used by IACP to help police agencies purchase quality systems and obtain useful forensic video.

In-car video recording is growing rapidly but there are no standards for the systems purchased by police agencies. To help assure that agencies purchase quality systems the International Association of Chiefs of Police has led a program to develop standards. As part of that effort, the National Institute of Standards and Technology has developed a prototype testing device in the form of a complex scene generator. To provide guidelines for inputs into the design of scene content, the light available at a traffic stop was measured. Specifically, measured were aggregate color temperature, spectral reflectance of typical scene contents and reflectance of light from key elements such as the target car, its license plate, and the officer at the side of the target car. In addition measurements were made of the dynamic range of typical video camera systems. It was found that the color temperatures were very much as expected, the spectral reflectance were not highly selective and the range of reflectance from key scene elements was greater than the dynamic range of the typical camera system.

Lighting, In-Car Video, Traffic Stop

D79 Identification of Images From Cameras

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The goal of this presentation is to describe methods for identifying an image from a camera.

This presentation will impact the forensic science community by validating methods of pixel defects and noise.

In forensic casework the question of authenticity has to be answered if a certain image has allegedly been made with a specific digital camera. Another question that may be asked is if two images have been made with the same camera. In order to answer this question noise, pixel artifacts, and information from the headers and footers of image files can be used. Furthermore, the method of examination of pixel artifacts combined with headers and footers is useful for integrity research: finding traces of manipulation (e.g., cut and paste) of the images.

A digital image is composed from a matrix of pixels (picture elements). For capturing a digital image CMOS (Complementary Metal Oxide Semiconductor) or Charge Coupled Device (CCD) are used in cameras. When manufacturing image sensors, they sometimes contain artifacts. An artifact is visible in the image as a pixel artifact if the image sensor element has a different light sensitivity compared to the surrounding image sensor elements.

For the examination of pixel artifacts we have developed a standard operating procedure in our forensic casework. For the examination there are two approaches. If the camera is available, test images are made with the camera with a white, grey or a black surface. These images are used as a reference set. If the camera is not available, one set of images as reference set will be used.

In some of our casework pixel artifacts could be visualized without averaging or image processing, since they were visible in the images themselves without any processing. However, for visualizing the pixel artifacts it is often necessary to add and average the intensities of the

images. As a result, fluctuations in the images due to the image itself will be averaged. In order to visualize the pixel artifacts a filter, for instance a median filter can be used.

The locations of the pixel artifacts in the reference images are compared with the location of the pixel artifacts of the questioned images. If the locations of the pixel artifacts agree with each other, this provides strong support for the hypothesis that they have been made with the same camera. The conclusions are not quantitative however, since not enough statistical data is available from the randomness of pixel artifacts.

Conclusions from pixel artifacts are reported as level of support to the hypothesis that an image has been acquired with a specific camera, and/or the level of support to the hypothesis that the have been acquired by a different camera. The following levels of support can be given: "no support", "limited support", "moderate support", "strong support", or "very strong support". In cases with similar support to both hypotheses, no conclusion can be drawn due to discrepancies.

Header and footer-information is often available in the digital files that are received. The information in the headers and footers is not visible in the image it self, however by using software (for example a hexviewer) the information can be made available. In JPEG-images from cameras this information often provides camera settings and brand and type of the camera itself, and sometimes provides information with which software the image has been edited. It is possible to modify the header and footer information by using software, so for forensic casework the examiner has to be aware of this possibility before drawing conclusions. If the header provides information that the image has been taken with a specific camera, it is possible that someone has altered the contents of this header, and that the picture actually has been taken with a different camera.

Another method is investigating the noise that is always present in digital images. The various causes for noise in digital images are:

- Photo response non-uniformity
- Photon shot noise
- Dark current
- Dark current shot noise
- Reset noise
- Amplifier gain non-uniformity
- Quantization noise

Most of these noise contributions are caused by a stochastic process and thus different from frame to frame. Two causes are, to a certain extend, constant from frame to frame: the photo response non-uniformity (PRNU) and the dark current. The former is a result of minor differences in sensitivity to a certain intensity and is easily visible in frames of constant illumination, so-called flat field images. In the latter case, noise is added by thermally generated free charge within a pixel. This charge generates a signal even when no light is measured by the sensor, hence the name "dark current."

Both mechanisms are introduced during manufacturing of the sensor and are a result of numerous causes, e.g., material in homogeneity, slight non-idealities in the lithography optics, dust particles during any stage of the production process, etc. Even though these contributions to the noise are not really noise in that the resulting signal is not random, they introduce noise-like deviations from the ideal, noise-free image: pixel-to-pixel variations of intensity in the order of 1% full scale.

Of the two contributions, the PRNU in pictures taken under normal circumstances (regular lighting conditions, shutter times below one eight of a second, room temperature) is dominant over the dark current contribution. As PRNU is a constant pattern, this pattern can be used to identify the camera that took the picture. To do so, a reference pattern is obtained by means of flat fielding. To remove the random components of the noise, a large number of flat field images was taken and averaged.

To compare a given picture with such a reference pattern, the noise has to be extracted. This is done by applying a Gauss filter which removes scene information from the obtained noise. The resulting pattern is then compared to the reference pattern by means of the two-dimensional cross correlation.

For this research a large collection of cameras was available, among which webcams, phone cams, and handheld compact cameras, of varying quality and price. Of each model, multiple cameras were tested.

Noise, Camera, Identification

D80 Digital Cameras as Evidence: Cautions and Tips

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After attending this presentation, attendees will understand the importance of referencing the user's manual as soon as possible when dealing with any digital camera. The importance of that step cannot be overemphasized and is the primary lesson each participant must understand. The attendee will also learn that the evidence may be time sensitive and should be treated as such. The main issue with regard to time sensitivity concerns a loss of power. A loss of power may mean a loss of evidence. The attendee will also be taught information about storage and media concerns when dealing with digital cameras as evidence. For example, several points will be covered with regard to internal memory. Practical advice for searches will also be given.

This presentation will impact the forensic science community by providing information regarding digital cameras as evidence. If digital cameras are handled improperly, evidence can be lost. Therefore, it is important to understand certain issues such as power and storage. This presentation will help investigators learn the forensic aspects of dealing with digital cameras as evidence.

It is common for digital camera models to stay on the market between three and six months. With such a turnover rate and the large number of manufacturers, it is no wonder that there is such great variety in models and styles that are or have been available. It is also no wonder that law enforcement and forensic scientists are seeing increasing numbers of digital cameras as evidence. As with any piece of evidence, an investigator, law enforcement officer, or forensic scientist must know how to properly handle and treat that evidence. This lecture will discuss tips and cautions for working with digital cameras. Experiences and lessons learned from research for a digital camera database and from conducting examinations of digital cameras will be shared. The intended audience is anyone from first responders and evidence response teams to laboratory personnel.

Digital Camera, Recommendations, Search

D81 Identification of an Automobile Make and Model From Digital Video - A "Cold Hit"

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After attending this presentation, attendees will learn how automobile make and model identifications from images are performed and will learn about resources available to them.

This presentation will impact the forensic science community by alerting the attendee to resources available to assist them in automobile make and model identifications from surveillance images.

Attendees will learn how image analysts determine the make and model of automobiles recorded in surveillance video, including databases and other reference materials available to them.

Surveillance cameras can provide images that are useful in investigations. In many cases, a surveillance image from a crime scene, such as a bank that was robbed, may enable investigators to identify a suspect, either because the investigators are familiar with the subject or

because a member of the public recognizes the individual. At other times, images depicting a suspected getaway vehicle may be used to generate leads or help narrow the list of potential suspects. This paper will describe an instance in which the identification of a vehicle's make and model from the surveillance images led directly to the identification of a suspect who was ultimately convicted of the crime.

A bank in Coeur d'Alene, Idaho was robbed in December, 2003. Investigators had few leads besides surveillance video. Video images depicting partial views of the robber's face were not enough to allow investigators to develop a suspect. Another piece of video evidence showed a vehicle thought to be the "getaway car", but investigators could not determine the make and model. Therefore, they sent this video to the FBI Digital Evidence Laboratory's Forensic Audio, Video and Image Analysis Unit (FAVIAU) in Quantico, Virginia. The request was made to identify the make and model of the vehicle.

When a case requesting make and model is received in FAVIAU, the first step in the forensic process is to extract the best images available from the questioned video. In this case, the surveillance video consisted of an AVI file downloaded from a digital closed-circuit television system. Once still images are extracted, they are processed to enhance the visibility of detail within the images. With the enhanced images in hand, the process of identifying the make and model of the vehicle begins with the distribution of the enhanced images to other examiners and technical personnel familiar with a wide variety of vehicles, in the hope that one of them will recognize the make and model. This process invariably leads to the identification of a number of potential candidates. These candidates are then compared by the examiner against available reference materials and the list of potential candidates is further reduced, until it is determined that no further reduction in the list is possible. The process is the same as that performed in any photographic comparison – vehicles which do not share class characteristics with the questioned vehicle are eliminated.

The FAVIAU manages a reference collection called the "National Automotive Image File" (NAIF), which contains materials collected from automobile manufacturers for over thirty years. The NAIF was started in the 1970's as an adjunct to the FBI Laboratory's automotive paint chip file, which is used in hit-and-run cases. The NAIF contains brochures, photos, slides, and digital media produced by the manufacturers for sales and marketing purposes. In the late 1990's, using funds provided by the National Institute of Justice, some of these materials were incorporated into a server-based digital database called the "Digital Automotive Image System" (DAIS). In early 2007, with the support of the Technical Support Working Group (TSWG), a DVD-based version of the DAIS was produced and distributed to over 18,000 agencies in the U.S. The DAIS includes both thumbnail and high resolution images of thousands of vehicles dating to the 1980's, and it is searchable based on parameters such as make, model, number of doors, type of vehicle and size. In addition to the NAIF and DAIS, the Internet can also serve as a valuable source of information on automobiles – especially since the NAIF and DAIS often lack information on late model vehicles.

The review of the images in the Coeur d'Alene bank robbery case ultimately led an investigator to suggest that the vehicle in question was an Oldsmobile Toronado, a vehicle manufactured in the late 1980's and early 1990s. The Toronado, a version of which was also called the "Trofeo", was not included in the DAIS, so brochures depicting this vehicle were found in the NAIF and its characteristics were compared against the questioned vehicle. As with most vehicles that are in production for more than a year or two, the Toronado underwent modifications during the course of its production run. It was found that the class characteristics of the questioned vehicle, including the passenger compartment outline and the configuration of lights, were only consistent with Toronados produced between 1990 and 1992.

Investigators took this information, queried motor vehicle records for the northern 5 counties of Idaho and located approximately 20 matching vehicles. Only one of the matching vehicles was of a color matching that of the questioned vehicle. This vehicle was owned by a woman whose husband was recognized by investigators as being consistent with the bank robber. He was subsequently arrested, tried, and convicted in the robbery.

In most make and model identification examinations conducted by FAVIAU, it is not unusual for such a search of motor vehicle records to return hundreds or thousands of possible matches. This case represented the first known instance of a "cold hit" in which the make and model identification led directly to the apprehension of the individual ultimately convicted of the crime.

Image Analysis, Automobile Identification, Digital Video

D82 Are Camouflage Uniforms Unique? Estimating the Probability of Accidental Match for Camouflage Uniforms

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The educational objective of this presentation is to introduce and familiarize forensic scientists and investigators with new, quantitative methods and tools for evaluating matching of camouflage uniforms.

This presentation will impact the forensic science community by disseminating information about new forensic technology, thus investigators will know that it is available when confronted with certain types of uniform matching challenges.

It is well known that criminals and terrorists have worn camouflaged and military clothing during the commission of terrorist acts, robberies and other felonies. Fortunately, the increase in video surveillance means that these criminal acts are often caught on digital or analog media, which in turn becomes forensic evidence useful for analysis. In these videos the subject's face is not always visible for further identification, thus non-facial clues must be studied in an attempt to establish identity. The association of a garment worn during the criminal act, and appearing in the surveillance video, to the suspect is a key area of interest to forensic investigators.

In forensic investigations surrounding military environments, many of the garments encountered are part of a camouflage uniform. The problem faced by investigators in such environments, then, is how to identify suspects solely upon matches of a camouflage pattern (uniform) when other forensic evidence is unavailable or inconclusive. The answer lies in how one can measure the uniqueness of a uniform match – that is, given a qualitative observation of match by a forensic examiner, how many other uniforms will yield the same match?

While finding unique matches for most garments typically depends on visible differences (e.g., wear-marks or manufacturing imperfections), camouflage uniforms are an exception. This is because (1) the portion of the pattern observed at a fixed point on a given garment is unlikely to be the same as the same point on another garment made from the same pattern, and (2) there is an adherence to a consistent specification and a relatively standardized process for manufacturing. These factors enable the creation of a statistical model of all significant sources of variation in the manufacture of a camouflage uniform garment. Hence, while the association of a camouflage garment to a surveillance image may not preclude the *possibility* of an accidental association, the *probability* of an accidental association can be quantified objectively.

The probability of an accidental match is computed by statistically modeling the portion of camouflage pattern that is visible at any point on the uniform, and finding all distinct portions of the pattern that are qualitatively similar. Some parameters of the statistical model are measured directly, whereas others can only be estimated. In the interest of

computing a probability that is sufficiently robust to be presented as evidence, a conservative upper-bound is applied for every parameter that cannot be reliably measured. Hence the true probability of an accidental match is guaranteed to be lower than the bound computed by the statistical model. The model is general and can be applied to any camouflage uniform and can be expanded to other types of patterned or camouflage garments. Furthermore, the model allows the forensic examiner to input relevant information about the context of the investigation. For example, if it is known that all the camouflage garments in the vicinity were sourced from a single manufacturer, then the probability of an accidental association is greater than if the garments were sourced from many different manufacturers.

In this presentation, an overview of a year long research study on the statistical individualization of camouflage patterns will be provided. The research shows that a qualitative match of a military camouflage uniform, specifically the Army Combat Uniform (ACU), can be quantitatively assessed via an estimate of probability of accidental match. The presentation will describe the research (including visits to uniform manufacturers) and outcomes, and specifically will focus on a software tool that has been created to assist forensic investigators (the Military Uniform Uniqueness Statistical Evaluator – MUUSE). The tool provides forensic investigators a way to easily and accurately perform this analysis and generate reports suitable for use in legal proceedings.

This work is a major, unique contribution to the area of garment matching for forensic purposes, and will strengthen uniform matching evidence in future cases.

Digital Evidence, Camouflage Pattern, Photographic Comparison

D83 Considerations for the Forensic Authentication of Digital Audio Recordings

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After attending this presentation, participants will have learned about the differences in the approaches to the forensic authentication of analog and digital audio recordings. Common analyses and those unique to each will be discussed, and special considerations related to the analysis of digital recordings will be introduced.

This presentation will impact the forensic science community by providing a framework for the formal development of a methodology with regard to the forensic authentication of digital audio recordings. Such a methodology will directly assist examiners in the field.

The methodology for the forensic authentication of analog audio recordings is well-established in the field, most notably through the 1974 report regarding the examination of the Nixon tapes by the Advisory Panel on White House tapes and "Authentication of Forensic Audio Recordings" (Koenig) published in the *Journal of the Audio Engineering Society* in 1990. These documents provide detailed descriptions of the various analyses employed by government and private forensic examiners when authenticating analog recordings. The analyses which form the core of the examination include physical inspection, critical listening, high-resolution waveform, magnetic development, narrow-band spectrum, spectrographic, and other related scientific analyses.

With the proliferation of digital audio recordings in law enforcement investigations and consumer activities, these analog authentication methodologies and analyses need to be revisited, updated, and modified, as appropriate. Digital audio recordings can be stored on a wide variety of media (CD, DVD, fixed memory, memory cards, digital tape, etc.) and can be in a standard or proprietary format, with each combination of media and format bringing with it unique challenges for playback and analysis.

While most of the techniques employed in the authentication of analog recordings are also applicable to digital recordings, magnetic development may negatively impact digital recordings or may provide no meaningful data, depending on the media containing the recording. Magnetic development is crucial to the authentication of analog recordings, as it assists the examiner in visualizing the magnetic patterns of the information recorded on the analog tape. However, with digital recordings, such examinations are meaningless with non-magnetic digital media (CDs, memory cards, etc.); may potentially render some forms of magnetic digital media (DAT, NT-2, etc.) unreadable, in part or in whole; and even when applied in a non-destructive way to magnetic digital media, may provide no useful information to the examiner.

Conversely, some digital recordings offer new forms of analyses which have no direct corollary in analog recordings. Metadata contained within a digital audio file, for example, may provide information above and beyond the audio data itself, which can be useful when determining time/date information, recorder information, and other administrative characteristics related to the recording. Additionally, mathematical algorithms which produce a "unique" value (generally referred to as "checksum" or "hash" values) based on the size and/or contents of the file may also be incorporated into the metadata and may directly determine if changes have been made to the audio data.

Deciphering and/or obtaining information about the structure and encoding of the metadata and audio data itself may be difficult or impossible, especially with the increase in the number of digital audio recorders employing proprietary file formats. In situations where this information (the non-standard structure of a digital audio file) cannot be determined, attempts are made by the examiner to decode the file structure through detailed data analysis techniques and exemplar recordings produced on the original recorder or a similar model recorder, if possible.

Because of the wide variety of physical media/format possibilities and the intricacies of various digital file formats, published research related to the forensic considerations of individual media, file formats (standard and proprietary), the applicability of the various "analog" analyses to digital recordings, and the development of new analysis techniques becomes even more critical for the establishment of a formal methodology.

Digital, Audio, Authenticity

D84 Using Automated Digital Tools for Forensic Audio Examinations

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The goal of this presentation is to provide testing results and guidance regarding automated audio analysis tools for use in forensic digital audio examinations.

This presentation will impact the forensic science community by increasing awareness of the benefits and cautions when using automated digital tools for forensic audio examinations.

Current technology offers a continually changing array of tools for forensic audio examinations. There has been significant progress in the design and usefulness of the tools available to the audio examiner in recent years. Traditionally, the forensic audio examiner had limited choices for electronic filters and other tools for forensic use. However, today there is a wide array of systems and tools to use for audio enhancement, duplication, voice comparison, signal analysis, and authentication examinations. This analysis investigates a variety of those audio tools and functions that are in common use. Particular emphasis is placed on analysis tools that improve the efficiency and effectiveness of examinations for the audio examiner. Some of the functions evaluated are noise removal, phase detection, prior digitization, tone-detection, statistics and batch processing. Functions related to computer forensics, for example hashing and file comparison, are not covered in this analysis. The primary focus for this analysis is the testing and review of tools for use in audio enhancement, signal analysis and authenticity examinations. There is widespread use of

digital audio analysis tools for these examinations, but there is very little measurable data for the examiner to judge the value of these tools. This analysis provides test results and recommendations concerning possible improvements in the speed and accuracy of audio examinations when using automated digital tools. Cautions are also provided to the examiner concerning certain technical limitations when using automated digital audio tools.

Some of the test results reveal inconsistent data and inappropriate application of technology. However, some of the systems performed well and clearly provide improved effectiveness and efficiency for certain forensic audio examinations. The function "phase detection" was tested and analyzed. Its test results show that inconsistent data occurs and can be misinterpreted. For example, a test recording with a minimum of ten stop/start recording events was tested with one of the phase detection systems. The goal of the system under test was to automatically detect possible alteration of recorded events, for example recording stop/start events. This automated analysis function would be used in an audio authenticity examination to determine among other details whether or not the recording was original, continuous and unaltered. The system under test concluded that "no phase changes nor alterations" were present on the test recording. Therefore, using that system for conducting an authenticity examination would be flawed. There are other alternative tools that provide effective results for detecting alterations in digital audio files. Another system was tested for its ability to conduct batch processing for the enhancement of an audio recording. The benefits of this function include improved efficiency and effectiveness, particularly for longer recordings exceeding an hour in length. This particular system depended on setting its filter parameters in the first few seconds of the recording. This meant that the enhanced version had no filtering effects for the first few seconds of the recording and the filtering was only effective after the parameters were 'learned' by the system. The system design for this type of batch processing would be considered not appropriate for forensic audio enhancement examinations.

Testing results indicate that the forensic audio examiner must be aware of the technical limitations of digital audio tools before using in actual examinations. In addition, all forensic tools should complete a series of validation tests to determine whether the tool is appropriate and whether the analysis results of the tool are accurate.

Audio Analysis, Digital Audio, Audio Authenticity

D85 Comparison of Methods of Performing Body Height Measurements in Images

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The goal of this presentation is to compare the performance of two separate methods of performing body height measurements in images.

This presentation will impact the forensic science community and/or humanity by presenting two methods of performing body height measurements in images.

With the growing number of security cameras in the public and private domain, more and more incidents are recorded. In forensic practice, facial comparison of perpetrator to suspects is not always possible, the quality of the images being too poor or the face of the perpetrator not being visible. In these cases it may nonetheless be possible to do an estimation of the body height of the perpetrator. The results can be used to exclude or gather evidence against suspects and as such are interesting to police, judges and lawyers.

In the literature, two methods for doing height measurements in camera images are predominant, both based on photogrammetry (literally: measuring in photographs).

When some a priori knowledge of the scene is available, height measurements can be done on a single image, without the need of camera calibration. Essential for height measurement by *single view metrology* are a reference height of an object in the scene, a set of vertical parallel lines and two sets of horizontal parallel lines (in different directions.) The analysis is based on projective geometry, through the use of so-called *vanishing points*. Together with a reference height, these make it possible to compute a height on the image.

The second method of doing height measurements in images is through the construction of a 3D model of the crime scene, by means of as an example either photogrammetric software or a laser scan. Operators link scene points of the 3D model to corresponding points in the questioned image, which makes it possible to determine position, rotation and focal length of the camera taking the images ("camera match"). Using the retrieved camera information, a virtual camera is placed in the 3D model of the room, looking at the model from the same perspective as the real camera at the real crime scene, and height measurements in the image are performed by placement of cylinders or bipeds (3D models of humans) over questioned persons.

For both of the methods, results need to be validated by doing reconstructions, positioning persons of known height in front of the same camera, under identical circumstances so that comparable reference measurements can be made.

For any height measurement of an operator on a donor, the difference between actual and measured height is assumed to have a normal distribution with a certain systematic bias and variance, both unknown.

Systematic biases result from:

- Loss in height because of the pose of the donor, and
- Inaccuracy of the 3D model and the camera match.

Non-systematic bias of the differences is due to random variation mainly because of human interference (operator effects). On the basis of the readings from the reconstruction, the systematic and random error made in measurements is then modeled and confidence intervals for the questioned person's height can be determined.

Comparison of methods takes place by checking:

1. Consistency of the results and
2. Width of the confidence intervals.

The investigation comprises comparison of the methods in a casework example in which four perpetrators stood in front of two cameras.

Body Height Estimation, Photogrammetry, Validation

JURISPRUDENCE

E1 Crime Differences in Two Neighboring Cities in Northwest Turkey

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Upon completion the audience will be informed about the crime profile of Northwest Turkey. Furthermore the factors that shape this profile will be discussed.

This presentation will impact the forensic science community by informing attendees of the type of crimes and their percentages in Northwest Turkey and provide information about the differences in two neighboring cities in the area.

The prevention of crime can be achieved to increase of the awareness of the problem in the society. Generalized strategies may not be applicable and effective in different groups of people where attitudes are different. Therefore it is essential to estimate the current situation prior to any attempt of programming prevention methods. In this study a retrospective review is reported of general crimes in Kirklareli and in Edirne, two of the four cities in the Northwest part of Turkey, for the time period between 2001 and 2006. These two cities are interesting to study and compare because although they are neighboring and the have typical similarities however they show a different social make up. This research originates from the case records of the High Criminal Court of the province for rendered judgments for both cities. The case records were examined for demographic and medico legal aspects. The cases were analyzed for age, birthplace, criminal record, educational level, job, marital status, type of assault, and judgment. The analysis was done for both the victims and the perpetrators. The analyzed parameters were age and sex, alcohol influence, presence of violence, economical prosperity of the family, admissible evidences that were present for identification, and educational level of the involved people. The classification of the crimes were: sexual assault, counterfeiting, opposition for the code, homicide, fraudulent act, misconduct in office, seizure by violence, misappropriation, drug crime, breach of duty, depredation, criminal assault and battery, illegal trafficking, and the acts of bribery, acceptance of a bribe, breach of trust, arson, wielding, criminal libel, restraint upon liberty, burglary, rigging a competitive bidding process, maltreatment, indemnity, signing a bill by force, seeking treasure without permission, enforcement of a right, excavating without permission, providing explosive material, misrepresentation, illegal immigration trafficking, illegal arms trafficking, revile, human trafficking, invading privacy of the home, destruction of documents, bearing false witness, and escape. The total crime in number shows little difference between the two cities and if the larger population of Edirne is taken into consideration, the difference diminishes. However the types of crime differ in percentage. Sexual assault seems to be the highest in both cities at 17.19% in Kırklareli and 15.77% in Edirne. Illegal drug cases occurred in 3.21% of crimes in Kırklareli whereas it occurred 7.74% in Edirne. Burglary is the same rate for both cities at 0.72%. There were no cases of arson crimes in Kırklareli, however arson occurred 1.21% in the cases in Edirne. The data did not show an increase annually for both cities but it rather seems to be stable when total numbers are examined, however when individual crimes are considered there is a small increase in violent crimes in Edirne. A general stability is present for Kırklareli. The differences in the two cities are not surprising because although geographically they are very closely situated their social make up is different. Edirne is a city with borders to both Greece and Bulgaria, has an established university, and quite an important number of immigrants from other parts of the country. Kırklareli on the other hand has quite a uniform population with minimum of immigration. Therefore it is not striking that the two boarder cities have different percentages concerning smuggling, drugs trafficking, and illegal immigration traffic.

Thank you to Mr. Mustafa Erdogan, Chief Judge of the High Criminal Court of Kirklareli and Mr. Ibrahim Ethem Dikmen, Chief Prosecutor of Edirne Judiciary for access to their records and continuing support for the research.

Crime, Northwest Turkey, Crime Prevention

E2 Towards a Better Understanding of Latino Youth Gang Violence: A Growing Domestic Terrorism Problem for Medical Examiners/Coroners

Cliff Akiyama, MA, University of Pennsylvania, School of Nursing, 420 Guardian Drive, Room 402, Philadelphia, PA 19104/6096*

The goal of this presentation is to present timely data on Latino youth gangs and to offer strategies on how to recognize and interpret various tattoos and graffiti associated with these gangs, which could assist the medical examiner/coroner and death investigator in the positive identification of the decedent out in the field and/or in the autopsy room.

This presentation will impact the forensic community and/or humanity by assisting the medical examiner/coroner community in understanding the "signs and symptoms" of Latino gangs in order to keep themselves and those around them safe when investigating the deaths of these gang members.

Throughout the country in urban, suburban, and rural communities, medical examiners, coroners, and death investigators are constantly being challenged by intramural shootings between rival gang members admitted to the medical examiner/coroner's office. As first-hand witnesses of youth gang violence, the medical examiner/coroner's office, represent a highly skilled community resource in the modern multi-agency approach to help combat this new form of domestic terrorism. Youth gang violence has continued its upward trend nationwide, increasing over 20% according to the Department of Justice, Office of Juvenile Justice and Delinquency Prevention. Furthermore, gangs have been identified in every single state, meaning that gangs are no longer a California problem. Nationwide there are 24,500 gangs with a gang membership of over 750,000, while the ethnic composition of these gangs include 47% Latino, 31% African American, 13% Caucasian, 7% Asian, and 2% Mixed. In particular, youth gang violence in the Latino community has had a dramatic increase in the last few years. In Los Angeles County California alone, there are currently 635 documented Latino gangs with a gang membership of over 83,000. Demographics show a gang member average age of 15 with a range of 8-22 years. Other counties within California and nationwide have also seen increases in Latino gangs. The author interviewed over 300 gang members out in the streets, jails, and juvenile halls, using a target questionnaire; concomitantly went a step further disguised as a gang member out in the streets of Los Angeles to experience the state of mind of having "power." This study identified 8 distinct manifestations of gang violence and 9 ethnic differences and similarities among Latino gangs. A sample of the findings include: definite cultural differences between Latino gangs and various other ethnic gangs; drugs; weaponry; killing over turf/territory; extortion; defacing property/graffiti; women in gangs.

The purpose of this paper is to present timely data on Latino youth gangs. Most importantly, it is imperative that the medical examiner/coroner community understand the "signs and symptoms" of Latino gangs in order to keep themselves and those around them safe when investigating the deaths of these gang members.

Youth Gangs, Youth Violence, Latino-American

E3 Guru Demon Illusionist? Is It Time for an Overhaul of Expert Qualification Procedures?

John R. Nixon, MBA, Athena Research & Consulting, PO Box 66, Bippus, IN 46713; and Suzanne Drouet, LLM*, Innocence Project, Suite 1600, 201 East Baltimore Street, Baltimore, MD 21202*

After attending this presentation, attendees will learn how an expert is defined in a court of law, what the important aspects of expert qualification are, and the relationship between them. Additionally, attendees will learn why, and how, expert credentials should be scrutinized by opposing counsel, and the consequences of neglecting this important duty. The benefits and feasibility of the establishment of an independent entity responsible for expert qualification and certification will be discussed.

There is increasing concern among criminal justice professionals, and society at large, that experts are nothing more than paid advocates. This presentation will impact the forensic community by presenting strategies to ensure that unqualified and/or unscrupulous experts do not reach the witness stand, and that they wreak less havoc in those cases that do not make it to the courtroom. The pros and cons of an independent system for expert accreditation will be discussed. It is postulated that widespread adoption of these strategies will ultimately improve, and bolster public confidence in, the criminal and civil justice systems.

Judges are responsible for keeping unqualified 'experts' out of the courtroom. They must make reasoned and rational judgments based upon limited information, and in a short amount of time. It is postulated that much of this qualification burden could be borne, prior to trial, by opposing counsel. Additionally, because much expert consultation occurs prior to trial, the concept of expert qualification and certification by an independent organization is explored.

It is important that the courts have a supply of competent and ethical experts on hand to analyse evidence, review documentation, and explain complex technical and scientific issues to those involved in the case. In recent years, allegations of résumé "puffery", fraudulent qualifications, and misleading or dishonest courtroom testimony have tarnished the reputation of the entire expert community. The unfortunate result of this is that experts are increasingly viewed as paid advocates.

Judges must act as gatekeepers to their courtroom, using their judicial experience and judgment to weed out unqualified "experts", thereby keeping junk science and dishonest or misleading testimony from the ears of jurors. This process sounds plausible; however, judges have but a few minutes to accomplish this task in the courtroom. Inevitably, some less than stellar experts slip through the net, and juries have been exposed to quackery and deceit that, ultimately, may have led to injustice.

Judges routinely qualify experts in their courtrooms, and the process has become so mundane that it is often easy to overlook the fact that the process took place at all. In performing this qualification function, judges must assess the proffered experts based upon their education, training, and experience. The weight assigned to each of these criteria can be the subject of criticism.

In most cases judges are expected to perform this qualification process in just a few minutes, in front of the entire courtroom, and with minimal information validation. Clearly, there is insufficient time for the judge to verify any information presented, either in support of, or against, the "expert" presented to them. Very often judges will hear experts run through an impressive sounding list of memberships in "scientific" societies, plus a long list of publications, and this may well sway the final judgment with regard to expert suitability to testify on the matters at hand.

It can be argued that it takes an expert to know an expert and, by definition, even the most capable judges are not sufficiently knowledgeable to reliably assess the credentials of experts in every scientific field and subspecialism. It is postulated that juries would be exposed to fewer unqualified and unscrupulous experts if opposing counsel, with the assistance of an appropriate expert consultant, more thoroughly researched and challenged experts prior to trial. Opposing counsel should devote the time and resources necessary to research the expert's academic credentials, the nature and purpose of individual scientific societies, and the quantity and quality of the proposed expert's published work. Techniques for achieving these goals are discussed, and case studies presented.

Even if the courtroom expert qualification process worked flawlessly, the issue of the influence of non-testifying experts must be considered. The vast majority of criminal and civil cases never make it to the courtroom, and under the current system any 'experts' rendering opinions in these cases are not subject to any formal qualification procedures, yet their work may ultimately have a great influence on many lives. The long-term goal of establishing an independent national expert qualification and certification body is discussed.

Expert, Qualification, Accreditation

E4 The AJS Institute of Forensic Science and Public Policy - Science and the Law

Matt Epstein, JD, LLM, AJS Institute of Forensic Science and Public Policy, 101 West Friendly Avenue, Suite 100, Greensboro, NC 27401*

After attending this presentation, attendees will: learn about multidisciplinary approaches to forensic science, learn about trends in scientific testimony, and learn about research initiatives in forensic science.

This presentation will impact the forensic science community by. Issues of science and the law have reached critical levles in recent years, nowhere more so than in the forensic sciences. DNA exonerations and scientific skepticism have shaken the public trust in the criminal justice system. Recent initiatives based on multidisciplinary approaches have begun to improve the quality of forensic sciences and the capacity of lawyers and judges to deal with them.

DNA based exonerations and skeptical scientific reviews have undermined public trust in the forensic sciences specifically and in the criminal justice system generally. The American Judicature Society created the Institute of Forensic Science and Public Policy and the Commission on Forensic Science and Public Policy to bring together national leaders to address the issues and improve outcomes. The Commission, Co-Chaired by Scientist Stephen Fienberg, former Attorney General Janet Reno, and former CIA and FBI Director William Webster, is comprised of leading national scientists, judges, prosecutors, defense attorneys, law enforcement officials, and others. Together the Institute and Commission create a multidisciplinary approach to supporting and conducting needed research and education in forensic sciences.

The presentation will cover the following areas:

1. The current work of the Institute and Commission;
2. Ongoing field studies in eyewitness identification;
3. The problems facing courts in dealing with forensic issues;
4. The problems facing forensic scientists in dealing with courts; and
5. Proposed solutions and recommended practices.

At the end of the presentation it is anticipated that attendees will have a greater understanding of the problems as seen from multiple perspectives, a better grasp of potential solutions, and greater knowledge of current initiatives.

Research, Eyewitness Identification, Multidisciplinary

E5 Checking All the Cabinets: Dealing With Neglected and Overlooked Evidence

Betty L. DesPortes, JD, Benjamin & DesPortes, PC, PO Box 2464, Richmond, VA 23218; and Harry L. Miles, JD*, Green, Miles, Lipton, & Fitz-Gibbon LLP, 77 Pleasant Street, PO Box 210, Northampton, MA 01061-0210*

After attending this presentation, attendee will be familiar with two recent situations involving neglected or overlooked evidence. The presentation will address the impact of the neglected or overlooked evidence on laboratory resources and the criminal justice system.

The presentation will impact the forensic community by demonstrating the need to take remedial action in order to prevent a failure to process evidence samples. Strategies for preventing the neglect or omission of evidence samples include regular audits, independent inspections and increased involvement of oversight agencies.

Evidence samples from thousands of crime scenes across Massachusetts – some dating as far back as 1989 - were ignored at the State Police crime lab. Although backlogs in casework are common at crime labs across the country, the situation in Massachusetts appears to be the product of neglect and inadequate performance oversight within the laboratory system. State officials are now dealing with the lab's failure to process potentially crucial DNA evidence from as many as 16,000 cases.

In 2001, Virginia discovered additional evidentiary samples in an unexpected place – taped within case files from the 1970's and 1980's - held in state's long-term storage facilities. The inadvertent discovery of the evidence enabled Marvin Anderson to prove his innocence and obtain a gubernatorial pardon for his 1982 rape conviction. The evidence also permitted the state to convict the true rapist 20 years after the crime. Other inmates also requested testing and four more men were exonerated when DNA testing proved their innocence. The Governor of Virginia then took the extraordinary step of ordering the review of all case files (almost 500,000) to catalog evidence and the analysis of all samples that might exonerate the wrongfully convicted and implicate the true perpetrator. State officials expect hundreds of cases to be submitted to a private laboratory for DNA testing to determine whether the individuals convicted of the crimes can be exonerated. Additional unsolved cases are expected to be analyzed in the second phase of testing.

Neglected, overlooked, or inadvertently discovered evidence presents ethical and legal considerations that must be addressed by laboratories and the criminal justice system. The stakes in testing evidence samples that have been forgotten or overlooked for a long period of time are often higher than in current casework. Testing previously ignored evidence can solve decades-old crimes, but uncomfortable questions often arise about the responsibility for the failure to test – especially when additional crimes have been committed by a perpetrator or someone has been languishing in prison for a crime they did not commit while the evidence samples were neglected. Additional ethical and legal concerns arise when statutes of limitations lapse in cases involving neglected evidence.

Neglected evidence can also have a very high financial cost. The testing often requires hiring private firms to handle the testing because state crime labs are already operating at capacity – or over capacity – handling current casework. Massachusetts anticipates spending as much as $6 million to analyze samples; Virginia has already allocated $1.4 million to catalog the evidence and submit it to a private laboratory for analysis. Compensation to the wrongfully convicted also adds to the state costs. Virginia has paid millions of dollars in wrongful-conviction compensation and recently implemented a statutory scheme to compensate the wrongfully convicted and provide educational and career training.

The highest cost, however, may be to the system itself. The failure to process or track evidence samples can lead to a crisis in public confidence in the laboratory and the criminal justice system.

To avoid all of these costs – monetary and non-monetary – remedial steps need to be taken at all laboratories, including audits, external monitoring, independent inspections, and increased involvement of oversight agencies. Increased training of prosecutors and defense counsel to inquire into the existence and analysis of data would provide another opportunity to avoid error.

Not knowing what is in your refrigerator can cost you dearly.

DNA, Samples, Neglect

E6 Eyewitness Identification: Recent Developments in the Science and Policies

Sheri H. Mecklenburg, JD, U.S. Attorneys Office, 219 South Dearborn Street, Chicago, IL 60614*

The goal of this presentation is to educate the audience about the issues surrounding the science of eyewitness.

This presentation will impact the forensic science community by familiarizing attendees with the current issues surrounding the science of eyewitness.

The presenter is the director of the ground-breaking Illinois field study on eyewitness identification, the first field study to examine eyewitness identification procedures in hundreds of lineups involving real crimes, real victims, real witnesses, and real suspects. The Illinois pilot program, a year-long study of both photo and live lineup procedures from three different law enforcement agencies, grew out of recommendations made to address wrongful convictions. The Illinois study is the first field study to collect data on recommended reforms, the first field study to concurrently collect data for comparative purposes on traditional lineups and the first field study to offer a comparative analysis. Two nationally-renowned experts analyzed the data independently.

The acceptance of DNA evidence by the judiciary revolutionized the criminal justice system, allowing police and prosecutors to determine with certainty the guilt or innocence of suspects in crimes where the offender left behind probative biological evidence, such as those involving sexual assault. The acceptance of DNA also opened the door to exoneration for the innocent who had been wrongfully convicted prior to the availability of DNA. The first wave of these DNA exonerations shook the faith in and foundations of the criminal justice system, leaving law makers, lawyers and law enforcement to search for answers as to what had gone awry and to seek safeguards to prevent such miscarriages of justice in the future. In attempting to learn lessons from these DNA exonerations, mistaken eyewitness identification emerged as one of the most common contributing factors to wrongful convictions.

Since the role of mistaken eyewitness identifications in wrongful convictions came to light, the way in which eyewitness identification is obtained by law enforcement has been called into question. Some answers have been offered by experimental research studies of eyewitness identification procedures. This body of science has offered, among other things, "the sequential, double-blind eyewitness procedure" for lineups. Though the protocols for the sequential double-blind procedure are not yet standardized, this method generally involves showing photos or participants one at a time rather than side-by-side, with the witness required to make a decision on each photo or person before viewing the next one. The "double-blind" component requires that the lineup be conducted by an administrator who does not know which photo or live participant is the suspect and which are the fillers or "foils."

Although the National Institute of Justice recommended in 1999 that field studies on proposed eyewitness identification reforms be conducted, it was not until Illinois undertook such a study in 2006 that the call for field studies on eyewitness identification procedures gained widespread support. The findings of the Illinois study will surprise you. The response to the study also may surprise you. However the Illinois study is viewed, two questions relevant to all scientists cannot be ignored: (1) to what scientific standards will the science of eyewitness identification in this post-DNA world be held; and (2) to what extent has politics influenced the science of eyewitness identification?

The presenter will present the findings of the Illinois study, address the criticisms and make recommendations for the future of eyewitness identification.

Eyewitness Identification, Lineups, Field Studies

E7 Coping With the CSI Effect: From the Perspective of a Career CSI

Thomas L. Martin, BA, Crime Scene Forensics, LLC, P.O. Box 515, Red Hook, NY 12571*

After attending this presentation, attendees will understand the legal and investigative issues created by the Hollywood portrayals of forensic science and crime scene investigations. This presentation will put forensic crime scene investigations back in perspective, and will re-focus attendees to the practical aspects of conducting a criminal investigation, and presenting evidence in court.

This presentation will impact the forensic community by explaining the objectives of collecting physical evidence to support or refute information as it develops during the course of an investigation.

Every crime scene tells a story, and every person at the center of a criminal investigation tells a story. At times that story can be quite detailed and complex, at other times, the story can be quite simple. The job of the crime scene investigator is to collect and document physical evidence. The role of the criminal investigator is to compile information in any form in which it is presented. At the end of the day, in a properly conducted investigation, the crime scene investigator and the case investigator should sit down and compare notes in an effort to determine whether or not the physical evidence corroborates the story behind the case.

As the field of forensic science, continues to progress, we see science taking center stage in more and more criminal cases. Science and technology have their appropriate place in criminal investigations and subsequent court proceedings, but should not replace the basic common sense and logic that has solved cases for many years.

The inception of the CSI fad has notably caused a change in the expectations of jurors who constantly watch forensics related programming. This realization is somewhat understandable, given the fact that most people know about forensic science what they've learned from their favorite television show. The cause for greater concern is the effect that forensic science is having on the criminal justice community. Most criminal cases are solved with hard work and perseverance; compiling information, documenting and collecting physical evidence, tracking persons of interest, and interviewing anyone and everyone with viable information. Investigations should not be *limited to* forensic science, but should rather be *supported* by forensic science. The basic observations made at a given crime scene and the subsequent documentation of those observations will corroborate or refute the "story", or the information being gathered. In analyzing the physical and informational evidence together, a just and reasonable conclusion can be drawn. Forensic science techniques should be added as additional information from which the conclusion should be drawn; hence, the "story" should never be ignored.

The term "CSI Effect" has become common place in the criminal justice community; however, the term "Tech Effect" may be more appropriate given the suggestion behind the term. The expectation of jurors to see something scientific presented as evidence may be satisfied through demonstrative evidence which accurately and collectively displays the physical and informational evidence collected during the investigation. Furthermore, the crime scene today no longer ends at the four walls in which it is encompassed. The crime scene today extends to such lengths as phone records, e-mails, financial transaction records, travel records, etc… These records can number in the thousands, and need to be properly displayed and organized to first be interpreted by the investigator, and later be demonstrated to a jury. Modern technology allows for the analysis and display of such records to paint a vivid and accurate picture of one's activities.

This presentation will further explain the pertinent observations that should be made and documented by the crime scene investigator, as well as the technology available to display the information normally used to track the activities of principles in the case.

Forensic Evidence, CSI, Technology

E8 Intimidated or Not Convinced? A Study of Juries and Unexpected Acquittals

Judith G. Fordham, BSc, LLB, Murdoch University, School of Biological Sciences & Biotechnology, Murdoch, WA 6150, AUSTRALIA*

Attendees will gain an insight into the reasons for unexpected acquittals, and an apprecaition of the prevalence, forms, and effects of juror intimidation. Attendees will be able to implement these findings into trial practice, and consider means of avoiding acquittals "against the evidence."

Acquittals against the evidence must be avoided as far as is possible, but it is crucial to ensure that the evidence to convict is indeed strong. This presentation will impact the forensic science community by demonstrating how reasons behind unexpected acquittals must be closely examined, and "easy" answers even more closely examined, in order to ensure just outcomes.

Juries will sometimes return verdicts which fly in the face of prosecutorial expectations. Cases which are said to be strong forensically will end with acquittals. Afterwards public recriminations fly, especially where the crimes are gruesome, the victim especially photogenic, or the accused "known high profile organized crime identities". The media criticises the quality of the prosecution, the defense criticises the fact that the prosecution took place at all, the acquitted give press interviews claiming persecution, and in due course the finger is pointed at the jury: either they were too incompetent to understand the forensic evidence or they were intimidated by the accused. Issues of jury competence in respect if forensic evidence were previously considered, but very little systematic and rigorous work has been carried out internationally in respect of the latter question. Were the jurors intimidated? And if so, just who or what intimidated them, and how? How did it affect the juror(s)? Importantly, did the intimidation affect the verdict? Or were there other reasons contributing to the failure of the prosecution?

Following several celebrated acquittals in Western Australia, and ensuing media and public pressure (informed and otherwise) for the abolition of juries, the author was tasked to examine the extent and nature of jury intimidation in criminal trials in Western Australia. A random and representative sample of almost 5000 jurors from 400 criminal trials held in the Supreme and District courts in Western Australia over the past legal year (2006-2007) were approached to complete a detailed survey, with those who reported some form of intimidation and who were willing, interviewed about their experiences.

The results shed the first light upon failed prosecutions, indicating that the reasons are often more complex than suggested by post-trial reports. The media reports and statements by public figures may be at odds with the self-reports of jurors, and the source of intimidation when it occurs may be different from that suspected.

The true reasons for the "unexpected" acquittals are explored, with sometimes surprising results.

Given the experience of intimidation is not dependent upon the precise nature of the justice system within which it occurs, the data, conclusions and recommendations are of universal application.

Conclusions about the effectiveness of institutional measures designed to reduce the chance of intimidation are drawn, and the effect upon jurors of intimidation, and/or public criticism of their verdicts are drawn.

Lessons for forensic scientists, police and investigators generally, and prosecuting and defense attorneys are drawn from the resulting data. Recommendations are made for procedural and behavioural changes to minimise the prospects of intimidation and of the tainting of verdicts by such malign influences.

Juries, Intimdation, Acquittals

E9 Impulsive Legislation: Adverse Consequences of Excluding Appropriately Qualified Experts From the Lawmaking Process

John R. Nixon, MBA, Athena Research & Consulting, PO Box 66, Bippus, IN 46713*

After attending this presentation, attendees will learn that not all laws are well drafted, what the adverse consequences of this are, and what can be done to improve the situation.

There is increasing concern among criminal justice professionals and society at large that poorly drafted laws result in prosecution of non-target groups, and a waste of law enforcement and prosecutorial resources that could be better utilized in the arrest and prosecution of hardened criminals who genuinely pose a legitimate threat to society. This presentation will impact the forensic science community by seeking to raise awareness of this problem, and provide impetus for change.

Lawmakers draft laws that are frequently riddled with technical inaccuracies, vague and ambiguous language. This paper presents examples, and proposes that greater involvement of suitably qualified experts at the drafting stage would result in more accurately targeted legislation and a smoother running justice system.

Congress is the Legislative Branch of the U.S. Government, responsible for the formulation of new laws that are intended to, among other things; protect the U.S. populace from physical and financial harm. Despite the fact that many new laws contain a plethora of technical information and definitions, new legislation is drafted by elected officials and their staff, very few of whom have a scientific or technical education. It is often assumed that those who draft the proposed new legislation have consulted technical and scientific experts in the appropriate fields; however, the abundance of inappropriate, vague, and ambiguous language contained in much of our legislation may cause the rationally minded to question this assumption. Unfortunately, once legislation is enacted, it is very difficult to modify.

It is evident that some legislation is the result of whiplash emotional reaction and media pressure in the aftermath of catastrophic events, and it is argued that this approach is not conducive to reasoned and effective legislation.

The net result of these legislative shortfalls is that the lawmakers intended targets will not be dissuaded from participating in undesirable behaviour and, more importantly, otherwise legitimate law abiding citizens are inconvenienced and/or convicted. In extreme cases harmless citizens may receive long custodial sentences and hefty fines because they inadvertently and/or unintentionally violated a piece of legislation that was intended to curtail the actions of hardened criminals or terrorists.

This phenomenon is particularly prevalent in the federal system. Many over zealous prosecutors feel obliged to prosecute each and every case aggressively, irrespective of mitigating circumstances. Where bench trials are concerned, judges, often sympathetic to defendants whom they consider pose no threat to society, feel that they have no choice but to follow the letter of the law and convict defendants of the charges against them. Fortunately, judges often have a great degree of latitude in the sentence that they impose; however, a lenient sentence does not mean that the convict avoids a felony conviction record. Juries often have difficulty interpreting confusing and illogical legislation, and the conflicting "expert" testimony that is often presented in court.

This paper explores the adverse political & social consequences of poorly drafted legislation, and examines how technical experts may be better utilized by lawmakers during the legislation drafting process. It is postulated that, with better communication between the legislative and scientific communities, far less ambiguous legislation could be formulated. Case studies are used to illustrate key points.

Experts, Legislation, Congress

E10 Mandate and Functions of the United Nations International Narcotics Control Board and the Emerging Threat of Unregulated Drug Markets

Sevil Atasoy, PhD, United Nations International Narcotics Control Board, Vienna International Centre, PO Box 500, Vienna, 1400, AUSTRIA*

After attending this presentation, attendees will understand the important and highly sensitive role of the International Narcotics Control Board in national and transnational drug and crime fighting.

This presentation will impact the forensic community by providing the forensic community with first hand information on the membership, mandate, function and recommendations of the International Narcotics Control Board.

The independent and quasi-judicial monitoring body for the implementation of the United Nations international drug control conventions, namely the International Narcotics Control Board (INCB), was established in 1968 and had predecessors as far back as the time of the League of Nations. The mandate and functions of INCB are laid down in the Single Convention on Narcotic Drugs, 1961; the Convention on Psychotropic Substances of 1971; and the United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances of 1988.

INCB consist of thirteen Members elected by the Economic and Social Council (ECOSOC) for a term of five years. Ten members are elected from out of nominations received from Governments and three out of nominations received from World Health Organization (WHO). The members of INCB function in their personal capacities and do not represent their governments. The INCB secretariat is an administrative entity of the United Nations Office on Drugs and Crime (UNODC) reporting exclusively to the Board on matters of substance. The first part of the presentation will summarize mandate, function, membership and activities of the Board.

INCB, monitors compliance with drug control treaties, endeavors in co-operation with governments that adequate supplies of drugs are available for medical and scientific uses and that diversion of drugs from licit sources to illicit sources do not occur. The Board also monitors governments control over chemicals used in the illicit manufacture of drugs and assists them in preventing their diversion into illicit channels and supports them by different means in combating illicit cultivation, production, manufacture, trafficking and abuse of drugs. The Board identifies where weaknesses in the national and international control systems exist and contributes to correcting the situation. As a last resort, the treaties empower INCB to recommend to parties that they stop importing drugs from a defaulting country, exporting drugs to it or both.

The INCB is mandated to publish an annual report on its activities, which provides a survey of the drug control situation in the world and analyses, trends in abuse and illicit traffic and suggests necessary remedial action.

The second part of the presentation will focus on unregulated markets in relation to narcotic drugs and psychotropic substances under international control, identified by the Board as an emerging threat and elaborated thoroughly in the first chapter of its last year's annual report. Examples will be presented on the wide variation in the forms of unregulated markets and the ways they operate, which have evolved and exist in different forms, in different parts of the world. Common factors that have created demand for an unregulated market such as the limited access to hospitals, clinics or pharmacies, the lower price of most medicinal products found on the unregulated markets, the need to obtain controlled drugs in privacy, the lack of public awareness of the dangers of buying drugs on the unregulated market, the overly stringent prescription requirements in some countries and the increasing need to performance-enhancing drugs available only with a prescription will be discussed.

The presentation will also emphasize the problem of counterfeit drugs, which according the World Health Organization comprise 25-50 percent of the medicines consumed in developing countries, the risks involved in buying pharmaceutical products through unregulated, illegal Internet pharmacies

and will conclude with recommendations of the Board to Governments and relevant parties such as the industry, wholesalers, retailers, professional associations, consumer and patient groups and international organizations to remedy the situation. The presentation will also provide a personal view on the necessity of networking among forensic science laboratories of law enforcement agencies and on the urgent need of their global capacity improvement for a successful combat against unregulated markets.

International Narcotics Control Board, International Drug Control Conventions, Organized Crime

E11 Proportionality of Sentences for Drug-Related Offences: Analysis of the Situation and Recommendations by the International Narcotics Control Board

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After attending this presentation, attendees will learn concepts and origins of the principle of proportionality and the recommendations of the International Narcotics Control Board for governments to ensure the principle of proportionality is respected in dealing with drug-related offenses.

This presentation will impact the forensic community by demonstrating the relevant provisions of the international drug control conventions to determine whether they meet the proportionality standards in the light of the proportionality principle, and the proposed recommendations for governments to ensure the principle of proportionality is respected in dealing with drug-related offenses.

The International Narcotics Control Board (INCB) is the independent and quasi-judicial monitoring body for the implementation of the United Nations international drug control conventions. It was established in 1968 in accordance with the Single Convention on Narcotic Drugs, 1961. It had predecessors under the former drug control treaties (the Permanent Central Narcotics Board and the Drug Supervisory Body) as far back as the time of the League of Nations.

The Board has thirteen members elected by the Economic and Social Council (ECOSOC) who have to serve independently (of Governments as well as of the United Nations) and impartially in their personal capacities for their five year term of office. Ten members of the Board are elected from a list of nominations by governments and three, from nominations by the World Health Organization.

The mandate and functions of INCB are laid down in the Single Convention on Narcotic Drugs, 1961; the Convention on Psychotropic Substances of 1971; and the United Nations Convention against Illicit Traffic in Narcotic Drugs and Psychotropic Substances of 1988. 183 U.N. member States, namely 95% of all, are party to all three international conventions, meaning an almost universal adherence.

INCB has a secretariat located in Vienna, Austria, that assists it in the implementation of its treaty-related functions. The secretariat is an administrative entity of the United Nations Office on Drugs and Crime (UNODC) but it reports solely to the Board on matters of substance.

INCB strives, in cooperation with governments, to ensure that adequate supplies of licit drugs are available for medical and scientific uses and that the diversion of drugs to illicit channels does not occur. INCB also monitors control over precursor chemicals used in the manufacture of illicit drugs and support governments in preventing the diversion.

As regards the illicit manufacture of, trafficking in and use of drugs, INCB identifies weaknesses in national and international control systems and contributes to correcting such situations. INCB is also responsible for assessing chemicals used in the illicit manufacture of drugs, in order to determine whether they should be placed under international control.

INCB is called upon to ask for explanations in the event of clear violations of the treaties, to propose corrective actions and, where needed, to assist governments in overcoming difficulties. If, however, INCB notes that the actions necessary to remedy the situation have not been taken, it may call the matter to the attention of the Commission on Narcotic Drugs and ECOSOC. As a last resort, the treaties empower INCB to recommend to parties that they stop importing drugs from a defaulting country, exporting drugs to it or both.

INCB is mandated to publish an annual report on its activities, which provides a survey of the drug control situation in the world and analyses, trends in abuse and illicit traffic and suggests necessary remedial action. The report is supplemented by technical reports providing details of estimates of annual legitimate requirements in each country as well as data, the licit production, manufacture, trade and consumption of these drugs worldwide.

Furthermore, the report is supplemented by the report to the Commission on Narcotic Drugs on the implementation of article 12 of the 1988 Convention which contains an analysis of measures Governments have taken against the diversion of precursors and essential chemicals and trends in illicit trafficking in such substances.

Since 1992, the first chapters of the annual reports have been devoted to a specific drug control issue on which INCB presented its conclusions and recommendations in order to contribute to policy-related discussions and decisions in national, regional and international drug control.

In this years' (2007) report the Board examined the concepts and origins of the principle of proportionality, particularly in relation to but not limited to sentencing for drug-related offences.

This presentation will specifically focus on the analyses by the Board of current implementation of laws and practices around the world, the review of the relevant provisions of the international drug control conventions to determine whether they met those proportionality standards in the light of the proportionality principle, and on proposed recommendations for governments to ensure the principle of proportionality is respected in dealing with drug-related offences.

Proportionality of Sentences, Drug-Related Offences, International Narcotics Control Board

E12 Rush to Judgment! Do Some Forensic Scientists Jump to Conclusions, Thereby Facilitating Injustice?

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After attending this presentation, attendees will learn that some forensic scientists jump to conclusions, possible reasons for this recognized phenomenon, and what safeguards and solutions may be appropriate in order to minimize the adverse consequences, and reduce future occurrences.

This presentation will impact the forensic science community by raising awareness of rushed and erroneous forensic science work. It discusses why scientists may exhibit this behaviour, and explores strategies to minimize the number of times that forensic scientists hastily form scientifically invalid and unjustifiable conclusions.

Some forensic scientists jump to conclusions when they examine evidence and report their findings. The intervention of opposing experts in some cases has averted great injustice. However, the majority of forensic science work does not undergo the rigors of an independent expert evaluation and, inevitably, some erroneous forensic science work must be slipping through the net. Will greater use of independent experts result in a fairer justice system, or will other reforms prove more effective?

Poor forensic science is usually exposed only when one side hires and independent expert consultant to review the work of the original forensic scientist. It is not rare to find that the original scientist may have taken short-cuts in the work and, for whatever reason(s), has jumped to an invalid conclusion. In civil proceedings the result may be an unjustified financial loss for one party; however, in the criminal arena the consequences can be erroneous loss of liberty or life.

There is no question that some forensic scientists have rushed their work, and jumped to conclusions that were subsequently proven to be

incorrect. Two examples, where the lack of independent expert intervention may have resulted in lengthy false convictions, are used to illustrate this point.

Potential reasons for erroneous work are considered and discussed, such as bias in favour of the hiring party, intimidation by the hiring party, overly heavy workload (fatigued and/or rushed), laziness, poor motivation, laboratory distractions, and lack of education & training.

Whether an expert is working for the prosecution, plaintiff, or defence, they are undoubtedly hired by someone. In most jurisdictions the crime lab has strong ties to the prosecutor's office, and local law enforcement officers. Independent experts are usually hired infrequently by a large number of clients. Consequently, it can be argued that the crime lab forensic scientist is more likely to feel pressure to conform, and meet client expectations, than is the independent forensic scientist. After all, the 'clients' have the power to influence, or even end careers. Even if the employee does not feel intimidated by this overt master-employee relationship, they may feel pressure to deliver results for those they view as their friends and colleagues - the good guys of law enforcement.

It is no secret that most crime labs are under great pressure to handle ever increasing caseloads. Under these conditions forensic scientists may feel obliged to rush their work and/or become fatigued by the fast pace. Poor management and working conditions may de-motivate once conscientious scientists, and distractions in the office or laboratory may lead to errors in work - is that open plan office really such a great idea? Does it really make sense to hire general forensic scientists for work that probably requires detailed specialist knowledge or in some instances to hire ridiculously inappropriately qualified people? You wouldn't accept a motor mechanic doing your kidney transplant; so why accept a registered nurse performing engineering work?

Techniques and strategies to minimize the instances and adverse effects of rushed work are discussed, including the hiring of independent consultants to review work, and the improvement of crime lab management and quality procedures.

Invalid, Scientific, Conclusions

ODONTOLOGY

F1 Where Oh Where Did the Maxilla Go?

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After attending this presentation, the audience will consider the limited number of forensic identification cases in which a mandible is present and the maxilla is absent. The difficulty of identifying a victim that has a mandible, but no maxilla and several missing teeth is greatly augmented.

Attendees will extrapolate possible events that may have led to the disappearance of the victims' maxilla by studying the skull fragments for markings, trauma, abrasions, perforations, and fractures. A forensic odontologists' primary goal is to identify a victim by studying their remains and evaluating all accrued scientific data and observations. This presentation will impact the forensic science community by aiding law enforcement and forensic scientists in assessing trauma and resultant markings on the skull bones and fragments.

A skull and mandible were found in the woods, under thick bushes and vegetation. The skull had no soft tissue present. The Maxilla was totally detached from the skull and absent from the death scene. All of the facial bones, inferior orbital bones, and temporal bones were absent as well. The sutures of the skull were slightly enlarged, if not fractured. There were abrasion markings along the outer perimeter of the skull, which appeared to be animal gnaw marks. There were no shot gun pellets or weapons found at the site of the remains. There are two hypotheses' that can be suggested from this unusual situation. One thought is that there was blunt trauma to the front of the victims face, resulting in severe fracturing of the facial bones. As decomposition engulfed and broke down the soft tissues, the fractured facial bones separated. It was noted that abrasions consistent with animal gnaw marks were present around the frontal, occipital, and orbital bones of the skull. One possibility is that an animal gnawed and removed the damaged maxilla, and deposited it at an unknown location. Another hypothesis is that the victim was mutilated and the assailant removed the maxilla. A third possibility is that an animal was able to remove the victims' intact maxilla with constant gnawing and tearing of the skull.

The skull and mandible were photographed, x-rayed, and studied. The teeth of the mandible were charted on a postmortem dental chart. There was postmortem tooth loss of teeth #21, 24, 25, 26, and 31. Tooth #17 was a partial boney impaction. There were no dental restorations. Police provided a list of possible victims. The list was from a missing persons list. Antemortem records and x-rays were studied and charted on an antemortem dental chart. Comparisons of the antemortem and postmortem dental records were analyzed. Bone trabeculation and socket structure were studied. A word search was conducted using the AAFS library, searching for similar cases where maxillas' were missing from death scenes.

The victim was identified after antemortem records, x-rays, and postmortem records were compared and contrasted with postmortem records. The abrasion marks on the skull fragment were conjectured to be animal gnaw marks. There were no cases found in the word search that matched this case exactly. There was considerable literature regarding the loss of the mandible as a result of animal activity.

The reason for the loss of the maxilla and maxillary teeth remain a mystery. The most logical conclusion is that the victim had forceful trauma to the face, which led to the maxilla being easily separated from the skull. The marks on the skull were consistent with animal gnaw marks.

Forensic Odontologists, Maxilla, Animal Activity

F2 Skill Assessment System to Facilitate Personnel Management of Forensic Odontologists at Mass Disasters Requiring Victim Identifications

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Upon completion of this presentation, participants will understand (1) the need for a shift or team captain's ability to quickly assess the skills of dentists seeking to assist in forensic odontology victim identification efforts, (2) a proposed system for classifying forensic odontology skills, (3) the potential for creating education partnerships between victim identification teams and dental schools, the American Society of Forensic Odontology and/or the American Academy of Forensic Sciences to administer an educational qualification program and (4) the importance of skill assessments in validating a dentist's ability to be educationally qualified as a member of an ID team.

During a mass disaster victim identification effort, there can be a need for a large number of dentists with forensic odontology skills. For example, during the World Trade Center identification effort, approximately 300 dentists participated. While participants needed to show completion of forensic odontology courses, these qualifications did not enable team captains to quickly or accurately determine a participant's experience, knowledge or skill level. The implementation of a Forensic Odontology Victim Identification Skill Assessment System will impact the forensic science community by facilitating this determination and enabling the most effective utilization of personnel in the time of a mass disaster victim identification effort.

The events of September 11, 2001 and Hurricane Katrina brought to American soil the horror of terrorism and natural mass disasters. These acts were of a proportion few imagined was possible. Hundreds of individuals provided time and expertise to address the forensic identification needs. Lessons learned from those experiences encountered during these disasters conclude that more comprehensive planning and training would make future responses more effective and efficient.

While there have been suggestions as to the content of forensic curricula, none of these proposals have suggested educational qualifications which would enable identification team captains to quickly and fully recognize the level of competence of a community dental practitioner or a non-board certified forensic odontologist presents with during a mass disaster identification emergency. Knowing the skill levels of dentists wishing to participate in large scale victim identification efforts could greatly assist individuals responsible for ensuring the efficiency and integrity of the victim identification process.

It should be noted that the proposed educational qualifications do not equate to board certification. Board certification by the American Board of Forensic Odontology requires proficiency and documented experience in victim identification, bite mark analysis, as well as expert testimony. The proposed framework only indicates that a dentist has completed

educational programs and has successfully completed skill assessments in victim identification.

Four educational qualifications, each corresponding to one of the four teams normally organized in a mass disaster victim identification effort, would be required in order for an individual to be educational qualified as a *Mass Disaster Victim Identification Forensic Odontologist.* These qualifications include: (1) Antemortem, (2) Postmortem, (3) Comparison, and (4) Shift Leader & Field Teams. An individual who is educational qualified for all four teams will be educationally qualified as a *Mass Disaster Victim Identification Forensic Odontologist* when all four team sub-qualifications have been completed. Normally, Shift Leader & Field Team qualification would be the last qualification completed, with other team educational qualifications being achieved in any order.

By establishing four educational qualifications, dentists can participate based upon their skill level. Shift or team leaders would immediately know the skill level of dentists who have achieved various educational qualifications, thus minimizing time required to credential team participants in a mass disaster victim identification effort.

To facilitate training for individuals wishing to achieve such qualifications, dentists would be required to complete courses developed by dental schools, the American Society of Forensic Odontology or the American Academy of Forensic Sciences. Web based courses would enable dentists to rapidly receive some of this training in the event of a major emergency.

Educational qualifications would be based upon dentists passing skill assessment examinations. Dental schools, the American Society of Forensic Odontology and/or the American Academy of Forensic Sciences would develop and administer these skill assessments. Assessment mechanisms may include written examinations to confirm foundation knowledge as well as hands-on simulation examinations such as resecting maxilla and mandibular bones in a cadaver laboratory, taking photographs and radiographs in a cadaver laboratory, completing ante- and postmortem chartings and entering chart information into forensic identification software (including the scanning of radiographs), and making victim identifications using victim identification software.

This presentation will also report the status of a novel partnership between the University of Medicine and New Jersey - New Jersey Dental School and the New Jersey Disaster Victim Identification Team (NJ-DVIT).

Victim Identification, Educational Qualification, Forensic Odontology

F3 Personal Identification by Morphometric Analyzes of Intra-Oral Radiographs of Unrestricted Teeth

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The goal of this presentation is to elaborate a biometric method for personal identification, comparing digital intra-oral radiographs simulating antemortem and postmortem data.

This presentation will impact the forensic community by underlining the importance of the use of a morphometric analysis in odontological identification.

Introduction: Routine means of identification includes visual recognition, clothing, personal artifacts, fingerprints, DNA matching and also skeletal and dental examinations.

In particular intra-oral radiology is an important tool for victims' identification.

It is based on the comparison between antemortem and postmortem radiographs, looking for individual distinctive features, such as morphology and pathology of teeth and alveolar bone, and details of dental restorations.

Dental treatments, in fact, result in specific and individually characteristic restorations, which for the most part are well depicted on intraoral radiographs.

However, nowadays, preventive interventions have reduced the number of dental restorations. The change in dental health status has interfered with the discriminating potential of dental restorations, which is apt to make conventional forensic dentistry less powerful.

In this way obtaining a positive match by using methods based on manual comparison of intra-oral radiographs without restorations is more difficult.

The aim of this study was to elaborate a biometric method for personal identification by comparing simulating antemortem and postmortem digital intra-oral radiographs, using a computer analysis of dental anatomical structures.

Materials and Methods: The sample consisted of 140 digital intra-oral radiographs (70 subjects) carried out by RVG using long cone technique Rinn aim rings and bite-blocks.

In the application of this method, measurements were taken only on inferior right first molars with no restorations.

From the beginning two points of the cemento-enamel junction (CEJ1-CEJ2) were recognized for tracing the straight line that joins those points; subsequently, at this line was carried the perpendicular from distal cemento-enamel junction intersecting profile of distal root in the most apical point (R1). From this point was carried the parallel to the straight line connecting CEJ1 and CEJ2 intersecting profile of mesial root in most external point (R2). Traced the straight line connecting R2 and CEJ2 the diagonals of obtained quadrilateral were drawn; they locate radicular furcation point (F).

Both passages - design drawing of the line and the acquisition of intra-oral radiographs - were effectuated by digital systematic research using a specific dental software.

After making a quality selection of the images, they were submitted to morphometric analysis using dedicated software.

Following the operative protocol, 5 previously located reference points were identified and marked by the software on every acquired intra-oral radiograph.

The program then automatically supplies values of the absolute distances, the relative distances, the shape factors, the moments, the perimeter values and the areas of the triangles obtained by joining the points. Six numerical sets were thus obtained for each image.

Statistical comparison was made of the sets by the linear regression, determining the correlation coefficient

Cross-analysis was made on each of the six numerical sets obtained from the 140 images (70 patients X 2), yielding 29400 comparisons (6 X 70 X 70) for heterologous correlations and 420 comparisons for homologous correlations (6 X 70).

Results: Analyzes showed that the areas of the triangles, the shape factors and the moments did not serve for identification purposes due to overlapping, the maximum values for the correlation coefficient in the heterologous comparisons being in the same range as those for the homologous comparisons in a lot of samples.

On the contrary, cross comparison of the correlation coefficients for the sets of absolute and relative distances, and perimeters showed that they could potentially be useful, possibly in association with other analyzes, for identification purposes.

The numerical results were:

- The correlation coefficients for autocorrelations for the absolute distances was 0.9999
- The correlation coefficients for autocorrelations for the relative distances was 0.9999
- The correlation coefficients for autocorrelations for the triangle perimeters was 0.9999
- The correlation coefficients for heterocorelations for the absolute distances was between 0.9855 and 0.9997
- The correlation coefficients for heterocorelations for the relative distances was between 0.9783 and 0.9996

- The correlation coefficients for heterocorelations for the triangle perimeters was between 0.9798 and 0.9996

The results indicate that:

- The section point for the output of comparison of the absolute distances is 0.9997; higher correlation coefficients indicate certain identification and lower values certain exclusion.
- The section point for the output of comparison of the relative distances is 0.9996; higher correlation coefficients indicate certain identification and lower values certain exclusion.
- The section point for the output of comparison of the triangle perimeters is 0.9996; higher correlation coefficients indicate certain identification and lower values certain exclusion.

Thus it can be concluded that if the comparison of two intraoral radiographs yields a higher correlation coefficient than minimum threshold for autocorrelation of the absolute distances, relative distances and triangle perimeters, there is a clear identification.

Morphomemetric Analyzes, Forensic Odontology, Intra-Oral Radiographs

F4 Use of UV LED Light as a Tool in the Forensic Dental Examination of Unidentified Human Remains

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The goal of this presentation is to highlight the value of inexpensive, portable UV LED lights in determining the presence of composite restorations during the forensic dental examination.

This presentation will impact the forensic science community by demonstrating how the use of these small and inexpensive UV LED lights can make the presence of tooth colored restorations more easily detected by the examining forensic dentist.

According to the American Dental Association, the number of posterior composite resin restorations placed by all private practitioners in 1990 was estimated to be 13,860,000. By 1999 that number had increased by over 300% to 46,116,000. The decrease in the use of amalgam as a dental restorative material for posterior teeth and the significant increase in the use of composite resin in posterior teeth will undoubtedly complicate the forensic identification of unknown human remains.

The increase can be attributed to the fact that dentists are doing more conservative restorations; the adhesives that bond the composite to the dentin and enamel are producing higher bond strengths. Color stability, and wear resistance have been improved. Patients are more aware that there are "white fillings" available and they are requesting them.

Determining the presence of an amalgam restoration during the postmortem clinical examination, even in dentitions involved in fires is relatively easy. Because the shade of the composite restoration often matches the tooth so closely it can be overlooked during the postmortem examination. Complicating this is the fact that the forensic odontologist may be performing an identification in a location that he or she is not familiar with such as a funeral home, a temporary morgue, in a tent, or warehouse where the available lighting may make visualization more difficult and the ability to thoroughly clean the dentition may be limited.

The use of UV lights to detect the fluorescent properties of composite resins is known. The use of battery operated small UV LED lights in forensic odontology is relatively new. This case will demonstrate to forensic odontologists the value of these lights.

The partially decomposed remains of an adult male was found by hikers. There was no wallet or other form of identification on or near the body. There were no scars, tattoos, or other identifying marks present. Fingerprints were obtained, but no antemortem fingerprints were on record. During the initial clinical dental examination several composite restorations were noted. These restorations closely matched the shade of the surrounding tooth. A small UV LED light was then used, and several additional composite restorations became visible. The radiographic examination confirmed the presence of multiple composite restorations which were detected by the UV LED light.

The local police department was notified of a possible missing person. Good detective work allowed investigators to obtain the antemortem radiographs and treatment records of a possible missing person. The antemortem and postmortem radiographs and treatment records confirmed that this was a positive identification.

The use of UV LED lights is not meant to be a substitute for careful visual and radiographic examinations. However, with the increased use of composite dental materials these lights can be valuable in identifying the presence of composite resins that might be overlooked during the visual examination or difficult to detect with radiographs.

UV LED Lights, Composite Restorations, Forensic Odontology

F5 Comparative Analysis of the Effects of Heat on the PCR-Amplification of Various Sized DNA Fragments Extracted From Sus Scrofa Molars

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After attending this presentation, attendees will learn that DNA from sus scrofa teeth embedded in jawbone and from whole fleshed heads can be amplified at high temperatures.

This presentation will impact the forensic community by demonstrating an increased rate of success in DNA amplification compared to previous research conducted on isolated human teeth and exemplifying the sus scrofa dentition as a viable alternative to humans in such experimentation.

This study investigates the degree of protection afforded to the pulp chamber of *sus scrofa* dentition by the dental enamel, alveolar process and soft tissue mass of the head during incineration. Further, it examines the temperature above which DNA can no longer be amplified using PCR-based analysis. Segments of defleshed *sus scrofa* maxilla and mandible encasing the fist molar (n=60) were subjected to a range of incineration temperatures (302, 437, 572, 707, 842, 977ºF) for a fifteen minute duration. Dental pulp was retrieved and subsequent amplification of PCR products using a three primer (101, 200, 283 bp) and four-primer (101, 200, 283 and 450 bp) multiplex showed no degradation of the largest fragment analyzed following exposure to 842ºF. Amplification of the largest fragment analyzed in the three-primer multiplex (283 bp) was successful following exposure to 977 ºF but only in maxillary samples. Observations made during this study have revealed the enamel density of maxillary first molars to be greater than mandibular molars in *sus scrofa*. Pulp temperature data demonstrated that the mandibular pulp chambers experienced higher temperatures compared to maxillary pulp chambers.

Following incineration of whole, fleshed *sus scrofa* heads in the field for fifteen minutes (n=10) and for one hour (n=4) at an average temperature of 1157ºF, amplification of the largest fragment analyzed (450 bp) was successful from the dental pulp of both maxillary and mandibular first molars. The amplification success experienced in this study exceeds that obtained from previous research conducted on isolated human teeth and emphasizes the significance of the alveolar process and soft tissue mass of the head in terms of the protection afforded to the pulp chamber during incineration.

Observations made during this experiment indicate that trends observed in human teeth exposed to increasing temperatures are consistent with teeth from *sus scrofa*. This combined with close similarities between species in soft tissue thickness promotes the experimental use of whole *sus scrofa* heads as a sample dentition representative to that of humans.

DNA Analysis, Burnt Human Remains, Dentition

F6 The Role of the Skin in Bite Marks, Part I: Biomechanical Factors and Distortion

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The goal of this presentation is to investigate bite mark distortion in both size and direction with regard to mechanical and anatomical properties of the skin. Attendees will appreciate how basic biomechanical features of the skin affect the appearance of a bite mark and the degree of distortion that can result.

This presentation will impact the forensic community by beginning a knowledge base that may allow for possible quantification of bite mark distortion on human skin.

Skin is a notoriously poor recording medium. It behaves in an in-homogenous, non-linear, visco-elastic, anisotropic manner. It also exhibits hysteresis, stress relaxation and creep. This problem is compounded by the fact that these properties vary from site to site on an individual and differ with age, sex, weight, and underlying physiological conditions. Yet, a basic understanding of these properties as they relate to bite mark interpretation is essential for the forensic odontologist and it is imperative to conduct research, however daunting, in order to gain knowledge in an under-explored area.

In most areas of the body, skin is in a constant state of anisotropic tension. Anisotropy, simply defined, means that skin has different properties in different directions. Thus, skin tension is greater in one direction, the direction being dictated by skin tension lines. There are 36 tension line descriptions that exist to depict this property of human skin, and the most widely accepted are Langer lines. Tension lines not only vary between different regions on the body, but vary in different directions at a single site. They also alter with movement. Site to site variation of skin extension is dictated by the mechanical demands of each part of the body, such as articulation of joints. For example extensibility of the medial side of the thigh is relatively large to accommodate abduction of the hip while over the ventral aspects extensions are much less.

Once a force is applied, greater deformation will occur in the direction in which tension forces are the largest. Once the forces are removed, relaxation of the skin takes place, being greatest in the direction that initially had the most tension.

The load deformation relationship for skin is distinctly nonlinear. At low loads, the skin exhibits fairly extensible properties, but as the load increases, the skin becomes progressively stiffer. Therefore, during normal activity at low loads, the skin behaves elastically, however, as stress levels increase, skin exhibits elastic and viscous properties, hence the term visco-elastic. For visco-elastic materials, retraction does not occur instantaneously. It is this property that causes indentations of teeth to remain in skin for an indeterminate amount of time before rebounding. The viscous nature of the skin is primarily the result of the ground substance moving through collagen fibers in the dermis, which typically occurs late in stage II of the stress-strain curve. It is this curve that demonstrates the non-linearity of skin. Visco-elastic materials also exhibit stress relaxation and creep. Consequently, applied stress decreases with time and permanent deformation can result.

Therefore, taking all of these properties into account, the position that the victim was in at the time of the bite is extremely important as to distortional effects of the bite-mark. Work has been implemented in this direction. DeVore (1971), Harvey (1972), Barbenel (1974), and Sheasby (2001) all commented on the distortion on bite marks with regard to movement and directional variation and it is imperative that work continue on this topic.

PVS impressions were collected from an individual who was to serve as the biter. These impressions were poured in low viscosity metallographic epoxy resin under vacuum. Following complete set of the epoxy, the models were articulated and mounted onto hand held vice grips. The maximal opening of the biter was determined and the vice grips were set to not exceed this dimension. The bite pressure on the apparatus was tested and the bite force was determined to be well in the range of a human bite.

Human Subject Review Board (HSRB) exemption was applied for, and granted for cadaver use in this project. Bites were inflicted on un-embalmed human cadavers. The cadavers were stored at 4C and had no apparent tissue break down. Though the wounding effects will not be seen (bruising and edema) in cadavers, most mechanical features of skin are retained after death. Hence, transfer of the dental arch and resultant distortion can be accomplished. Each cadaver received bites in locations known to be both static and highly variable with regard to skin tension lines and also in various positions of flexion, extension, adduction, abduction, rotation, and supination.

All of the bite marks were digitally photographed with a Canon Rebel XTi 10.1 MP camera. An ABFO ruler was in place for each photograph. The images were entered into Adobe Photoshop. Metric/angular analysis was performed on each bite (Johansen and Bowers method).

The upper and lower dentition of the biter was scanned on a flatbed scanner (Hewlett Packard 6100/CT) at 300dpi resolution, the dentitions were then entered into Adobe Photoshop. Hollow volume overlays were constructed and metric/angular analysis was performed (Johansen and Bowers method). These were compared to all of the inflicted bites. Deviations and discrepancies between bites based on location and position were calculated.

Bite mark evidence has come under scrutiny. Therefore, it is imperative to conduct research of basic fundamental principles. Skin has been largely ignored in bite mark research, when in fact, it is an important variable. In this presentation, the importance of the biomechanical properties of the skin with relation to bite mark distortion and analysis is explored.

Bite Marks, Skin, Biomechanics

F7 The Role of the Skin in Bite Marks, Part II: Macroscopic Analysis

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The goal of this presentation is to evaluate to what level the human dentition can be considered unique once it is impressed in the skin. Attendees will appreciate how skin can alter tooth size, inter canine distance, and rotation of the teeth.

This presentation will impact the forensic community by demonstrating if dentitions, which were measured and determined to be unique, can still be considered unique once impressed in the skin.

One of the issues today in forensic odontology is the question regarding the uniqueness of the human dentition. Many studies have been performed to address this issue utilizing various means of sophisticated evaluation, such as 3D scanning, and geometric morphometric analysis. However, most studies measure the model itself without reference to any bitten substrate. Studies that do make a comparison to a bitten substrate have used wax or plaster, both of which behave quite differently from skin. Hence, this study incorporated the measurement of models with assessment of those measurements to the resultant bite in human skin.

Skin, with its varying biomechanical properties, creates a situation that is less than ideal to accurately record the dentition. It is indisputable that a degree of discrepancy will result between the actual measurements of a model and what is registered in the skin. The resultant distortion poses the question: To what degree of certainty can we recognize uniqueness based on the dentitions appearance in the skin?

Human Subject Review Board (HSRB) exemption was applied for and granted for this project. Three hundred and thirty four polyvinylsiloxane (PVS) impressions were randomly collected at the State University at New York School of Dental Medicine. These impressions were from the patient pool at the dental school clinic, and since this was a random collection, age, sex, and race were unknown to the authors of this study. Of these impressions, one hundred lower impressions were selected for this study. The criteria for inclusion were an impression that satisfactorily recorded the anterior dentition and that the dentition had a full complement of teeth from canine to canine (#22-27). The same upper arch was used for all of the models and served as a constant, the lower being the variable. This allowed for evaluation of distortion between bites.

All one hundred of the lower models were poured under vacuum in jadestone, and scanned into a flatbed scanner (Hewlett Packard 6100/CT) at 300dpi. Hollow volume overlays were constructed and metric/angular analysis performed with Adobe Photoshop (Johansen and Bowers method). Mesial to distal width, angle of rotation, and inter-canine arch distance was measured and recorded for teeth #22-27. Mal-alignment patterns were evaluated and assessed. Frequency of occurrence was noted. The models were then grouped according to their mal-alignment patterns.

The biters represented models from each of the mal-alignment groups. These models were articulated and mounted onto hand held vice grips. Bites were inflicted on un-embalmed cadavers. The cadavers were stored at 4 °C and had no apparent tissue breakdown. After the bites were made, care was taken to photograph the wounds in the same position they occurred.

The resultant bites were photographed with a Canon Rebel XTi 10.1 MP digital camera and entered into Adobe Photoshop. An ABFO ruler was in place for all of the photographs. Metric and angular analysis was performed (Johansen and Bowers method).

The bites were then compared to the measurements acquired from the models in each test group. Deviation in the skin was compared to actual dimensions of the models. This discrepancy is described and assessed.

Bite mark evidence has come under scrutiny in the judicial system. It is therefore important to conduct scientific studies that address unknown answers in bite mark analysis. It is not so much a question of the uniqueness of the dentition but rather does that dentition retain its uniqueness once transferred to the skin. In order for bite mark analysis to maintain validity in a court of law issues such as this must be investigated.

Bite Marks, Skin, Uniqueness of Dentition

F8 The Role of the Skin in Bite Marks, Part III: Microscopic Analysis

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In this presentation, microscopic methods of investigation into bite marks are assessed. This study represents a fundamental approach to obtaining the maximum information that could potentially link a dentition to a bite mark through the techniques of Optical, Scanning Electron (SEM), and Confocal Laser microscopy. As inspection of exemplars by microscopy requires the highest quality of model fabrication, an improved method of exemplar fabrication will also be discussed.

This presentation will impact the forensic science community by providing knowledge of microscopy methods, as well as, demonstration of the type of information that can be achieved with regard to bite mark analysis. These techniques will be discussed with application to both the teeth and the skin separately as well as transfer of the tooth surface to the skin.

If an object is viewed with increasing magnification, a point is reached at which detail is observed which renders that object unique. In the oft-quoted example, if a hundred identical objects (such as a ruler) were examined with sufficient resolution, they could all be considered different. This is true for both the skin and teeth.

Under magnification as little 20x-30x, individual characteristics and patterns on teeth can be recognized which undeniably render the surfaces unique. Under this level of enlargement, it is the small chips, angulations, restorations and wear patterns that give each tooth its own identity. Few would argue the uniqueness of the dentition on this level. If unique features of individual teeth transferred to the skin, and could be recognized by standard methodology, then investigators would have an additional means of exclusion or inclusion of a suspect.

However, skin is a poor recording medium that possesses a number of qualities that hinder registration of detail during and after infliction of a bite mark. Distortion due to the anisotropic mechanical properties, visco-elastic behavior and the hyteresis effect during rebound after the bite all compound to alter the possible detail transfer. The skin also possesses dynamic properties that result in the eventual healing and disappearance of bite mark evidence. Also the angulation of the tooth-skin contact may result in transfer of detail from unexpected features on a tooth, for example, the detail on a lingual surface may be evident, but not the detail from the incisal edge. The skin also possesses its own individual patterns which are unique to site on the body and between individuals. These are the primary, secondary and tertiary lines that comprise the topography of the epidermis.

Thus, a bite mark may be described as the superimposition of one pattern over another. Now that we can visualize the two patterns separately, is it possible to discern the combination of the patterns? The detail observable in teeth consists of irregular and geometrically complex shapes, whereas the skin has a repetitive, although still unique, surface topography. Attendees will appreciate the difficulties encountered in interpretation of a bite mark by microscopy.

The stereomicroscope is of particular utility in inspection of bite marks and teeth. The twin optical paths of the microscope result in a true three-dimensional view of a surface. Photographs taken with this instrument, however, use only one of the optical paths so the resulting image is two-dimensional. Oblique illumination can aid in visualizing shallow topography. The SEM uses a scanned electron beam to produce images of the sample surface. The SEM has superior depth of field and excellent resolution, allowing fine surface detail to be seen. The Confocal Laser microscope is an optical system with which a sequence of images with very shallow depth of field may be taken. The images may be stacked together to produce a true three-dimensional data set.

However, in order to use these microscopy techniques and visualize these minute details, exemplars of high quality, detail and resolution must be fabricated.

The standard method of impression collection using an extra light body polyvinylsiloxane (PVS) compound is used. A heavy body PVS backing may be applied if necessary, but no further stabilization is required. After cleaning in alcohol, the impression is poured with the resin. A low viscosity epoxy resin is then mixed and placed under vacuum to remove any admixed air. Because the resin has a water-like consistency it is possible to completely encase the impression without risk of distortion. The poured impression is then placed back in a vacuum. It is this step that helps to achieve the replication of detail with few bubbles in the model. If the model is being prepared for Confocal Microscopy, it would be necessary to add a fluorescent agent to the epoxy during the initial mixing stage. For this project, Eosin was used as the fluorescent agent.

Following curing the resin, the model is trimmed on a band saw and coated with gold. Gold coating is a standard preparation step for SEM, but

it also renders the surface reflective and suitable for inspection by stereomicroscopy.

This method is applicable to any surface that needs to be replicated and is used in other branches of forensics such as tool mark analysis. This paper explores the application of microscopy in bite mark analysis and describes exemplar fabrication techniques.

Bite Marks, Bite Mark Research, Microscopy

F9 The Role of the Skin in Bite Marks, Part IV: Clothing Weave Transfer

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After attending this presentation, attendees will gain an understanding of the appearance of fabric weave transfer to human skin when a bite mark occurs though clothing. An examination of the microscopic characteristics of various fabrics will be evaluated with regard to Optical and Scanning Electron Microscopy (SEM). These microscopy techniques will also be used to view the transfer of the fabric patterns to human skin.

This presentation will provide the forensic community with knowledge of the microscopic appearance of common fabrics once they have been impressed upon human skin by means of a bite mark. The time persistence of these impressions in skin as well as the specific weave pattern and fiber diameter will be discussed.

Bite marks are associated with violent crimes. Sometimes the victims of these violent crimes are found deceased and clothing is absent. It is common practice to swab the bitten area for DNA evidence. However, if the victim was bitten through clothing, saliva may be absent from the skin. The physical appearance of the bite mark itself may be a poor indicator if clothing was present or not at the time of the bite. If microscopic analysis of the bite can demonstrate that the bite occurred through a fabric, then investigators may have an additional clue, since it is likely that salivary DNA from the perpetrator would exist on the clothing.

Human Subject Review Board (HSRB) exemption was applied for and waived for this project. A polyvinylsiloxane (PVS) impression was collected from an individual who was to serve as the biter. This impression was poured with low viscosity metallographic epoxy resin under vacuum. It was articulated and then mounted onto hand held vice grips. The bite force was measured and determined to be within the range of a human bite.

Various fabrics were collected. These included polyester (100%), nylon (90%)/ spandex (10%) blend, nylon (80%)/ spandex (20%) blend, and polyester (64%)/ nylon (36%) blend. All of the fabrics exhibited different weave patterns with varying primary fiber diameters. Bites were inflicted through each fabric on human cadavers. The cadavers were stored at 4C and had no apparent tissue breakdown. Immediately following the bite, a photograph was taken with a Canon Rebel XTi 10.1 MP digital camera. The photographs and impressions were made in the same position in which the bite occurred. Each bite was impressed with Extra Low Viscosity polyvinylsiloxane (XLV PVS). Due to the ambient temperature, the PVS required 20 minutes to fully set. This process was repeated at 1 hour, 24 hours, and 96 hours after infliction of the bite.

The PVS impressions were cleaned with alcohol and poured under vacuum with light viscosity metallographic epoxy resin. Due to the thin consistency of the epoxy, no backing was required as the impressions maintained their curvature reminiscent of the location of the body in which they occurred. Once fully set, the epoxy exemplars were trimmed on a band saw and coated with gold for inspection with SEM. A sample of each fabric was also prepared for examination with SEM. Each exemplar and fabric sample was examined at 30x, 100x, 200x, and 500x magnifications.

Unlike the irregular detail seen on tooth surfaces, fabric possesses two recognizable geometric properties. One is the primary fiber diameter, and the second is the geometric nature of the weave. It is these features that transfer to and are recognizable in the skin. One or the other of these properties may dominate in the bite mark imprint, depending on the relative sizes of these features. In this case, the fabric pattern dominates over the skin pattern when superimposed.

In this study it was seen that the fabric weave imprint in cadaver skin persisted long after the bite mark had rebounded and had become invisible by conventional photographic means. A correlation was demonstrated between the attributes of the fabric's material and weave pattern to the time persistence of the bite mark. The use of the SEM proved to be an invaluable tool in visualizing the patterns after a period of time as they become essentially invisible to the eye.

This study demonstrates that additional information may be obtained from microscopic analysis and best practice exemplar fabrication. It indicates that there may be hidden information present on the skin surface that may persist and be recognizable for some time period after death.

Bite Marks, Bite Mark Research, Fabric Weave Pattern

F10 A Geometric Analysis of the Inherent Inaccuracies Found in Linear Measurement of Curved Bite Mark Surfaces

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The Forensic Odontologist must be capable of presenting evidentiary accurate measurements and documenting such measurement by photographic and/or digital images. This presentation will explore the extent of the inaccuracies found in recording measurements utilizing the ABFO #2 ruler on hypothetical curved surfaces.

This presentation will impact the forensic science community by making suggestions for minimizing such inaccuracies.

The Forensic Odontologist relies on highly accurate measurements to facilitate evidentiary quality bite mark analysis. Reasonably accurate Alginate or the more stable and accurate polyether or polyvinyl siloxane impression materials are capable of producing measurement friendly dental stone study models. All these measurements are usually taken in a flat plane linear environment. For example the inter-canine cusp measurement is accomplished by simply placing the standard ABFO #2 ruler across the model and recording the appropriate dimension. Such data accurately translates to photographs (both film and/or digital) through specialized scanning techniques and photo processing software. The resultant images are generally accepted as evidence in litigation. Analysis of the bite mark is more problematic. Bite marks by their very nature are subject to either in vivo healing or postmortem decomposition. Elastomeric impressions, methacrylate tissue excision techniques, and specialized 1:1 close-up photographs or digital images all serve to preserve the bite mark as evidence. Measurement problems occur because bite marks are rarely made in a truly flat plane environment. It is the natural curves of the human body that lends itself to exhibiting a bite mark that has been made around a curved surface. If one should photograph the bite mark with the #2 ruler in view all objects are in a two dimensional posture and all measurements taken of a curved surface with a straight ruler with have some inherent inaccuracies. It is this inaccuracy that this paper will address.

Methodology for this analysis is based on the geometric relationships present between a straight ruler and a curved body part. If, for example, one considers a ruler resting on an arm in cross section the geometric shapes represented here are a straight line drawn tangent to a circle. It is obvious that the measurement on the line from the point of tangency towards the periphery would by nature be shorter that the arc length circumscribed by the resultant curve of the circle. It is this difference that will be calculated to determine if it is significant.

The #2 ruler is marked in 5 centimeter divisions with millimeter markings therefore all measurements will be in millimeters. Incremental measurements were made for each angular degree from the center of the circle. Both the arc length and the tangential distance from the origin to a point formed by the intersection of a line drawn from the extended radius perpendicular to the tangent will be calculated and compared. An Excel spreadsheet was created to perform the numerous calculations. Five columns were established: "θ" – the angle of the radius in degrees, "Arc Length in mm", "Tangent Length in mm", "Error in mm", and "% Error". If one should envision the focal plane of a camera to be placed above and parallel to the tangent line the resultant photographic image would not show anything passed the 90º arc. Recognizing that it is only this "quarter circle" that is being analyzed, calculations were made for "θ" values of 1 through 90 in one degree increments.

Initial results verified the known geometric relationship between the arc length and the tangent length as evidenced by the constant % Error fixed at 36.31%. The results also show significant differences in mm measurements as θ increases. A one degree deviation from the perpendicular results in an arc length (the arm and embedded bite mark) of 0.87mm and a tangent length (the ruler) of 0.56mm with an error of 0.317mm. While 0.3+mm error may not be significant at that level, a fifteen degree angulation results in a 4.75mm error on a 13.8mm arc length (arm & bite mark) with an 8.33mm tangent length (ruler). As one would expect the greatest discrepancy occurs at 90º. Here an error of 28.5mm is seen. These measurements are accurate only for a perfect circle. In vivo measurements will more likely be taken on some elliptical form. If the greater diameter of the ellipse is perpendicular to the tangent then a proportionately greater error is seen. In the case of the lesser diameter being perpendicular to the tangent the resultant circumference would present a flatter and arguably more accurate measurable surface.

This analysis suggests that measurements along a curved surface should be made by rotating the ABFO #2 ruler along the arc or by using some flexible measuring device.

Measurement, Inaccuracies, Bite Mark

F11 The Significance of Expert Disagreement in Bite Mark Casework

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After attending this presentation, the attendee will recognize the range of opinions reached by odontologists in actual casework. The amount of disagreement will be assessed in over 50 cases used in criminal cases in the United States and Europe.

This presentation will impact the forensic science community by demonstrating how the reliability of bite mark opinions will be determined in actual casework as opposed to experimental studies of bite mark evidence.

A recently published JFS article titled "Development and Validation of a Human Bite Mark Severity and Significance Scale" proposed a qualitative bite mark index (ratings from 1-6) that can be used to weigh the forensic significance of the physical characteristics of a wide range of skin injuries. The purpose of this paper is to apply this scale to actual bite mark cases generated by prosecutorial investigations in the United States. The sample was taken from 55 bite mark cases reviewed by the primary author in the course of acting as a defense bite mark expert. These cases were independently scaled according to the "Human Bite mark Severity and Significance Scale. Their results were then correlated for inter-examiner reliability using non-weighted Kappa statistics. The mean of their results were then compared to the opinions expressed by the prosecution bite mark experts who participated in the original cases. The preliminary results suggest that the lower forensic value bite marks are considered by some experts to have high forensic significance. Considerations regarding low inter-examiner correlation will be discussed. The rating of bite injuries between examiners of similar experience and training should be, in an objective science, highly correlated. Forensic sciences in which this is not the case risk accusations of subjectivity.

Bite Marks, Expert Reliability, Expert Disagreement

F12 Comparative Analysis of Hollow Volume Overlays Fabricated Using Adobe® Photoshop®

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After attending this presentation, attendees will be familiar with several methods of digital hollow volume overlay production using Adobe® Photoshop®. The objectivity/subjectivity of each method will be discussed and the similarities and differences of the results of each method will be compared and statistically analyzed.

This presentation will impact the forensic community by investigating the techniques of fabricating computer generated overlays. The study also explores whether they are reproducible and consistent techniques as they relate to the admissibility of bite mark evidence in court.

A difficulty in bite mark analysis is examiner subjectivity in creating exemplars, including hollow volume overlays. Many efforts have been made to achieve objective methods for overlay fabrication based on a scanning technique first described by Christensen in a 1996 AAFS presentation and later published by Bowers and Johannsen. In 2000, Pretty and Sweet presented information on the effectiveness of bite mark overlays. In 2002 and 2003 respectively, Dailey and Tewes each independently presented techniques for improving overlay objectivity and incorporated topographic mapping of dental casts. McNamee, Pretty, and Sweet reported in 2004 the comparative reliability of computer generated bite mark overlays. Brzozowski and McGivney investigated the accuracy of Photoshop® generated overlays by an analysis using WinBite software. In a continued effort to demonstrate reliable and reproducible methods of overlay production, this study focused on utilizing Adobe® Photoshop® in a manner that emphasizes examiner objectivity.

This study evaluated the ability of independent examiners to produce similar hollow volume overlays when given specific instructions utilizing Adobe® Photoshop® software. Thirty examiners were provided a digital image of scanned dental casts and were directed to follow specific steps in fabrication of the hollow volume overlays. Three different methods of specific overlay instruction were provided to each examiner. Examiners were not allowed to alter or enhance any image beyond what was provided in the instructions. A fourth technique utilizing a more subjective method was also included for comparison. In addition, a brief questionnaire was included to obtain specifics regarding variations in individual examiners' hardware, software version, and bite mark analysis experience. After a two week interval, examiners were then again requested to produce an additional set of four overlays using the same instructions. To facilitate compliance, all instructions and scanned casts were distributed and results were returned by electronic mail.

The resulting overlays were then analyzed by pixel by pixel comparison of each image. Statistical differences between the results of each method of overlay production were recorded for all examiners. Additionally, overlays created by individual examiners were analyzed to investigate intra-examiner reliability. The overlays from the various techniques were analyzed to establish a mean for each technique and to determine the variation from the mean for each overlay.

This study asks and evaluates whether the use of Adobe® Photoshop® allows the production of consistent and reproducible hollow volume overlays when prescribed techniques are followed. The study further analyzes the statistical significance of the differences between the overlays produced.

Digital Overlays, Bite Mark Analysis, Reliability

F13 Determination of the Accuracy of Decision Making in the Interpretation of Bite Mark Analysis

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After the presentation, attendees will understand that training and certification of professionals who are to give opinion-evidence in cases of bite mark patterned injuries is important to the successful outcome of the analysis.

This presentation will impact the forensic science community by demonstrating how experience and training for bite mark patterned injuries is important to the successful outcome of the analysis.

This presentation will provide information regarding the accuracy of examiners in distinguishing the correct dentition that may have made a bite mark. The study was designed to evaluate the reliability of responses in bite mark analysis between two observational periods, between three groups of examiners.

A series of simulated bite marks were made on three juvenile female domestic pigs using a device design to mechanically produced bite marks in-vivo. A biting device consisting of upper and lower dentition-anvils were attached to a vice-grip. A monitoring load cell was used to maintain pressure consistency of 23kg/50lbs for 60 seconds. Three removable sets of dentitions made in chrome cobalt were inserted in the device for the study of individual bite mark characteristics. All sets of teeth had the same class characteristics with the same surface contact area to make sure the force applied was equally distributed. The dentitions used differed only with respect to the individual position of the teeth i.e., angulations and rotations. Models were labeled suspect A, B, and D. Suspect D was used to create the bite marks but was not sent to the examiners, creating a situation in which one of the biters was not represented in the circulated sample. A fourth set of teeth labeled suspect C was prepared and sent for examination but was not used for biting, creating another situation in which none of the cases represented the biter. With the animal under general anesthesia, 18 bite marks (six per pig) were made on the pigs' abdomen and thorax.

Thirty volunteers were recruited for the analysis of the bite marks. Ten participants were recruited from three separate groups: inexperienced local dentists (Novices), dentists with an interest in forensic, members of a forensic association or society (Members) and experienced examiners, Diplomates of the American Board of Forensic Odontology (Diplomates). Each participant received 18 simulated bite mark cases, which contained 3 sets of dental models identified suspect A, B, and C, 18 casts of bite marks respectively identified, a CD-ROM containing photographs of each bite mark, paper photos of the bite marks, forms and answer sheets to be completed. Examiners had to decide, among other questions, whether each bite mark could be attributed to one of the suspects. A second assessment of the same cases was conducted a few months later to evaluate the reliability of responses.

The results of the study demonstrated that the Novices often did as well as the Diplomates, and better than the Members. Incorrect suspect identifications were more common among Members meaning they falsely attributed a dentition to a bite mark it did not make. For dentition A and B, the rates of critical errors for the Diplomates were consistent with those seen in some studies on fingerprinting. For dentition D, all three groups had higher percentages of incorrect identification. There was no apparent effect on the time period between evaluations.

The study demonstrates that experience and training for bite mark patterned injuries is important to the successful outcome of the analysis. Bite mark analysis should be evaluated and considered on a case-by-case basis by trained professionals respecting the principals of bite mark investigations. If such evidence is obvious, logical, and understandable to the trier of fact, it should be admissible and the appropriate weight given to the evidence based on the merits of each case.

Bite Mark Analysis, Porcine Skin, Biting Device

F14 Demographic Variation Effects on Human Bite Force

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The goal of this presentation is (1) to add to previously collected data on the levels and variations in bite force within a population with consideration of demographic data (age, sex, and race/ethnicity), and (2) to combine those data with information previously reported as a resource to forensic dentists in the evaluation of bite mark injury patterns.

This augmentation of a pilot study using a gnathodynamometer device will impact the forensic science community by providing attendees a clearer understanding of the forces involved in biting, concentrating on the demographic variation in force created by the anterior teeth most often involved when humans bite humans.

Method: Two hundred forty (240) individuals were randomly selected to participate in the current bite force study. After entry into the study, the participants were then subdivided based on age, sex, and race/ethnicity. The study also took into account the participants' height, weight, dental occlusion classification, presence or absence of TMJ pain/trauma and presence or absence of anterior restorations. Only persons willing to participate and able to give full consent were utilized. There were no incentives offered to participants. The participants were asked to complete a brief questionnaire reporting demographic information. For this study all subjects were examined and had a complete or near complete complement of teeth. Additionally, none of the subjects had removable prosthetics of any kind. Each participant was instructed to bite with maximal force onto the wax covered plates of the transducer of the gnathodynamometer. The gnathodynamometer records the bite force in pounds. Participants were asked to bite an additional time if the bite had errors such as slippage of teeth off the center of the bite pad. This process was repeated up for each participant, if necessary. The highest of the three recorded values were used for statistical analysis. The dental exemplar impressions produced in the wax were maintained with the study, along with the participant identification number and pressure reading (in pounds), as part of the data base. The wax bite pad was then scanned into Adobe® Photoshop® CS2, the surface area of the biting teeth was measured, and the bite force in pounds per square inch (PSI) was calculated. The bite forces in pounds per square inch and grams per square centimeter will be reported along with the age, sex and race/ethnic distribution. The two hundred forty subjects in this study were subdivided into three age ranges (18-27 y.o., 28-37 y.o. and 38-47 y.o.) by sex and by one of four race/ethnicities: African/African-American, Asian/Pacific Islander, Caucasian, and Hispanic. In each age group there were no fewer than 20 participants, and in each race/ethnicity group there were no fewer than 60 participants. Additional data acquired from the study participants included height, weight, TMJ dysfunction, history of dento-facial trauma, and overbite/over jet relationship of anterior teeth.

Results: The data recorded in this study will be statistically analyzed and documented to show the range of bite forces for a given demographic of individuals and the variables that affect it. Variations or lack of variations between the groups will be discussed. Additional research is needed to continue to build a database of force levels and factors that influence bite force. Also needed are studies of biting force variations among other groups including, but not limited to, those with different skeletal classifications or periodontal status. Individuals who have lost some or all anterior teeth and those who wear partial or complete dentures should also be studied. Once known force ranges are established and the effect of population variations are better understood, the association of specific bite forces to the types and severity of tissue injuries caused by teeth in skin can be better analyzed.

Forensic Odontology, Bite Force, Bite Mark

F15 Three Methods of Measuring the Force of the Human Bite

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The goal of this presentation is to present simple methods of measuring and verifying the force of the human bite.

Getting accurate bite force determinations will impact the forensic science community by aiding in understanding bite mark injury patterns and the dynamics of the jaws in clinical dentistry.

Three methods are presented. The first utilizes a simple weight scale. The second uses pneumatics. The third involves suspending a weight on the subject's mandible.

One apparatus is the simple scale which utilizes Hooke's law, where the extension of the spring inside the scale is directly proportional to the weight it is measuring. The device allows for an adjustment to allow it to be placed in the mouth so that a measurement can be made which is directly read off the scale.

The pneumatic apparatus use a regulated air pressure inside an air cylinder, in which an attachment that fits comfortably in the mouth is attached to the piston. The air pressure is adjusted upward until a point is reached where the subject cannot move to close the piston. The area of the piston is known and so is the pressure. Force equals pressure divided by area, therefore force can be calculated.

The third method consists of suspending a known weight from a device which rests comfortably on the subject's mandible. The subject can start out with very light weights, and either attempt to make closure of the jaws or close the jaws with the device in place and attempt to lift the weight from a slack position.

Anecdotally the human bite force has been reported any where from a 100 to 150 pounds. The above provides some simple methods for determination and verification.

By having simple and verifiable determinations of human bite force, the understanding of the causes of human bite mark injury patterns will be better understood. In addition the dynamics of mastication and occlusion in clinical dentistry will be better understood.

Hooke's, Pneumatic, Bite Mark

F16 Hydraulic Forces as a Cause of Human Bite Mark Injury Patterns

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The goal of this presentation is to explain the causes of bite mark injury patterns in humans. Some of the bite mark injury patterns can be readily associated with teeth of the perpetrator. Marks found inside the identified teeth marks that were formerly erroneously called "suck marks" can now be explained by compressive or tensile forces. It is not as much a function of the magnitude of these forces but their asymmetry. Coefficients of friction and Newton's Laws of Motion are necessary to explain the origin of these marks. Examples in diving and aerospace and medical physiology will be presented to give cogent and simple examples of the above hypothesis for the attendees.

The understanding the origin of the bite marks is important so the scientific community can now understand why a three dimensional event can be plotted very accurately in two dimensions as in bite mark analysis.

Bite mark pattern analysis is a still a valuable tool in forensic science because DNA samples may not be available. When DNA can't be used, as in the case involving zygotic twins, BPA has been used to successfully identify or rule out the perpetrator.

This presentations objective is to explain the observed injury patterns in human bite marks in terms of terms of engineering principles such as compressive and tensile loads. It is not the absolute value of these pressures or forces, but asymmetrical hydraulic derivatives, or unbalanced fluid forces or pressures that cause the injury. These forces or pressures will be focused on two tissues: the skin and blood vessels.

This presentation will relate bite mark injury pattern analysis (BIPA) which is in the realm of Odontology specifically, to the forensic and scientific community in general, in terms that can be readily understood, which will provide a better appreciation of the BIPA in the prosecution or exoneration of suspect. Bite mark injury pattern, analysis is most important where DNA evidence is absent or where the suspects are "identical twins."

In order to understand how bite mark injury patterns evolve, several factors must be understood. First is the form and function of the teeth as they relate to a particular species. Secondly, the dynamic process of the bite must be staged so that the forces can be individually analyzed according to pressure/forces applied. The anatomy of the tissue must be considered. In addition general knowledge of physiology that is known in underwater diving and aerospace medicine also shows us that the human body can sustain large symmetrical forces, but not asymmetrical forces.

There are two major ways in which teeth function. One is puncture and the other is maceration. Human's teeth function mainly by maceration and tearing. Carnivore's teeth function mainly by puncturing and tearing. Herbivores macerate their food.

Among odontologists, certain aspects of the bite mark injury patterns caused disagreements. One such disagreement was whether the buccal surfaces of the teeth also appeared with the lingual surfaces in a bite mark injury pattern. Understanding the species specific form and function, and also staging the bite attack in with respect to the forces involved on the skin clears up that issue. Also marks that appeared inside the oval form the perpetrators dentition on the victim can now be understood in terms of asymmetrical hydraulic pressure/forces.

The bite mark attack can be divided in three stages, the first where sliding of the teeth over the skin happens, causing one type of mark, the second where the teeth have purchase over the skin and the relative motion of the skin and teeth stops. The third stage is where equilibrium is reached when the reactive force or pressure of the victim's tissue equals the applied force or pressure of the attacker jaw muscles. It is the final stage where the injuries to the skin and underlying vasculature occur resulting in a bite mark injury pattern.

BIPA will be briefly discussed. Now by understanding how the assailant's teeth cause symmetrical and asymmetrical hydraulic pressure/forces on the victim's skin, a one to one relationship to the bite mark pattern and the perpetrators teeth will become scientifically apparent.

Inferences on the magnitude of forces on the body can be estimated by the known pressure of a "G" suit on a pilot in a 10G dive. Injuries have been reported on pilots sustaining these G's that resemble strangulation victims. Untrained divers sustain injuries routinely, to lungs and ears because equalization of pressures wasn't attained. Ergo asymmetrical vis-à-vis symmetrical forces or pressures.

Asymmetry, Bite Mark, Hydraulic

F17 The ABFO No. 2 Scale — A 20 Year Retrospective Study: The History and Accuracy of the ABFO No. 2 Scale

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After attending this presentation, attendees will better understand the history, accuracy, and markings on the ABFO No. 2 scale.

This presentation will impact the forensic community by providing an increased understanding of the history, use and accuracy of the ABFO No. 2 scale.

Since 1987, the American Board of Forensic Odontology Number 2 scale (ABFO No. 2) has been the accepted standard for use in the field of forensic odontology as well as many other forensic disciplines. William G. Hyzer and Thomas C. Krauss, DDS developed the ABFO No. 2 scale in February 1987. The American Board of Forensic Odontology encouraged the development of a "standard photogrammetric reference scale" and officially accepted the scale February 18, 1987. In 1987, Lightning Powder Company agreed to manufacture the scale, and that same year the scale was commercially available.

The designation ABFO No. 2 stems from the fact that there was an ABFO Scale No. 1 scale that was developed by Dr. Ray Rawson, who was then President of the American Board of Forensic Odontology in the mid 1980's and presented the ABFO No. 1 scale to the board. After discussion of the board, several revisions were suggested and Dr. Tom Krauss was assigned the task to develop a revised scale.

The ABFO No. 2 scale is unique in its design. The incorporation of three circles is useful in recognizing and compensating for distortion resulting from oblique camera angles. Graduations are metric, the width of the legs are one inch wide for English reference. The centimeter division lines are longer for tracing over and extending across the photographic print for gridding purposes. Measurements within the image are then made relative to the inscribed 1cm grid lines to compensate for distortion resulting from non-parallelism between the film and object planes. The gray areas of the scale have a reflectance value of approximately eighteen percent. The inclusion of alternate bars of black and white makes it possible to salvage useful metric reference information from poorly exposed photographs in which the finer graduations cannot be resolved. The scale is constructed from three layers of 0.343mm laminated plastic with an overall thickness of 1.016 millimeters. The millimeter markings are accurate to 0.1mm on inner edges. The overall size of the scale is 105mm x 105mm.

Twelve ABFO No. 2 scales were obtained from Lightning Powder Company, a subsidiary of Armor Holdings. Additionally, twelve scales that are similar to the ABFO No. 2 scales were obtained from Evident Crime Scene Products. These scales were sent to the National Institute for Standards and Technology (NIST). NIST is a non-regulatory federal agency within the U.S. Commerce Department's technology Administration. Each scale was compared to the purported error rates that Hyzer and Krauss published in the Journal of Forensic Sciences, Vol. 33, No. 2, March 1988, pp. 498-506. The reported error rates were as follows: "overall accuracy of ± 0.1 mm or ±1% for the major centimeter graduations. The widths of the two legs are 1.000 ± 0.002 in., which translates into a percentage error of ± 0.2%. The legs are mutually perpendicular to ± 2 rain of arc. The internal and external diameters of the three circles are 19.75 and 23.0 ram, respectively. The error in placement of the three circles is within 0.25% of the nominal 80-ram separation between their centers."

The results of these analyzes will be reported at the American Academy of Forensic Sciences 2008 annual meeting in Washington D.C. in the Odontology Section.

William G. Hyzer and Thomas C. Krauss, D.D.S. were men of remarkable foresight. Twenty years ago, they set out to create a "modestly priced standard reference scale providing the information needed to recover maximum information available from high-quality bite mark photographs." The scale is now used by the FBI and police departments across the world in addition to forensic scientists from many disciplines. The scale has been seen in television shows such as CSI. However, a study of the accuracy as well as the production of the scale is important information for all who use it.

Forensic Odontology, ABFO No. 2, Accuracy

F18 Forensic Odontology - Where We've Been, Where We Are, and Where We Are Going?

David A. Williams, DDS, and Joyce P. Williams, MFSA, Allegany Dental Care, 26 Grove Creek Circle, Smithsburg, MD 21783*

The goal of this presentation is to offer the attendee a comparison of the demographic data of members of the Odontology Section of the American Academy of Forensic Sciences over a ten year period. It will compare and contrast the composition of the section and also outline the eras in development of forensic odontology and provide some insight into the potential future developments which may impact the discipline.

The presentation will impact the forensic science community by stimulating discussion as to the future role of forensic odontology and how identified needs can be met.

A convenience sample was made from the American Academy of Forensic Sciences Members' directory from 1997 and 2007. The total number of section members, membership status, location and other data were extracted and placed in SPSS 11.5 for analysis. The results will be presented so that the attendees will see the changes in the demographics of membership in the Odontology section over the past ten years. Trends that may be identified will be discussed.

A review of the development of forensic odontology was undertaken to determine the milestones within the discipline to help the attendee to understand developments in the past that may help to identify future challenges and opportunities.

The presentation will provide an overview of the following eras of forensic odontology: historic era, organization era, and scientific era. The events that define each of these eras will be described and the trends that occurred during them will be delineated.

Historically the disciplines that comprise forensic odontology have been described as dental identification, bite mark analysis, and clinical examinations. The former two categories are relatively specific, with the latter covering a broad spectrum of modalities.

It is the presenter's opinion that "clinical examinations" should be expanded to include outreach to non-forensic dentists and members of other forensic fields. This may include a closer relationship with forensic anthropology and pathology from cases of genocide and crimes against humanity to providing a collaborative relationship with the local medical examiners/coroners.

Also targeted would be those other individuals and agencies that interact with members of the population that may be able to identify those who may require the services of a forensic odontologist. Mandatory reporters of abuse, including teachers and health care workers and others who are in contact with large populations of individuals could provide a vast reservoir of persons who have this potential need.

Outreach to the dental profession regarding standards of care and ethical issues that may help to prevent negative outcomes for the patient as well as the dental practitioner should also be included. Widespread dissemination of best dental practices both in prevention and treatment could improve the overall treatment of dental patients as well as limit the exposure of dental professionals to malpractice suits, disciplinary actions and other negative consequences of unwanted results of dental treatment.

This broadening of the mission of forensic odontology would also provide a challenge for those in the educational process to meet these expanding needs.

Overall, those within the discipline of forensic odontology should be looking at potential opportunities in the local, national and international community to ensure that challenges are identified and future needs can be met.

Forensic Odontology, History, Members

F19 The Verdict Is In: Can Dental Characteristics Be Quantified?

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Those attending this presentation will leave with an appreciation for the fact that dental characteristics occur in a myriad of combinations that can produce patterns reflecting variations in size, shape, position, angles of rotation, presence of supernumerary teeth, anomalous teeth, accidental damage, displacement, and a pattern of missing teeth.

When specific tooth characteristics are distinctly reflected in a human bite mark, it should be possible to statistically calculate the probability of any two individuals having the same dental pattern based on a database of the frequency distribution of dental characteristics.

The comparative forensic sciences have for several years been challenged to provide a scientific basis for the expression of probability. Critics have referred to bite mark analysis as "junk science." The U.S. Supreme Court trilogy, *Daubert*, General Electric, and Kumho Tire decisions, developed guidelines for courts on the admissibility of scientific and technical testimony. These guidelines have produced considerable confusion and uneven application. It should be pointed out that there are at least two types of science: exact or Newtonian sciences and the comparative sciences which involve scientific methods, but have a subjective or human element as to the interpretation of the evidentiary value of the objective observations.

In answer to the criticism, a two year pilot research project has developed the early stages of a database which should eventually enable the odontologist to quantify specific dental characteristics observed in both the human dentition and in clearly registered bite mark patterns. Initiated in 2005 with seed money from the American Society of Forensic Odontology, the California Forensic Dental Association and the American Board of Forensic Odontology, it was substantially funded by two research grants from the U.S. Department of Justice via the Midwest Forensic Research Center, Ames Laboratory, Iowa State University.

Using two computer imaging programs, the anonymous imprints of the upper and lower teeth of 419 individuals, representing the general population of Caucasian, Asian, Native American, Black and Hispanic, were studied for the frequency distribution of six dental characteristics: arch width, tooth width, angles of rotation, diastemata, and missing or supernumerary teeth. Inter-observer and intra-observer consistency, another of the challenges, were also studied. A seventh tooth characteristic, measurement of the displacement from the native curvature of the dental arch, is still under investigation.

A consulting imaging specialist from the Wisconsin Department of Justice Crime Laboratory assured that the protocol followed the guidelines of the Scientific Working Group on Imaging Technology (SWGIT) and a "Professor of Evidence" served as a consultant on admissibility issues concerning digital evidence.

Bite Mark, Quantification, Database

F20 On the Uniqueness of Human Dentition

Roger D. Metcalf, DDS, Human Identification Lab, Tarrant County Medical Examiner's District, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4914; Paula C. Brumit, DDS, 103 East Beltline, Suite H, Cedar Hill, TX 75104; Bruce A. Schrader, DDS, 9004 Francia Trail, Austin, TX 78748; and David R. Senn, DDS, 18 Villa Jardin, San Antonio, TX 78230-2749*

After attending this presentation, attendees will understand some of the problems and principles of investigation into the uniqueness of the human dentition, the essential assumption of forensic dental identification and of bite mark analysis. A method is presented for measuring the location of anterior teeth that may be used to establish a database for determining how often a particular arrangement of the anterior teeth appears in a population.

This presentation will impact the forensic odontology community by demonstrating a simple, robust method of measuring the location of individual teeth in the dental arch that can be easily applied to create an individual's "dental profile." This method also allows for capturing some three-dimensional information about the location of the incisal edges of the teeth relative to the occlusal plane.

The critical assumption of both dental identification and bite mark analysis is that every individual's teeth are unique. A further assumption in bite mark analysis is that this uniqueness can be adequately transferred to materials such as human skin (this second assumption is not addressed in this presentation.).

In this pilot study, the population of pre-treatment orthodontic patients was examined (both sexes, many races, ages from adolescent to adult) from his practice to establish background information about the amount of variation in this population. This group was arbitrarily chosen on the assumption that there would be a wide variation in location of each individual's teeth. In the next phase, sets of twins were then studied and compared to the baseline population to determine if the method presented was able to discriminate between both monozygotic and dizygotic individuals who have, presumably, less variation between their dental arches.

The method presented here for measuring location of the anterior teeth depends only on locating the cusp tips of the canines. All other measurements derive from the midpoint of the cusp-tip-to-cusp-tip line. It is believed that this makes for a simple and robust system which relies on as few anatomical landmarks as possible and does not require specialized computer image analysis software. The method is easy to implement and does not involve calculating orthodontic curves for each individual arch. Neither does this method depend on arbitrarily tracing the incisal edges of the anterior teeth. Further, this technique allows for reporting some 3-dimentional information about the distance of the incisal edges from the occlusal plane. It is believed this method might eventually be extended to describe bite marks, as well, and might allow for a numerical comparison of each dental arch to a corresponding portion of a putative bite mark. This procedure could be relatively quickly applied to a large number of dental casts in order to begin building a database that could help to determine whether a particular arrangement of the anterior teeth appears only once, or conversely, more than once in a particular population.

Odontology, Uniqueness, Dentition

F21 UT-Age 2008: An Update

James M. Lewis, DMD, 577 Hughes Road, Madison, AL 35758; and David R. Senn, DDS, 18 Villa Jardin, San Antonio, TX 78230*

After attending this presentation, attendees will understand the advantage of using computers in the generation of third molar age estimation reports.

The presentation will impact the forensic community by assisting the forensic community in utilization of computers to standardize, automate and create a database for age estimation reports.

Radiographic evaluation of third development has been widely used in estimating the chronological age of adolescents. In 1993, Harry H. Mincer, DDS, PhD, DABFO, et al., performed a study of the American Board of Forensic Odontology using the eight stages of crown and root formation to score third molar development proposed by Demirjian in 1973. This study resulted in the development of mean ages, standard deviations, and empirical probabilities of an individual attaining at least eighteen years of age for stages D through H based upon the residing arch of the third molar and the subject's sex. Although the subjects studied included 80% European, 19% African, and 1% "other" or "unspecified" ancestry, the data produced are only significant for individuals of European ancestry. Over the past several years additional studies have been performed using the Demirjian staging that estimated the chronological age and empirical probability of an individual attaining age eighteen for African and American Hispanic Ancestries. As these studies are published and accepted by the American Board of Forensic Odontology, they can be included in the database for age estimation calculations.

Determining whether an individual has attained his/her eighteenth birthday has great significance in our legal system. Of particular interest to the field of forensic Odontology is the Immigration and Naturalization Service's request for estimation of the age and evaluation of the empirical probability of an individual being at least eighteen years of age. Standardization of the report provides clarity in the report interpretation. Additionally, automation of the statistical data generated by the radiographic evaluation of third molar staging results in elimination of inadvertent error in statistical data calculations while simplifying and expediting the report process.

UT-Age was first introduced in 2002 as a Microsoft Access based application and database. However, as PC users updated their operating system to XP and now to Vista, many applications that used older Microsoft Access version applications failed to work properly necessitating continuous rewriting of the application. The latest version of UT-Age utilizes .NET Framework using a Microsoft Access database. .NET Framework provides a large body of pre-coded solutions to common program requirements, and manages the execution of programs written specifically for the Microsoft operating system. The .NET Framework is intended to be used by most new applications created for the Windows platform.

UT-Age 2008 incorporates many of the same features as previous versions of UT-Age but in a user friendly and familiar Windows layout. The computer program archives data for age estimation cases cataloging the case number, individual's name, ancestry, sex, profile and portrait photographs, stated date of birth, and radiograph(s). After entering the estimated development stage of the third molars present, the average mean age of the individual, the average age range to two standard deviations, and the average empirical probability of the individual having attained his/her eighteenth birthday is calculated. The program will then generate a report to the referring agency referencing the methodology of the analysis. The report is written and stored as a Word document allowing editing as necessary for supplemental information. The program also contains a user manual and Demirjian staging chart for quick reference.

The UT-Age program will be available for download from the CERF website, www.utforensic.org. Minimum system requirements for UT-Age 2008 are a Windows operating system, .NET 2.0 and Microsoft Word. .NET 2.0 is included on recent versions of Windows operating systems but is a free download from the Microsoft website if not currently on your computer system.

An overview and demonstration of the software will be presented.

UT-Age, Forensic Odontology, 3rd Molar Age Estimation

F22 Age Estimation: New Methodology to Assess Aspartic Acid Racemization in Teeth

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After attending this presentation, attendees will have a better understanding of a simplified aspartic acid racemization age estimation method comparing the use of whole teeth or whole teeth with enamel and cementum removed. The amino acid enantiomer detection utilizes high performance liquid chromatography (HPLC) coupled with mass spectrometry (MS).

This presentation proposes a method to estimate ages that may benefit humanity and science by improving the accuracy and reducing the ranges of ages estimated. This improvement will impact the forensic science community by providing medical examiners and coroners better information to identify unknowns and allow for more discrete search parameters for matches between missing person and unidentified body databases.

In nature, amino acids are primarily synthesized as levorotary or L-isomers. Spontaneous conversion over time by a process known as racemization converts some of the L-form of amino acids to the D-form resulting in a mixture of the L- and D-forms. These stereoisomers are detectable mirror image enantiomers. It is well established that an age-dependent racemization occurs in various human and animal tissues, including the white matter of the brain, the lens of the eye, the aorta, cartilage, skin, bone, and both tooth enamel and dentin. It is possible to calculate and use the ratio of the L and D forms, in long-lived proteins that are metabolically stable, to estimate the age of the individual at death or the age of a living individual.

The accuracy, reproducibility, relative simplicity of methodology, and time required make tooth enamel and dentin among the best target tissues for age estimation using these methods. Among the amino acids tested, aspartic acid appears to give the most reliable results. This method offers the potential for the most accurate age estimations with the smallest ranges for all age groups. (+/- 3-4 years).

Gas chromatography (GC) and high performance liquid chromatography (HPLC) coupled with detection of fluorescence methods have been reported. Different teeth and different portions of teeth have been tested. Since dentin and enamel form at different times for different teeth, aspartic acid racemization will vary for different teeth and vary at different locations of a single tooth. Most researchers currently recommend sectioning teeth from labial to lingual and using a full length section from near the center of the tooth.

The current study will investigate different methodology in both preparation of the teeth and detection of the enantiomers. Researchers report that the complexity of preparing the teeth seems to be the most likely cause of variations in their results. When possible, teeth were tested in homonymous pairs from the same individual of known age at death. The procedure in this study was designed to minimize the handling and manipulation of the teeth. Excessive processing may generate heat and accelerate racemization. Minimal sectioning and grinding was accomplished using water-cooled instruments. Single rooted teeth were tested in two forms, either intact with no mechanical processing or with the enamel and cementum layers removed using water-cooled, rotary dental instruments. If no homonymous multi-rooted teeth were available, the target teeth were sectioned longitudinally into mesial and distal "halves", and one of the halves stripped of enamel and cementum.

Samples were frozen and pulverized in a Model 6750 CertPrep freezer mill and the resultant powder stored in appropriately labeled sterile containers. The tooth powder samples were demineralized with pH adjusted Na_2EDTA in 2 mL centrifuge tubes. The washed sediment was transferred to another tube and hydrolyzed for six hours with 6 M hydrochloric acid. After drying, the residue was derivatized using Marfey's reagent to produce chromatographically distinct L and D forms of aspartic acid. The analysis was performed by LC/MS/MS in positive ion mode using an Applied Biosystem 3200 Q-Trap mass spectrometer with an Agilent 1100 HPLC. The column used was a Phenomenex Synergi Polar RP, 50x2 mm, 4 micron. Three MRM transitions were monitored for each of the enantiomers of aspartic acid, 386 to 341.2, 386 to 144.2 and 386 to 185.8 amu.

This study examined new methods both in preparation and analysis. The study compares results from tests performed on processed and unprocessed teeth. If accurate results can be obtained from unprocessed or minimally processed teeth using standardized analysis procedures, many of the problems associated with widely varying techniques for assessing aspartic acid racemization for age estimation can be minimized. Consequently, the most accurate method with the smallest range for estimating ages for persons both living and deceased and of all ages can become more available to investigators.

Age Estimation, Aspartic Acid Racemization, HPLC/Mass Spectometry

F23 Dental Age Estimation - The Norwegian Approach

Tore T. Solheim, University of Oslo, Box 1109 Blindern, 0317 Oslo, 0317, NORWAY*

The goal of this presentation is to learn about a special system of dental age estimation used in Norway and the importance of the expert's opinion. Learning about the Norwegian system of age estimation of young refugees using this system is also an objective.

This presentation will impact the forensic science community by possibly changing strategy in the examination and reporting similar cases of age estimation. It may also change the opinion of the role of the forensic dental expert in a case.

After attending this presentation the attendees will understand some of the principles of the Norwegian system of dental age estimation and the philosophy behind it. It will also be possible to understand the Norwegian system of age estimation of young refugees claiming to be below 18 years.

The presentation's impact on the forensic odontology community may be a reevaluation of the role of the forensic odontology expert. It may also have impact on the way dental age estimation will be performed and reported.

The approach involves a lot of trust in the forensic expert and his/her judgment and it will be explained why. The Norwegian system is not only a reporting of findings on radiographs and compared with tables. It involves the taking of a history (anamnesis) of the person to be examined, if living. Any diseases which may have impact on the teeth should be registered. Also the state of nutrition, especially in childhood, and any special problems with the teeth as well as how the teeth are kept and cleaned will be registered.

A clinical examination by the expert is then performed and the general state of the teeth including attrition and color and recession of the periodontal ligament is registered. The teeth present are also registered and this ends in the expert's clinical assessment of the age. Then, necessary radiographs are taken according to the techniques used for calculating the age.

The radiographs are then examined and the results in the age calculation will be reported. The expert must then, if deemed justified, change is first opinion on the age and formulate the final conclusion. In this conclusion the age is only given in whole years and after 20 years in 5 year intervals. Instead of a standard deviation, which always will be incorrect, it will be assessed how likely the given age may be and how likely the alternative age may be.

Finally, it will be described how this works in the examination of young asylum seekers to Norway who claim to be below 18 years.

As a form of quality assurance the reporting is done according to the IOFOS recommendations and the report is signed by two experts who must agree upon the conclusion.

Age Estimation, Norwegian System, Forensic Dental Expert

F24 Third Molars and Estimating Age of Majority in Young Adults From Thailand

Pisha Pittayapat,and Vannaporn Chuenchampoonut, DDS, Chulalongkorn University, Faculty of Dentistry Radiology Department, Henri Dunant Road, Pathumwan, Bangkok, AL 10330, THAILAND; and Patrick Thevissen, DDS, and Guy Willems, PhD, Katholieke Universiteit Leuven, School of Dentistry, Kapucijnenvoer 7, Leuven, B-3000, BELGIUM*

After attending this presentation attendees will have gained an insight on the methodology and usefulness of using the developmental stages of third molars for estimating the age of majority in young adults, and more specifically in male and female youngsters living in Thailand.

This presentation will impact the forensic community by providing an additional database for dental age estimation of unaccompanied minors in an effort to globally counteract child trafficking in a more scientific approach.

All over the world people are entering countries illegally. Child trafficking is one of the existing illegal pathways which is counteracted by authorities worldwide in an effort to protect children's rights. However some of these unaccompanied minors claim to be minor but are not in reality. Therefore, age estimation procedures have been designed in many countries internationally and are most of the time based on a developmental evaluation of bones of the hand wrist, the collar bone and teeth.

The purpose of this research was to analyze the development of third molars in relation to chronological age in an original population of young adults in Thailand.

The developmental stage of third molars was determined on panoramic radiographs according to an earlier published methodology of the main authors. More than 900 panoramic radiographs were taken in male and female youngsters between 15 and 23 years of age. All these individuals were original inhabitants from Thailand and had the Thai nationality.

The examined radiographs were from individuals that had at least one developed upper and one lower third molar present, they showed no relevant medical history and had no obvious dental pathology. Their chronologic age at the moment of taking the panoramic radiograph was calculated based on their date of birth and the date when the panoramic radiograph was taken.

The results are discussed in full extent and allow the age calculation of unaccompanied minors originating from Thailand in a scientifically more sound approach.

Dental Age Estimation, Third Molars, Forensic Odontology

F25 Analysis of the Possible Effects of Ethnicity on Dental Age Estimation

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After attending this presentation attendees will have gained an insight on the possible impact of ethnicity on the estimation of chronological age based on the developmental stages of third molars in youngsters.

This presentation will impact the forensic community by providing additional scientific data on the possible influence of ethnicity on matters such as development of the human dentition and its value in dental age estimation.

Due to lack of existing and extensive databases on the development of human teeth in young adults and their relation to chronological age, forensic experts often use the few existing databases calibrated for the respective specific populations on which they were designed. This is done internationally but caution is most of the time expressed by increasing the standard deviations of the age estimation itself or by choosing wider confidence intervals.

The purpose of this investigation was to try and analyze the possible effect of ethnicity on the correlation between age and dental development in young adults from distinctively different populations.

The results are discussed in full extent and throw some light on the role ethnicity plays in forensic matters like dental age estimation.

Dental Age Estimation, Ethnicity, Forensic Odontology

F26 Homicide Cold Case (Twenty-Year-Old) Solved With Aid of Bite Mark

Paul G. Stimson, DDS, 902 Lakespur Drive, Sugar Land, TX 77479-5909*

Upon completion of this presentation, participants will realize that homicide cases are never closed. This case was closed after a twenty year period by a cold case squad, and ultimately a trial by jury with a guilty verdict.

This presentation will impact the forensic science community by showing how an individual's statements and the use of evidence with more modern methods can close a 20-year-old case. A cold case squad brought this case to trial by jury with a guilty verdict.

The defendant, Francis F. Pelkey was 26-years-old at the time of the homicide. The victim was Nell Johnson, a 36-year-old hospital inspector. Her bullet-riddled body was found five miles from her car in a wooded area of Harris County. Mr. Pelkey called police and told them a convoluted story about his encounter with her the day after her body was found. Mrs. Johnson had a tire problem on a busy freeway and Mr. Pelkey stopped to assist her. After the tire repair she took him home for tools and they returned to the site where his van was disabled. He was fixing his van and she was sitting inside of it. According to his statement, two armed men approached. One reached into his van and obtained his .22 caliber pistol. He then shot Johnson with this pistol. The killers then took his cap and shirt and one of them drove off in his van with Johnson and his gun. The other killer kept him at gunpoint on the scene. When the other killer returned they threatened to kill him if he talked, returned his hat and shirt and drove off in their truck. He returned home to clean his clothing, van and gun. His description of the gunman matched his own appearance to the clothing he was wearing. There was not enough evidence at the time to arrest and charge Pelkey. At one point he told police, "I'll tell you what really happened." His wife told him to "shut up", and no further statements were obtained from either of them. There was a bite mark visible on his left arm when he was arrested in 1980. Police took photographs of this mark. The odontologist only had to testify, "it was consistent with a human bite mark made by someone whose mouth was the same shape as Johnson's." The interaction between the judge, prosecuting attorney and the odontologist, out of the jury's hearing, was the interesting portion of this testimony. The defense attorney wanted a *Daubert* hearing. The jury was excused. In a side bar conversation, the judge asked the odontologist about his knowledge of *Daubert* hearings in bite mark cases. The odontologist was aware that an odontologist from El Paso, serving as an expert witness had testified in two of these type examinations and was allowed to testify. The odontologist then stated that this case was like the Kumo tire case. As stated, these were side bar comments between the judge and the odontologist, who was then allowed the odontologist to testify. No match of dentition to mark was required. The testimony was this was a human bite mark injury photograph on Mr. Pelkey, and it was consistent in size of an individual with similar dentition to Mrs. Johnson. The jury found Pelkey guilty with more inconsistencies in his statements and other evidence. He was sentenced under the guidelines in effect in 1980 in Texas, and given 40 years. He will have to serve 13 years before becoming eligible for parole.

Homicide, Bite Mark, Cold Case

F27 Greg Wilhoit - An Innocent Man

Richard R. Souviron, DDS, Miami-Dade County, Medical Examiner's Office, 336 Alhambra Circle, Coral Gables, FL 33134*

This presentation will point out the danger of presenting unproven and non scientific evidence (the presence of bacteroids and candida albicans in saliva) in making the link to the suspect. The presentation will show the bite mark evidence and the dangers of making a positive link to a suspect, "like a fingerprint" with total disregard for the unanimous opposite opinion of twelve board certified forensic odontologists. This presentation will also point out the danger of presenting unproven and non scientific evidence (the presence of bacteroids and *candida albicans* in saliva) in making the link to the suspect. Most egregious of all is the fact that defense attorney Briggs would not use a defense expert and decided to "wing it" even when presented with the overwhelming opinions of twelve independent experts.

This presentation will impact the forensic science community by showing the importance of second opinions in bite mark cases. The use of bacteria and yeast in saliva should not be used to link a suspect to a bite mark injury.

In the novel by John Grisham "The Innocent Man", he describes the Wilhoit case in some detail. Bite mark testimony by the prosecution "experts", Dr. Tom Glass and Dr. Keith Montgomery were a major factor in the conviction of an innocent man-Greg Wilhhoit. Gross incompetence of counsel was the reason Mr. Wilhoit was granted an evidentiary hearing and subsequently a new trial. The defense was granted a directed verdict of acquittal at the second trial, some 6 years after his incarceration.

A bite mark was found on the right breast of the victim Kathryn Wilhoit at the time of her murder in 1985. Her estranged husband Greg Wilhoit was charged with first degree murder at an arraignment hearing in July of 1986 where Dr. Keith Montgomery testified as to a bite mark match. Mr. Wilhoit's trial for capital murder took place in Oklahoma in May of 1987.

Mr. Wilhoit's defense counsel George Briggs elected not to use defense bite mark expert Dr. Tom Krauss despite the fact that Dr. Krauss had sent the bite mark evidence to eleven board certified forensic dentists from across the United States and had affidavits from all eleven stating that Mr. Wilhoit could be eliminated as the biter. Defense attorney Mr. Briggs was under the influence of alcohol prior and during most of the trial. Mr. Briggs was subsequently disbarred by the Oklahoma State Bar.

The prosecution presented bite mark testimony by Dr. Glass and Dr. Montgomery along with their findings of bacteroids and *candida albicans*

in the saliva found in the bite mark and from Mr. Wilhoit's mouth. Their testimony was that this was a rare finding. Further, their testimony was that bite marks were like fingerprints in specificity. The jury found Mr. Wilhoit guilty and he was sentenced to death. He spent 4 years on death row at McAlister, the Oklahoma State maximum security prison.

Because of the ineffectiveness of counsel by George Briggs and the efforts of Dr. Tom Krauss, the court of appeals granted an evidentiary hearing in July of 1990. Judge Pearman conducted the hearing and issued a "finding of fact" and "conclusion of law". In March of 1991 his findings and opinions were presented to the criminal court of appeals. On April 15, 1991 the appeals court issued an order and reversed the sentence and remanded the case for a new trial.

At his new trial Greg Wilhoit's new defense attorney Mark Barrett was granted a directed verdict by Judge Pearman and Greg Wilhoit became a free man.

Bite Mark, Candida Albicans, Conclusion of Law

F28 Operator Exposure to Scatter Radiation From a Portable Hand-Held Dental Radiation Emitting Device (Aribex™ NOMAD™) While Making 715 Intraoral Dental Radiographs

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After attending this presentation, participants will understand the relative potential risk of operator exposure to backscatter radiation while using a portable hand-held dental radiation emitting device (Aribex™ NOMAD™). Specifically, attendees will be able to evaluate and compare the operator backscatter radiation dose received to Maximum Permissive Dose (MPD) and to dose levels of equivalent daily background radiation when positioning this device in a forensic (atypical) setting. The presentation will provide the forensic dental community and others whose disciplines require the use of this devise with the knowledge required to evaluate a radiation safety risk/benefit paradigm for the use of this instrument.

Specifically, attendees will be able to evaluate and compare the operator backscatter radiation dose received to Maximum Permissive Dose (MPD) and to dose levels of equivalent daily background radiation when positioning this device in a forensic (*atypical*) setting. Based on this study, similar comparisons can also be made to the MPD and equivalent daily background radiation when the devise is used according to the manufacturer's positioning recommendations in routine (*typical*) dental settings.

This presentation will impact the forensic community by presenting results which indicate that operator exposure to backscatter radiation from the use of a NOMAD™ dental radiation emitting device in forensic dental settings is minimal, and not clinically significant. Thus, risk of backscatter radiation exposure to the operator while using this unit in a morgue facility or multiple fatality incident scenario is similar to that received when the devise is employed in standard dental settings.

Introduction: The NOMAD™ radiation emitting unit received FDA approval in 2005 and had been authorized for use in multiple fatality incident situations associated with hurricane Katrina and the Indian Ocean tsunami forensic team mobilizations. Despite these facts, the radiation safety division of the Nevada State Board of Health required that a study of the backscatter radiation to the operator during dental related radiography be conducted prior to authorizing use of this device in the State of Nevada. This study was conducted at the UNLV School of Dental Medicine after review and approval by the school's Institutional Review Board (IRB) for Human Research.

Materials and Methods: Operator exposure to backscatter radiation while using an Aribex™ NOMAD™ radiation emitting device was determined while the operator employed various *typical* and *atypical* use scenarios during the exposure of 715 digital and/or film based dental radiographs. Additionally, 100 digital and 100 film based radiographs were exposed as controls in *typical* modes according to manufacturer recommendations.

Results: Study data was compared to the radiation safety Maximum Permissive Dose (MPD) and to equivalent daily background radiation. Results showed the reproductive organs received the highest dose and the thyroid the least. The average operator whole body study dose was determined to be 0.065 mSv (6.58 mrem) or 0.13% of the annual MPD and the effective dose of 0.034 mSv (3.4 mrem) to be 0.95% of annual background radiation or an added 3.5 days.

Extrapolating the data as an expression of averaged annual operator exposure resulted in a whole dose of 0.629 mSv (62.9 mrem) or 1.26% of the annual MPD. The extrapolated whole body effective dose was 0.331 mSv (33.1 mrem) which is equivalent to 9% of the annual background radiation or an added 33.5 days. These results are compatible with those published by the manufacturer.

Conclusions: Used in a *typical* manner, the manufacturer of the NOMAD™ hand-held radiation emitting device acknowledges that the unprotected operator will sustain a small additional amount of radiation (<1% of the MPD). This additional radiation exposure is directly related to the operator position within the "safe zone" provided by the acrylic/lead shield on the end of the primary beam collimator.

This study documented operator backscatter exposure in *atypical* situations in which the operator was not positioned according to complete compliance with the "safe- zone" recommendations of the manufacturer. Despite this fact, the results of this *atypical* use study for this device are similar to those of the manufacturer. The additional exposure of 0.065 mSv (6.58 mrm) in this study falls well below the 5.0 mSv (500 mrem) occupational limit at which dosimeter monitoring is required for dental personnel in Nevada.

The additional backscatter dose contribution is not incompatible with other occupations in which there are potential radiation exposure hazards. Any operator concerned about additional exposure when using the NOMAD™ device in an *atypical* configuration can choose to take appropriate shielding precautions.

Operator Radiation Exposure, Portable Radiation Emitting Device, Maximum Permissive Dose

F29 Mideo System CASEWORKSeis™: The Use of New Technology in Bite Mark Analysis and Forensic Identification

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After attending this presentation, attendees will understand and appreciate the nuances and workflow barriers that forensic dentists and other forensic specialists encounter when employing digital photography and radiography technology as components of their forensic comparison and evaluation protocols. Additionally, the presentation will provide attendees with information concerning a new device and computer software program that facilitates secure image workflow and addresses the problems previously encountered by forensic experts using this technology. This session will present the practical uses of this system, which is new to forensic dentistry and the coroner/medical examiner laboratory environment.

This presentation will impact the forensic community by presenting information which will facilitate the comparison of dental records in mass fatality incident situations, and cases requiring bite mark evidence, histological tissue and/or digital radiographic comparison.

The introduction of digital radiographic and photographic technology has introduced new comparison media into the forensic laboratory, making these procedures more difficult for the forensic scientist unfamiliar with the operational techniques required for their use. Currently, forensic practitioners are storing more information in digital formats. Thus, tracking, networking, and securing this stored data have become issues of high priority for the forensic community.

Comparing digital images and radiographs with conventional film based images and printed radiographs is more difficult than comparison of these components of forensic evidence within the same medium. The computer software program CASEWORKS*eis*™ developed by Mideo Systems, Inc. permits these operations and increases accuracy and efficiency in forensic identification and bite mark analysis. Additionally, CASEWORKS*eis*™ provides security, tracking, and storage and output solutions for management of forensic evidence.

The CASEWORKS*eis*™ program permits the user to capture non-digital radiographic formats and import digital radiographs. Once the capture sequence is complete, CASEWORKS*eis*™ offers the user tools to manipulate the radiographic images. Various filters are included for measurement, image enhancement, and comparison. The program also interfaces to various LIMS and/or coroner's case management software. Multi-level security provides the ability to attach case details to objects stored in the database of the program.

The ability to scan or photograph a dental cast into the software and bring it immediately to a 1:1 relationship with digital photographs of a bite mark pattern is unique to this program. This feature can greatly reduce the time required for bite mark comparison. A variety of image types, including radiographic or photographic projections, can be viewed in a single workspace. This feature permits the analyst to more accurately compare the data.

CASEWORKS*eis*™ stores each version of an image in a SQL/Oracle database, attaching it to the image. The unaltered original image/data can be accessed at any time during the analysis process. The program tracks and records all manipulation of the data. Image history and chain of custody information is documented to insure the authenticity of this evidence should questions arise. Data and evidence stored in the CASEWORKS*eis*™ program is readily available for court exhibits through quick, straightforward interfaces.

The capabilities of the CASEWORKS*eis*™ program will be demonstrated through review of several recent cases involving comparison of dental records and radiographs for identification and comparison of bite mark evidence. Beta testing of this software system has occurred at the Clark County, Nevada Coroners' Office and the Los Angeles Sheriffs' Crime Laboratory.

Computer Software, Evidence Comparison, Bite Mark Analysis

F30 The State of the Missing/Unidentified Persons Today and How Forensic Dentists Can Help With Closure

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The goal of our study and presentation is to make all agencies involved in the identification of Missing and Unidentified individuals aware of the current changes implemented by the National Crime Information Center. In addition, we would like to review new developments relating to Missing and Unidentified Persons that have occurred in general.

This presentation will impact the forensic science community by helping provide closure for the friends and families of Missing and Unidentified Persons.

The NCIC is a nationwide computerized information system available to law enforcement and criminal justice agencies. It was formed in conjunction with the International Association Chiefs of Police and the FBI in 1967. The system started with the Missing Article File, expanding to include the Missing Person File in 1975 and the addition of the Unidentified Person File in 1983. It has had shared management between the FBI, State and other Federal Criminal Agencies. The FBI has been the host computer for 50 states, District of Columbia, Puerto Rico, U.S. Virgin Islands, Guam, Canada and Interpol. Even so, it has been difficult for each state to collect information and to have the ability to share information. The Missing Person File and the Unidentified Person File has been hampered by the use of identifiers that related more to physical characteristics (hair, eye color, etc.) rather than something more stable like dental characteristics. Additional hindrances to the system included the failure to collect the necessary personal information, such as dental records, at the law enforcement level. A June 2007 statistical report from CJIS indicates that the number of Missing Person Files with dental records collected averaged less than 5% for the majority of states. Ten states had less than 1% of their missing persons cases with dental records submitted. Recently, significant changes have been implemented. The revised Unidentified and Missing Persons Data Collection Entry Guides (instituted in 02/2006) are simpler and easier to understand and are based on an adaptation of the WinID program. However, trained individuals are still needed to complete the revised forms. The investigation showed not all counties in New York were using the updated forms and not all individuals filing the forms were trained. With the help of the FBI and fellow members of the ABFO, reasons why were sought to discover what was occurring in the rest of the 50 states. All state clearinghouses were surveyed. The results of the experiences and survey will be presented in the hopes of making all agencies more knowledgeable of the tools available to them in helping to provide closure for the many family and friends of the Missing and Unidentified.

A National Dental Image Repository (NDIR) is being established at this time. It will provide a place for law enforcement to post dental images related to the missing and unidentified on the web. The NDIR is composed of experienced dentists qualified to make comparisons and are available for consultation to all law enforcement agencies. The dentists are trained to use the correct coding. Also updated coding forms will be available online. The NDIR is placed on Law Enforcement Online or LEO. This system operates 24/7 and is restricted to law enforcement, criminal justice or public safety agencies. Case information will be submitted and will be reviewed by a group of ABFO odontologists and approved. Once approved the information is posted by NCIC number on LEO in a .PDF format (portable document form).

Other new developments now include the dissolution of the National Center for Missing Adults (even though 3% of the missing are less than 18-years-old) due to lack of funds.

On July 2, 200,7 the Justice Department launched the National Missing and Unidentified Persons Initiative (NAMUS). This will be an additional repository of relevant information for medical examiners, coroners, victim advocates, law enforcement agencies, and the general public to access and search for records of missing persons and unidentified human remains to attempt to solve cases. Exactly how this will work with other agencies is not clear at this writing.

Missing/Unidentified Persons, NCIC, NDIR

F31 Advanced Dental Imaging as an Adjunct to Dental Age Estimation - A Comparison of Panoramic Radiography and Cone Beam Computed Tomography Assessment of Third Molar Development

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The goal of this presentation is to investigate the role of advanced imaging, using Cone Beam Computed Tomography (CBCT) to aid in determining the stages of third molar development. The technique will be compared to a conventional technique using panoramic radiography.

This presentation will impact the forensic science community by reaching better accuracy in the assessment of the developmental stages of roots.

Forensic dentists make chronological age estimates based on the stages of crown development, root development and apical apices closure of the teeth roots. In cases involving age assessments for immigration agencies, the third molar root apex closure is most often evaluated. These estimates are based on data from the studies of Demirjian (1973) and Mincer (1993) and the use of conventional radiographic images. Estimates based on third molars necessarily have large ranges (+/- 4 years) as the third molar is the most variable of all teeth in development. Advances in imaging and more discriminate staging may improve the technique and narrow those ranges. Even though panoramic images are the primary image source for assessing apex formation, the projection geometry and nature of panoramic image formation with its inherent layering of anatomical structures and distortion, make accurate assessment problematic. Panoramic imaging has many advantages in terms of time required, decreased radiation dosage to the patient, wide area of coverage, comfort to the patient, ease of infection control and cost effectiveness to reach a radiographic view of the teeth and their supporting structures. However, with the development of advanced imaging and multiple plane reconstruction, a more accurate assessment of the development of dental structures, can be achieved. This could result in better accuracy in the assessment of the developmental stages of the teeth including third molars.

The aim of this study is to investigate the role of advanced imaging, using Cone Beam Computed Tomography (CBCT) to aid in determining the stages of third molar development. The technique will be explained and contrasted to a conventional technique using panoramic radiography.

For this prospective study, Institutional Review Board approval of use of human subjects was previously obtained. The subjects consisted of patients being evaluated for 3rd molars extractions and/or orthodontic treatments. Both the departments of Orthodontics and/or Oral Surgery Department of the Graduate Dental Clinic were solicited for referrals. The population ranged in age from 14 to 19 years old. The panoramic and CBCT images were acquired by the residents of the Graduate Program in Oral and Maxillofacial Radiology of the University of Texas Health and Science Center at San Antonio. The digital panoramic images were acquired with the Planmeca Promax. During the same appointment, using the high resolution Morita Accuitomo 3DX, two additional CBCT were acquired for each subject. Demographic information was recorded from the dental record and the added information sheet provided with the consent form. The age estimation was made by using the Demirjian/Mincer stages of the third molar development for the panoramic images and the three dimensional CBCT images.

Advanced imaging and cross sectional reconstruction of the CT volumes should offer better information about the position of teeth and their relationship to anatomical landmarks that may eventually become valuable in clinical dentistry and in forensic identification. Information gleaned about apical development of the third molars is expected to prove to be superior to panoramic radiography.

Age estimation by means of tooth development assessment from conventional radiographic images has been in used for many years. While CBCT is becoming more recognized as a powerful additional tool for diagnosis and treatment in all areas of dentistry, it is still considered to be an emerging technology. The standard of care and the guidelines for best practices challenge forensic dentists to be prepared to use all available techniques to reach the most accurate conclusions. Cone Beam Computed Tomography is a promising "new" technique that allows practitioners of clinical and forensic dentistry views of anatomical features never before possible.

Age Estimation, Cone Beam CT, Forensic Odontology

F32 Dental Age Estimation by Calculating the Ratio of Tooth and Pulp Volumes Using Cone Beam Computed Tomography

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At the end of this presentation, participants will appreciate the value of the cone beam computed tomography in dental age estimation methods.

Estimation of age using cone beam computed tomography will be an adjunct to other age estimation techniques in identifying unknown individuals and assisting law enforcement officials in determining whether individuals have reached the legal age of adulthood.

Age estimation is an important factor in the identification of unknown individuals and integral in efforts to assist officials in determining whether individuals have reached the legal age of adulthood. The most common dental age estimation methods currently used are based on various age related changes in teeth. The methods that utilize formation and development of teeth are accurate for estimating ages in children and adolescents but ineffective for adults. Some of the methods useful for adults require the extraction and sectioning of teeth and are not applicable for living individuals. Morse (1991) and Kvaal et al (1995) discussed assessing the reduction in the volume of the pulp with increasing age for age estimation. The current study focuses on evaluating the tooth-pulp volume ratio (vT:vP) using images obtained from cone beam computed tomography (CBCT). The CBCT method may allow for a more accurate assessment of the tooth and pulp volumes than the two dimensional information provided by radiographs.

Using a Morita 3D Accuitomo Model, 150 images of 150 individuals of known ages were collected. The target teeth chosen for this study were paired maxillary incisors, maxillary first permanent molars and mandibular first permanent molars. The participants had at least one pair of target teeth, fully developed, and with no evidence of restoration/pathology.

For single rooted teeth the most coronal extent of the pulp and the location of the root tip were determined. Segments representing eighty per cent (80%), forty per cent (40%) and twenty per cent (20%) of the most coronal portions of the pulp tip to root tip portions of these teeth were analyzed. These selection criteria exclude that portion of the crowns with no pulp and a calculated portion of the root tip. The volume measurement for the mandibular first permanent molars was from the plane parallel to the tip of the most coronal pulp horn to the plane parallel to the most coronal portion of the furcation of the root with both planes perpendicular to the estimated long axis of the tooth. A second volume measurement for the

mandibular molars included the initial volumes added to volumes calculated for a segment of the root portions of the tooth equal to the initial segment. For the maxillary first permanent molars, the area of interest extended from the plane even with the tip of the most coronal pulp horn to the plane even with the most coronal portion of either root furcation. CBCT slices of known thickness were imported into Adobe Photoshop for area measurements of the tooth and the pulp. The volume was calculated by multiplying the tooth area and pulp area of each slice by the thickness of the slices. The sums of the vT and vP for all the slices included for each tooth was determined and the vT:vP was calculated.

The distributions of each set of vT:vP were tested for normality, and the angular transformation was applied when necessary. Linear regression was performed to determine the overall association of subject age with each set of vT:vP values. The subjects were then grouped by decade age, and one-way ANOVA tests were performed to determine if any significant mean differences between decade ages were observed, with the F-tests considered statistically significant if $p<0.01$. If the F-test was significant, then pairwise decade age mean comparisons of interest were performed using Bonferroni-adjusted Student's t-tests with $p<0.05$ considered statistically significant. The sample size of 20 subjects per decade age grouping was sufficient to detect a population effect size of 0.4 or more by F-test at the 0.01 level with power of 80%. The specific results of this study will be presented.

Forensic Odontology, Age Estimation, Cone Beam Computed Tomography

F33 Exemplar Creation In Bite Mark Analysis Using Cone Beam Computed Tomography

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After attending this presentation, attendees will learn a new way to gather and use three-dimensional information about the teeth of suspected biters.

This presentation will impact the forensic community by demonstrating a new technique to gather and use three-dimensional information about the teeth of suspected biters.

This pilot study investigates the use of Cone Beam Computed Tomography to assist in bite mark analysis by creating improved exemplars of suspected biters' dentitions that include the consideration of the three-dimensional nature of teeth.

There are numerous ways of producing exemplar overlays to compare biters' dentitions to bite marks. Past and current methods used for bite mark exemplar creation included hand-tracing, xerographic and radiographic methods. Currently, the most widely accepted method is a computer-assisted generation of exemplars using reflected light scans of dental models of suspected biters. This method has been touted as superior to other modalities. Scanners generate digital information by moving a scan head made up of mirrors, lenses, filters, and in high quality scanners, a charged couple device or CCD. The CCD collects light from either a cold cathode fluorescent lamp (CCFL) or a xenon lamp that is reflected from the dental models. This reflected light is not a dependable "reflection" of the actual three-dimensional profile of the biting surfaces of the teeth. The subsequent selection of the areas to be chosen to depict the biting surfaces, whether done manually or computer-aided is markedly subjective. Using the three-dimensional CBCT to help generate a series of two-dimensional exemplars is just the first step toward minimizing the shortcomings of other methods. The ultimate goal is to develop exemplars that will fully and accurately depict the variation of surface contour in the subjects' dentitions at various angles of attack.

With the use of CBCT scans of the biters' dentitions the creation of multiple exemplars of the suspects' dentitions facilitates depicting the variety of angles of attack and depths of attack of the teeth as they contact the bitten substrate. Curt Dailey, DDS, in his 2002 AAFS presentation "The Topographic Mapping of Teeth for Bite Mark Overlays" described a method using selective grinding of suspects' stone dental models. An advantage of the current method is that the three-dimensional images can be sliced and re-sliced at varying angles. Using current technology the slices can be as thin as 0.125 mm.

CBCT scans were taken on ten subjects using a Morita 3-D Accuitomo. Using I-Dixel software axial slices were taken every 0.125, 0.250 and 0.5 mm. For each slice, beginning with the initial contact of the incisors, a depiction of that portion of the teeth was outlined, creating a hollow volume overlay derivative of a method first developed and presented to the AAFS in 1996 by Heidi Christensen, DDS, MS and later published by Bowers and Sweet and Bowers and Johansen. A total of 8 to 16 of the 0.250 mm slices were used which is equivalent to 2 to 4mm of tooth structure from the initial tooth contact. The resulting layers form a pseudo-three dimensional reconstruction of the teeth. When combined the multiple outlines resemble a "topographic map" of the teeth. This method allows the use of different layers generated from varying angles to more accurately compare suspected biters to the bite mark.

This method of constructing overlays is a more accurate and comprehensive method to objectively construct two-dimensional and pseudo three-dimensional overlays. Limitations include the potential lack of access to CBCT for some and the cost of the procedure for others. Additional methods to ameliorate these limitations will be suggested.

Cone Beam CT, Bite Marks, Forensic Odontology

F34 Cone Beam CT Radiography for Dental Identifications

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After attending this presentation, attendees will gain an understanding of Cone Beam CT techniques and possible forensic dental uses.

This presentation will impact the forensic community by demonstrating a new method in dental odentifications.

Cone Beam Computed Tomography (Cone Beam CT) is a relatively new dental digital dental radiographic imaging technique that is rapidly gaining a place in dental diagnosis and treatment planning, and shows unlimited possibilities for future use. The essence of the technique relies on multiple skull or maxillofacial exposures onto a digital sensor plate taken from 360 degrees of rotation about the subject which is then synthesized by relational software into numerous possible viewing aspects simulating a medical CT Scan but at a much lower dose and cost to the patient.

In medical CT Scans, the beam is collimated to be thin and fan-shaped and slowly scans down through the patient (from head to toe) at ninety degrees to the body, one layer at a time. This induces a large amount of x-radiation exposure to the patient. Cone Beam CT, however, produces pulses of radiation exposing the patient with a beam shaped similarly to that used in exposing a cephalometric radiograph producing approximately 300 images around the patients head. Even though the exposure rotation time may be 20 seconds, the pulsed radiation exposure time to the patient may only be 4-6 seconds in duration. Therefore, a 20 second Cone Beam CT scan may induce a dose as low as 68 micro-sieverts whereas a traditional complete mouth radiographic series of intraoral radiographs induces a dose

of 150 micro-sieverts compared to the dose of a Medical CT dose of 1200-3300 micro-sieverts.

The robust amount of scanned information from all possible angles allows the practitioner to select multiplanar slices in three planes: axial, sagittal, and coronal. The slices may also be selected from 0.25 mm to 150.0 mm in thickness. Thus, traditional plane film images may be selected after-the-fact such as a panoramic view, cephalometric views, TMJ projection views (both lateral and antero-posterior), PA skull views, sialography examinations, and submentovertex views. Cone Beam machines with the capability of producing an extended field of view (typically 22 mm vertically) can also be used for airway assessments to be used with sleep apnea patient studies.

However, new image modes are also allowed by the scan by producing selectable axial images (as if looking down onto the selected plane from above), cross-sectional images (as if looking onto a segment of the mandible or maxilla cut at 90 degree angles) and also 3D images of the entire skull or orofacial complex. In fact, three dimensional models have been rendered from the single scan of a Cone Beam CT unit, eliminating the need of utilizing impressions and plaster pour-ups. Also, all Cone Beam CT images are displayed without distortion at a consistent 1:1 or life-sized ratio. The system also eliminates "ghost" image artifacts seen routinely with panoramic radiography which are superimposed on the actual radiographic anatomy and often hinders radiographic diagnosis.

This presentation will involve a "real time" demonstration of the Cone Beam CT imaging software and will suggest possible new methods of performing dental identifications and possibly bite mark analysis and comparison using this new and promising imaging technique.

Cone Beam, CBCT, Dental Identification

F35 UVIS -The Unified Victim Identification System - New York City's Master Disaster System Takes Shape

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The goal of this presentation is to familiarize the attendee with New York City's federally mandated emergency management computer software. The attendee will be introduced to the interoperability of a completed emergency management system as it relates to all aspects of victim identification.

The familiarization by the forensic odontology community with New York City's UVIS system will help expedite the identification of victims of a mass disaster or bioterrorist attack by odontological means. Since this risk of such attacks remains high, it's usefulness in the field of forensics and its impact on humanity is immeasurable.

Following the World Trade Center attack New York City implemented a comprehensive Mass Disaster Preparedness Program to ensure that the city was prepared in the event of another terrorist attack. A federal mandate required the New York City's Office of the Chief Medical Examiner have a single unified reporting system in place to allow for seamless communication between multiple city agencies. This lead to the development of the Unified Victim Identification System (UVIS).

UVIS is an ASP.NET, C#, and MS-SQL based system which deals with all aspects of victim identification management. This multi-module software system allows for rapid communication between multiple city agencies. This presentation will consist of an overview of the system especially how it relates to forensic Odontology. The discussion will begins with activation through the city emergency management office following by a discussion of the intake of missing person information through New York City's 311 based management system. Addition module of mortuary management will track postmortem specimen intake and tracking. DNA sampling, fingerprint identification and missing person reconciliation will also be discussed. The presentation will conclude with a discussion of a UDIM the UVIS Dental Identification Module a fully integrated Forensic Odontology management system.

UVIS - Unified Victim Identification System, UDIM - UVIS Dental Identification Module, Forensic Odontology Management System

F36 WinID Expansion as an Aid in Multiple Fatality Incidents

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The objective of this presentation is to (1) assess the impact of WinID program expansion in Multiple Fatality Incidents (MFI's) via survey of responders to previous MFI's, and (2) compile a comprehensive list of terms for identification to be incorporated into the WinID data base to aid in identification efforts in MFI'S.

The impact of this presentation will be to aid in management of data in Multiple Fatality Incidents.

A survey was taken of responders to previous MFI's requesting their input on the benefit of a program integrating all identifiers. This survey was conducted via the internet. Identification terms were gleaned from existing forms used for this purpose, i.e., Victim Identification Profile (VIP), National Crime Information Center Missing Person Data Collection Entry Guide, Interpol Victim Identification Form, as well as terms added by the author.

Managing a Multiple Fatality Incident (MFI) requires the collection of a large amount of antemortem and postmortem data. Organizing, accessing, analyzing, and making this data useful are a challenge for forensic personnel. The expectation of positive identification of the victims is high. Scientific identification is typically based on one or more of four methods, dental, DNA, fingerprint, and medically documented biological characteristics. Antemortem data that do not fall within these methods has the potential to be less useful particularly in cultures that require identification to be scientifically based. Not every culture demands that a scientific standard be met for identification. A database that includes as many identifiers as possible would allow for applications in third world countries where the identification standards are different than those of the United States and may be based solely on personal effects or biological characteristics such as hair or eye color. The collection of antemortem data that includes only the most effective and most used parameters is becoming more of a concern. Misinterpretation of terminology by both interviewer and interviewee can hinder the identification process as well. Prior incidents have been worked using two well known but different software systems that are written in incompatible languages. WinID was designed to manage dental antemortem and postmortem data while VIP manages broader biological identifiers as well as personal effects. This arrangement requires investigators to be proficient in two different programs to access all identifying data on an individual case. Surveys of responders to previous MFI's indicate that the integration of all antemortem and postmortem data would improve efficiency and decrease the workload of forensic investigators. This paper details a proposed single integrated web based software system, WinID that includes identifiers gleaned from forms already in use. The program will be written in ASP.net 2.0. The data will be formatted in Extensible Markup Language (XML). The XML format allows data to be accessed by programs using incompatible languages. It also allows for easy expansion and revision of terminology in the data base if necessary. A single software system, an expanded version of WinID, would allow all investigators access to all data to improve efficiency of identification of victims. In addition, having WinID web based allows easy access to the program online. The availability of the program online would

allow for access by investigators from any location. This includes investigators onsite of the disaster as well as those off site that may be interviewing family members.

Forensic Odontology, WinID, Multiple Fatality Incidents

F37 Identification of Incinerated Root Canal Filling Materials After Exposure to High Heat Incineration

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Upon completion of this presentation, the attendee will have an increased awareness of the different types and brands of endodontic materials that can be found in the root canals of human teeth. The attendee will also understand how endodontic sealers, filling materials, files, and cement that are contained in the canal will retain their specific elemental fingerprint after incineration.

The presented material will impact the forensic community by increasing the pool of antemortem data available to identify victims of incineration events.

With the increase in global terrorism there is a higher probability of having to identify victims of incineration events. The victims of incineration events challenge forensic odontologists when coronal restorations are no longer present to compile postmortem data. With 40 million root canals being completed annually in the United States, a very large pool of antemortem data is currently available to the forensic odontologist to make positive identifications. This pool of data can be more readily used if an analysis of the materials can pinpoint a specific type and brand of endodontic material.

This study provides fingerprints of root canal obturation materials to be utilized as a forensic identification aid. The analysis used Scanning Electron Microscopy/Energy Dispersive X-ray Spectroscopy (SEM/EDS) to assess the elemental composition of materials before and after high temperature incineration. Sixteen endodontic materials were analyzed pre-incineration and placed in extracted teeth. The filled teeth were subjected to incineration at 900° C for 30 minutes to simulate incineration events or cremation. Incinerated materials were radiographed and re-analyzed to determine if they retained their original elemental composition.

Results from the study determined that endodontic sealers, gutta percha, root end filling materials, silver points and separated files were distinguishable in the canal and traceable after incineration. The author will present a fingerprint of the endodontic obturation materials based on elements specific to each type and brand of material. This work represents the initial stage of database generation for root canal filling materials.

An understanding of root canal therapy will enable the forensic team to use postmortem radiographs to determine what procedure the patient underwent, what materials where used and what possible procedural accidents may have occurred. Initial root canal therapy involves the complete cleaning and shaping of all the canals of the tooth followed by filling the canal from the coronal orifice to the apex with a radiopaque obturating material. Endodontic accidents involve perforating the canal, separating a file in the canal or failing to locate a canal would be evident on the post operative radiograph. Surgical root canal therapy involves the resection of the apical third of the root followed by a retrograde filling. The materials used for the retrograde filling will significantly differ from the initial root canal filling. All materials should also be annotated in the patient's antemortem dental record. It is important to compile all possible antemortem dental information and it should be stressed that many dental patients are referred to endodontists for non-surgical and surgical endodontic treatment. If a referral was made to an endodontist, the specialist should be contacted to obtain their specific antemortem dental records that would contain the type and brand of material used to obturate the tooth.

Forensic Odontology, Endodontic Materials, SEM/EDS

F38 Dental Implants in Forensic Dental Identification: Morphologic and Radiographic Analysis

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After attending this presentation, participants will gain a better understanding of the morphology and radiographic appearance of dental implants used since their introduction as dental prosthetic device.

This session will impact the forensic community by providing information that will guide the forensic dentist in the postmortem identification of individuals with dental implants. The information will be particularly useful as a guide to determine the approximate time in history of the implant placement based on the evaluation of postmortem dental photographs and radiographs.

Due to the development of new engineering and surgical techniques, the use of dental implants has increased through the years. Their shapes and types have also evolved throughout history. In 1952 a Swedish research team led by Per Ingvar Branemark, an Orthopedic Surgeon, noticed something interesting during one of their research projects that involved the study of microscopic healing of bone. Branemark designed an optical chamber housed in a titanium metal cylinder that was screwed temporarily into a rabbit's thighbone to document and visualize the healing process. However, once the experiment was completed after several months, it was discovered that the cylinders could not be easily removed and that the titanium cylinders had fused to the bone. Branemark named this phenomenon "osseointegration." Branemark and his team went forward to demonstrate that under specific conditions titanium implants could be structurally integrated into living bone with a very high degree of predictability. It was additionally learned that the implants did not result in long-term soft tissue inflammation or implant rejection. During the past 20 years, dental implants have undergone rapid development. Dental implants can vary in multiple characteristics such as shape, placement within bone or sitting on top of the bone, material, and external coatings.

Dental implants are categorized into three main groups**:** endosseous implants, subperiosteal implants**,** or transosseous implants. Subperiosteal implants are implants which typically lie on top of the jawbone, but beneath the oral tissues. By definition they usually do not penetrate into the jawbone itself, and are usually not considered to be truly osseointegrated implants. Of all the currently used methods, it is the type of implant that has had the longest period of clinical use. These implants are not anchored inside the bone, but are instead shaped to rest on the residual bony ridge of either the upper or lower jaw. They have been successfully used in completely edentulous as well as partially edentulous upper and lower jaws with the best results achieved in treatment of an edentulous mandible. Subperiosteal implants are typically indicated in the case of a severely resorbed edentulous mandible, which does not offer enough bone height to accommodate endosseous anchoring devices. This type of implant is custom-made to fit each individual jaw. A CAT scan is taken of the jaw and a computerized modeling machine uses this data to reproduce a three-dimensional plastic model of the jaw to be treated, and the resulting model is used to design the individual subperiosteal framework, which is subsequently cast in metal. A coating such as titanium or hydroxyapatite may be applied to portions that actually come in contact with the bone itself in order to improve its bio-acceptance. The implant is then sterilized and

returned to the dentist for surgical insertion. After the subperiosteal implant has been surgically inserted, only a bar is visible extending from the right side of the lower jaw to the left side, onto which a denture can be clipped via a specialized attachment.

Endosseous implants are implants that are surgically inserted into the jawbone itself. These are the ones most commonly used today, and will be presented in detail during the presentation. These implants can be placed wherever one or more teeth are missing, so long as sufficient bone is present for their placement. They may be screw-shaped, cylindrical, or cone-shaped, with each implant design having its specific purpose intra-orally. They are further categorized into several sub-categories; based on their shape, function, surgical placement and surface treatment.

Transosseous implants typically have a plate on the bottom that is firmly pressed against the bottom part of the chin bone, with long screw posts passing through the chin bone all the way to the top of the residual bony ridge. The two protruding intra-oral attachments are used to serve as an anchor for a future over-denture. These implants are very prevalent any more due to the fact that their placement requires an extra-oral surgical approach which for the patient means undergoing general anesthesia, hospitalization and higher cost.

The slide presentation will inform the attendee about the results of the study. The presentation will include a guide to determining the years in which a particular type of dental implant was most likely placed, along with the radiographic appearances of dental implant types. This information is expected to aid in forensic dentists in the dental identification of human remains.

Forensic Science, Dental Identification, Dental Implant

F39 Teaching of Denture Marking Methods in Dental Schools in the United Kingdom and United States

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After attending this presentation, attendees will learn about: (1) differences between the United States and United Kingdom in denture marking, (2) differences in the teaching of denture marking in the United Kingdom and United States, and (3) the importance of denture marking in identification of individuals.

This presentation will impact the forensic science community by describing the teaching of denture marking in United States and United Kingdom dental schools.

The importance of placing identification marks in dentures has long been acknowledged by the dental profession. Weissenstein first proposed that dentures should have some form of identifiable marking in 1931. However, despite calls over many years from both the forensic and dental communities for legislation in support of mandatory denture identification in the United Kingdom, there remains a bewildering sense of apathy towards addressing the problem. More recent work done by Cunningham and Reddick (1993) and Richmond and Pretty (2007) further suggests that such ambivalence toward the practice of denture marking appears to exist more within the dental profession than the general public. This perception is augmented by information from their studies indicating that an overwhelming majority of patients appear very much in favor of concept and that a great many were unaware that their dentures could actually be marked.

The purpose of this study was to determine if denture marking methods were taught to students in dental schools in both the United Kingdom and the United States and if so, what methods were demonstrated. In those schools were denture marking was not taught, reasons why were sought to determine the barriers to the implementation of routine denture marking.

A questionnaire was sent to all the dental schools in the United Kingdom and a total of 16 United States schools. Anonymity was assured to all schools. Fourteen responses were returned from the United Kingdom (100%) and twelve from the United States (75%). In the United Kingdom 67% of schools taught a method of denture labeling, in the United States 86%. In both instances the same results were found for dentures produced by students and those produced by staff members. In the United Kingdom, consultant's dentures were marked 78% of the time; slightly higher than for other grades of staff.

In those schools were denture labeling was not routinely undertaken, 50% of United Kingdom and 23% of United States schools felt that they would like to introduce it. The most popular denture marking system in both countries was an inclusion technique. In the United States, those states with obligatory denture marking, 100% of schools taught a system that was in line with the recommended state legislation.

Sixty-four percent (64%) of United Kingdom and fifty-six (56%) percent of United States dental schools felt that if cost were not an option, they would consider using an RFID chip for their denture marking. Thirty-five percent (35%) of United Kingdom and twenty-nine percent (29%) of United States schools commented that personal privacy issues would be of concern with this system. Seventy-five percent (75%) of United Kingdom and eighty percent (80%) of United States schools felt that denture marking should be a legal requirement.

Denture marking is simple and cost effective means of identifying edentulous. Further work is required within dental education to ensure that dental and technical students are exposed to denture labeling methodologies to ensure that, when in practice, they are able to offer their patients an esthetically suitable marking system that is also resilient to common postmortem assaults.

Identification, Denture, Teaching

F40 Non-Radiographic Dental Identification: Great, Good, and Not So Good

Richard H. Fixott, DDS, 6690 South West McVey Avenue, Redmond, OR 97756*

The goals of this presentation are to review principles of dental identification, illustrate how to support a non-radiographic ID, discuss how a false positive can be avoided, and provide examples of interdisciplinary cooperation.

This presentation will impact the forensic science community by reminding participants of the principles for a record based dental identification and pitfalls that may arise from false assumptions and incomplete records.

Three cases will be presented where no radiographs were available for comparison.

Case 1: Human remains were recovered from an isolated burial site in Guadalcanal. An Identification Tag was present with the remains that corresponded to the name of a soldier missing in action. The records of all individuals known to be missing from that area were examined. Only one record documented the missing teeth noted in the remains. Consultation with the anthropologist revealed no skeletal inconsistencies. A positive identification recommendation was forwarded.

Case 2: Human remains were returned to the U.S. by Cambodian authorities. The remains were associated to the Mayaguez Incident. Dental remains consisted of a mandible. The dental information was compared to the dental records available for those lost in the incident. Two records were unavailable. Concordance to one record was noted and the dental identification was proposed. Several years later, a U.S. recovery mission was allowed to recover remains from the incident. Upon DNA analysis, the previous identification proposal was proved false. Assumptions about the source of the remains and lack of coordination with the anthropologist were factors in the false positive.

Case 3: Human remains were recovered in rural Oregon. After several leads were excluded dentally, an additional possible identification was proposed. The antemortem dental record showed no inconsistencies. The skull photograph was compared to the antemortem photograph and the superimposition showed good concordance. Further analysis by the anthropologist showed no inconsistencies also. The medical examiner used information from the dentist, anthropologist, scene, and incident history as a basis for a positive identification.

Dental Identification, Photo Superimposition, Dental Records

F41 Train-Pedestrian Collision: A Case Report

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After attending this presentation, attendees will: (1) be familiar with train safety issues, (2) understand the challenges in dealing with massive tissue injury, (3) be familiar with the role of dentistry in making the identification of the victim, and (4) understand the benefits of recovery of all tissue fragments from the accident scene.

The presentation will impact the forensic dental community by presenting the difficulties encountered in a case where massive tissue damage was related to a relatively infrequent train-pedestrian collision.

According to statistics provided by Operation Lifesaver, every two hours somewhere in the United States a motor vehicle or a pedestrian is struck by a train. In 2006, 2,897 people were injured or killed while working, walking or playing around railroad tracks, equipment or facilities. Fortunately most of these injuries were caused by falling from, tripping over or otherwise encountering stationary railroad equipment or tracks. These accidents typically resulted in injuries such as sprains, lacerations and broken bones but only very rarely did they result in loss of life. When moving trains are involved, they most commonly involve collisions with motor vehicles, often resulting in serious injury or death. Another relatively common occurrence is injury and the loss of limbs to railroad personnel and trespassers as a result of a previously stationary train making an unexpected movement. Least common are collisions between a pedestrian and a moving train resulting in loss of life. The reason these incidents are so rare is obvious; moving trains are very large and not easily overlooked, they are noisy so their approach is generally heard in advance of any danger and a collision can easily be avoided by simply getting clear of the track. Cases of pedestrian-train collisions where death occurs are usually associated with the pedestrian crossing a bridge or entering a tunnel and being caught when a train unexpectedly appears and they can't clear the tunnel or bridge in time to avoid the encounter with the train. A collision with a pedestrian on open ground in a heavily populated area is among the rarest of occurrences involving trains. This presentation is a case report of such an event that occurred in broad daylight only a few hundred yards from a busy shopping center. At the time of the collision, the train's speed was estimated at approximately 40 MPH. After impact, the train, due to its tremendous momentum even at such a relatively slow speed, took almost a half mile to come to a complete stop. As expected, the collision caused massive injuries of the victim with significant fragmentation and scattering of the remains over a length of approximately 600 yards.

The presentation will briefly discuss train safety issues in conjunction with the accident. It will also describe the challenges faced by the dental forensic team in dealing with the massive injuries and fragmentation. Of particular interest is the difficulty encountered in reconstructing the facial structures to obtain adequate postmortem radiographs. Additionally it will describe some of the challenges faced by the recovery teams to collect all the tissue fragments from the scene. With the remains dispersed over such an extended area and the collision creating such small fragments, recognition and recovery of all the tissue remnants presented a significant challenge for the recovery team. In cases such as these, having a physician, dentist or anthropologist on the recovery team to help identify the smaller fragmented parts to make sure all tissue fragments are recovered would have been beneficial.

The learning objective of this presentation is that at the conclusion of the presentation, the participants will have a better understanding of the issues and difficulties encountered in this case.

The presentation will impact the forensic dental community by describing the difficulties encountered in a case with massive tissue destruction and fragmentation to better prepare them in the event a similar accident occurs in their communities.

Train, Pedestrian, Safety

F42 A Unique Dental Identification Involving Co-Mingled Remains Following a Midair Aircraft Collision

Anthony R. Cardoza, DDS, Anthony R. Cardoza, DDS, Inc., 266-B Avocado Avenue, El Cajon, CA 92020*

After attending this presentation the attendees will come to understand a method used in forensic dental identification other than the typical use of radiographic comparison. The following identification was completed using dental oral appliances.

This case will impact the forensic science community by illustrating the significance of forensic odontological identification and its application to crash scene investigation.

On the afternoon of February 8, 2006, two single engine aircraft (Cessna 172, N9531B; Cessna 182, N759KE) took off from Gillespie airport in El Cajon, California. After about four minutes in the air the two planes collided over the Grossmont summit killing all on board both planes. The weather conditions at the time showed light winds from the west, few clouds, and twenty-five mile visibility.

Shortly after 4:37 P.M. the Cessna 172 (1B) took off from Gillespie field. On board this aircraft were two occupants, a student pilot in the left seat and his instructor in the right seat. The student was engaged in IFR (instrument flight rules) training so he was wearing a "hood" device which masked his view outside the cockpit. It was the duty of the flight instructor to maintain a visual while monitoring the student's progress. Cessna 1B took off in a westerly direction and then changed course to a southwest direction. About one minute later at 4:38 p.m. the second Cessna aircraft (Cessna 182, KE) took off from Gillespie field also in a westerly direction circling around the field finally heading southwest as well. The solo occupant in this aircraft was flying VFR (visual flight rules). Both aircraft were accelerating as they gained altitude. The Cessna 182 (KE) is a higher performing aircraft so its acceleration and rate of climb was greater than the Cessna 172 (1B).

At 4:40 p.m. both aircraft were now high enough over the El Cajon valley for FAA radar to detect both planes and begin tracking them. At 4:40:51 p.m. a computerized warning system transmitted a visual and audible warning to traffic control to warn that the two aircraft were on a potential collision course; however no warnings were radioed to the pilots. At 4:41:42 p.m. aircraft "KE" collided with the right side of "1B" at an altitude of approximately 2,300 feet over Harry Griffen Park adjacent to Grossmont High School.

On the ground there were two crash scenes due to the impact's trajectory. "1B" went straight down into the park (two victims) and "KE" crashed half a mile to the north into a residential area (one victim). The three victims in both planes were ejected from their aircraft. The "1B" victims landed in the park and the "KE" victim went through the roof of a private residence and landed in the side patio (1/2 mile away from the other victims). Investigators at both scenes recovered fragmented human remains including fragmented dental remains. At the "1B" crash scene both mandibular and maxillary dental fragments were recovered. Some of the fragments were still attached to the decedent and other fragments were

disassociated from the second body and scattered in the debris field. At the "KE" scene only an intact mandible was recovered in the debris field. No other dental fragments were recovered at that scene or on that body.

The investigators also collected antemortem dental information to aid in the identification. Only one of the victims in the "1B" plane had antemortem radiographs. The victim in the "KE" plane had no antemortem radiographs available but the M.E. investigator was able to obtain a maxillary bleaching tray and a maxillary orthodontic retainer.

In the Medical Examiner's office, the attached jaw fragments were resected and one of the victims on the "1B" plane was identified based on dental radiographic comparison. The other victim's unattached dental fragmented remains had been collected by the investigator at the "1B" crash scene and labeled accordingly. The remaining dental fragments were organized according to the respective crash site and M.E. case numbers. There were no antemortem radiographs available for the remaining two victims and the dental prosthesis's obtained for the "KE" victim was for the maxillary arch which was not recovered at the "KE" crash scene nor recovered on the body after extensive examination. The dental identifications for the remaining victims had reached a stalemate.

Upon closer examination of the fragmented remains of the second victim on "1B", it was discovered that the dental remains the investigators had recovered, bagged, and labeled from that crash site included *two* maxillary left posterior fragments. Since the dental remains of the first victim on "1B" were attached to the body and were accounted for, the additional maxillary fragment was from the victim on the "KE" plane *even though that aircraft crash scene was ½ mile away*. Now, both the orthodontic retainer and the bleaching tray were fit on the maxillary fragment with precision. Both appliances did not fit the other maxillary left fragment. With this additional evidence, a positive identification was made to positively identify the "KE" victim. The second victim on the "1B" plane was identified by DNA.

In summary, it was determined the wing of the "1B" aircraft passed through the cockpit of the "KE" aircraft decapitating the pilot of that aircraft at the point of the maxilla thereby bringing down the maxillary dental remains to the "1B" crash scene. It is imperative as forensic odontologists that all the dental remains from multiple victims are examined, regardless by whom or how they are collected and labeled, to avoid the potential of misidentification or failure of identification.

Dental Identification, Midair Collision, Co-Mingled Remains

F43 Identification of an Unknown Sailor From the Attack on Pearl Harbor

John A. Lewis, Jr., DDS, 4830 Glenhollow Circle, Oceanside, CA 92057*

The goal of this presentation is to identify the processes used to identify the skeletal remains of an unknown sailor killed during the December 7, 1941 attack on Pearl Harbor, Hawaii.

This presentation will impact the forensic science community by assisting the audience in learning of the procedures which have subsequently been used to identify the skeletal remains of several unknown service members who were killed during the attack but not identified until over 60 years later.

On Sunday, December 7, 1941, the tranquility of the island of Oahu, Hawaii, was shattered by the surprise attack on the U.S. Navy Fleet anchored at Pearl Harbor. Close to 2,400 military and civilian personnel were killed in the attack which launched the United States into World War II. Unidentified decedents from the attack were subsequently buried at the National Cemetery of the Pacific as unknowns. Through the efforts of Pearl Harbor survivor, Ray Emory, the unknown remains of a sailor were disinterred and positively identified using forensic odontology, forensic anthropology, and mitochondrial DNA testing.

Pearl Harbor, Odontology, Identification

F44 Cheiloscopy as a Reliable Tool in Human Identification

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After attending this presentation, participants will have a ''modern" look at cheiloscopy. Lip prints study was neglected in the past. The author wants to revive this useful tool in human identification.

This presentation will impact the forensic science community by giving a fresh look of cheiloscopy. Using modern technology will help push the limits of lip prints study.

Cheiloscopy (from Greek cheilos, lips and skopein, see) is the name given to the lip print studies. Many techniques exist to establish a person's identity. DNA, finger prints and dentition are the most reliable methods to identify a human being. Like finger prints and palatal rugae, lip prints are unique to one person. They are permanent and unchangeable. Lip groove patterns are visible as early as the sixth week in uterine life. Lip grooves rarely change through life. Lip tissue can resist many afflictions such as herpetic lesions. Only burns and pathologies that damage the lip subtract can permanently affect the lip's unique characteristics and rule out cheiloscopy study.

This paper reviews the different aspects of lip print studies. First, a historical review of cheiloscopy will demonstrate that lip print studies started as early as 1902 with the biological description of lip patterns by Fischer. Later in the century, cheiloscopy was used in criminology. In the 1950's, the possibility of using lip prints in the matter of human identification was developed. Santos, in 1960 was one of the first to suggest that lip patterns could be classified. Renaud, in 1972, with a huge study of 4000 lip prints confirmed the singularity on the human lip patterns. In 1974, Suzuki and Tsuchihashi developed a new classification for lip prints. They conclude not only lip prints singularity but also the response of the lip tissue to different trauma. After healing, the lip pattern returns to the initial state.

The second part of this presentation refers to an anatomical description of the lips. Differences with sex and race will be discussed and analyzed.

An overview of the different classifications of lip patterns will be discussed in the third part of the presentation. Santos, Suzuki and Tsuchihashi, Renaud, Afchar-Bayat, and Domingues will be explained.

Following the theorical review of lip prints history and classification; some techniques of lip print lifting will be explained. The major difficulties of lip print lifting and transfer will be developed and carefully analyzed. Photography, recording, and analyzing of lip prints will also be discussed. The use of Photoshop® will demonstrate the possibilities of lip print photograph enhancement.

This paper is the first chapter of several other fields of cheiloscopy. Future articles will discuss different techniques of lip print comparison.

Cheiloscopy, like bite marks study is an inexact science. With careful recording and analysis, lip prints can be a reliable tool when other techniques are not possible to perform.

Cheiloscopy, Lip Prints, Odontology

F45 Method Comparison for Jaw Resection

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The goal of this presentation is to present results of an assessment of jaw resection techniques using traditional and new tools.

This presentation will impact the forensic science community in the description of a new and efficient technique using a readily available instrument.

Circumstances often arise in victim identification when a person must be identified based on dental evidence. This is especially true in Mass Fatality Incidents (MFI) such as the World Trade Center and Hurricane Katrina. In these cases access to the dentition becomes of the utmost importance for visualization and charting of the victim's dental characteristics, and photography and acquisition of diagnostic postmortem radiographs for comparison to antemortem records. Jaw resection may be necessary in these conditions for complete examination of the dentition. The consideration for resection may also occur in burn victims when viewing of the body is not an option. Recognizing the potential loss of anatomical characteristics valuable to the physical anthropologist, it has been stated that the careful removal of the jaws should be standard procedure in any case of resection. Consent of the medical examiner or coroner or the written consent of the next of kin is required for resection. Failure to acquire these permissions is considered desecration which carries penalties in all states

When jaw resection for dental identification purposes is indicated and permitted, the forensic odontologist has a range of techniques by which to accomplish this task.

Common methods and instruments for resection have been described in the literature including the use of bone saws, the Stryker saw, piano wire saw, garden loppers and mallet and chisel. For maxillary resection the operation can be described as a simple form of the LeFort type 1 osteotomy, in which the maxilla is resected maintaining intact root tips. For mandibular resection, it may be sufficient to only sever the ascending rami, giving care to avoid 3rd molars and to maintain a tissue bridge.

The advent of battery operated reciprocating saws offers the odontologist another option in the choice of instrumentation. The reciprocating saw allows for an efficient and accurate resection, and frees the upper and lower jaw segments with minimal time and tissue damage. These segments can then be repositioned and sutured back in place at completion of the dental autopsy. The use of a six-inch metal cutting blade enables the cut to be made in a single operation. Care must be taken to angulate the blade correctly. Cuts through the maxillary bone are made high on the malar processes and above the anterior nasal spine to avoid the apices of the maxillary teeth.

This study compared the traditional methods of resection using garden loppers and a Stryker saw, with the use of a reciprocating saw in human cadavers. In this study, it was determined that a technique involving only three cuts was sufficient to complete the entire operation with the reciprocating saw. First, a horseshoe-shaped incision is made below the mandibular base to free the submandibular soft tissue. Then a single cut is made across the ascending rami. Lastly the angulated cut is made through the maxillary bone. The sequence of these cuts is important as it is more difficult to obtain clean separation if the order is reversed.

While comparable in time to an experienced operator using the garden lopper method, resection with the reciprocating saw produced a superior clean cut, allowing possible replacement of the jaws should further anthropological measurements be desired. The Stryker saw method was a distant third. The short blade length of the Stryker saw required an additional step of separation of the distal portions of the maxillary bone with tools such as bone chisels.

Equipment is available that is compatible with other instruments in the operating area such as portable X-ray units and flashlights. The batteries powering these devices are interchangeable, allowing efficiency in inventory and instrumentation. The result of this project will be recommendation of a jaw resection technique that can be used in Mass Fatality Incidents or any situation when a victim must be identified on dental evidence and when access to the dentition is restricted. Practical information obtained from the described research project results in recommendations for forensic odontologists and medical examiners in selection of equipment and technique for oral autopsy use.

Forensic Odontology, Identification, Resection

F46 Examples of the National Incident Management System (NIMS) Protocols Within a Local Medical Examiner's Office

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This presentation will provide an example of where forensic odontology fits within the Medical Examiner's Incident Command System. How the Medical Examiner office integrates within the scope of a larger disaster will also be discussed. Participants will learn the basics of the NIMS-ICS protocols and basic terminology.

This presentation of NIMS-ICS will impact the forensic science community by improving rescue and recovery in a major disaster.

First responders and rescue workers have found large and small disasters to be logistical nightmares. Multiple jurisdictions responding to an incident can cause over utilization, shortages and redundancy of assets. Command and control of these incidents becomes more difficult under these circumstances. In addition, inadequate communication among local responders from various jurisdictions can compromise safety.

In 1970 California had experienced a series of devastating wildfires in which sixteen people lost their lives. In addition 700 structures were destroyed and the cost was approximately $18 million per day.

"Although all of the responding agencies cooperated to the best of their ability, numerous problems with communication and coordination hampered their effectiveness." To protect life and property, the United States Congress mandated the U.S. Forestry Service to design a system that would allow the local firefighters, police and other responders to merge themselves into a larger organization. The command structure that arose out of these disasters was the origin of the National Incident Management Systems (NIMS). Originally, this was referred to as Firescope (FIrefighting RESources of California Organized for Potential Emergencies). The system was simple in design, allowing for an easy expansion and contraction throughout any fire disaster.

The federal government and emergency management organizations quickly realized the flexibility of Firescope. Eventually Firescope became known as Incident Command System (ICS), an all hazards system.

For example the Incident Commander (IC), the person in charge, will be the most qualified to run the event. Reporting to the IC will be the operations, logistics, planning, and finance sections. As the flow chart continues beneath each section, there are Divisions. Under the Divisions are Branches, then Groups or Units. This flow chart system creates a title and description for each position. Command and control are immediately more manageable. Common terminology became essential for everyone to be able to understand each other.

As additional jurisdictions are requested for the event, the ICS is able to change to a Unified Command System. This allows for individuality of the organizations participating in the disaster. NIMS-ICS, as it is now called, provides for a set of standardized protocols for multi-agency coordination. Incident action planning becomes paramount in order to coordinate the influx of personnel and equipment from multi jurisdictions. Proper use of these resources will result in a successful outcome.

The medical examiner's office is one of the agencies that is incorporated into a mass casualty disaster plan. Forensic odontology is within the Operations Section. Understanding and training of NIMS-ICS is essential for all dental personnel who participate in a mass casualty incident. For example, most private dental offices have a command and control built into their flow of the office. The dentist is the incident commander. The office manager is the operations section chief and runs the day-to-day activities. When dentists participate in a mass casualty incident, they invariably forget that they are a part of a larger organization and command system. Understanding and following the command structure often gets lost in the "I know best, I am a forensic odontologist here to identify human remains" attitude.

NIMS, ICS, Forensic Odontology

F47 Forensic Odontology: Critical Expertise for a Search and Recovery Team

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The goals of this presentation are to: (1) learn how the forensic odontologist can contribute to a search and recovery team, (2) understand that forensic dental identification is a significant contribution during mass fatality incidents, as well as, criminal cases involving fragmented remains, (3) encourage the forensic odontologist to aggressively pursue opportunities to participate in search and recovery teams.

This session will present to the forensic community, how forensic odontology can make a significant contribution to search and recovery teams, and will impact the forensic science community by potentially facilitating and expediting identification of remains.

Fragmented remains are a challenge from the standpoint of identification. Identification techniques can include forensic dental, fingerprint, and DNA. Victims of the Rhode Island Nightclub Fire and the recent Comair airline crash in Kentucky were identified primarily by forensic dental identification.

Explosion, high velocity impact, and other forms of blunt force trauma and incineration can all result in fragmentation. The severity can range from various degrees of dismemberment to extremes, whereby, fragments measuring only centimeters or several millimeters are able to be recovered. The recovery process can be further complicated if the remains are incinerated or severely burned.

The recovery process will vary depending on the degree of fragmentation, as well as, the size of the debris field. In instances of severe fragmentation, a specialized, multidisciplinary team is indicated. This team should include not only an experienced forensic odontologist, but a forensic anthropologist, a medicolegal death investigator and forensic pathologist if available. A trained staff to aid in gridding and site excavation is also required. Once the debris field is excavated, the contents are sifted through screen to allow fragment visualization and recovery. The trained eyes of the forensic odontologist are essential to identify dental fragments, as well as, maxillofacial structures. Without the presence of a trained forensic odontologist on the team, the potential for loss of vital dental information is significantly increased.

Search and Recovery, Fragmented Remains, Forensic Dental Identification

F48 Mass Disaster Courses in Switzerland: Are They Necessary?

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The goal of this presentation is to present and discuss a model for basic training in odontology applied to the context of a mass disaster.

This presentation will impact the forensic science community by describing mass disaster courses, their importance, and feed-back.

Education in the field of forensic odontology in Europe still suffers from disparities. Thus, the fact that there is no recognized specialization in this field may well create a serious problem in some future judiciary procedure. A recent thesis, published in France in 2006, describes the current status of forensic odontology training based on a survey of a number of dentists from different countries that all had some interest in the field. This publication shows that forensic odontology is usually taught towards the end of the University curriculum. In most countries, such teaching amounts to less than ten hours, with only three countries offering more than twenty hours (Norway, Italy, and Croatia). In all of the countries, teaching is purely theoretical as no practical training is offered. The study concludes that students receive an adequate introduction to forensic odontology only in Scandinavian countries and in Croatia. At the same time, professionals in Southern and Eastern Europe are well aware of the shortcomings in their educational offerings in this field.

The mass disaster courses in odontology organized in Lausanne, Switzerland have the following objectives:

A. Objectives for professionals
- Satisfy the need for undergraduate training,
- Satisfy the need for postgraduate training,
- Satisfy the need for continuing education.

B. Public interest objectives
- Improved readiness in the context of expanding mass transportation,
- Improved readiness in the context of an increased terrorist threat,
- Improved readiness in the context of an increasing number of conflictual situations, etc.

The courses are designed as an introduction to the essentials of odontological identification. On the one hand, the participants learn the basics of identification: the postmortem examination and the analysis of antemortem records (odontograms, x-ray data, photographs, etc). On the other hand, they also learn the key features of management of odontological identifications based on fragmentation and comingling in the context of a mass disaster.

As a continuing education program, these courses first organized in Switzerland in 2006, are unprecedented in the field of mass disaster management. Currently, they span only two days, as opposed to the usual four to five days offered by other institutions. In 2006 and 2007, the course program was sent to approximately 400 dentists in the French-speaking part of Switzerland. The courses were also advertised in the monthly Swiss Journal of Odontostomatology.

In each case, over 200 dentists responded but only 30 could enroll because of the limitations inherent to the organization of practical, hands-on exercises. The speakers and other staff (odontologists, forensic scientists, investigators) were appointed on the basis of their academic training, experience in the field of identification and teaching experience. All of the specialists had actively participated in the management of several mass disasters.

The first day of the course comprised an introduction to legal medicine, to forensic odontology and to the principles of odontological identification. This theoretical part was followed by a practical exercise of identification of human maxillaries carried out by teams of two participants.

During the second day of the course, the participants were introduced to mass disaster management. After a theoretical introduction, practical exercises were carried out to simulate a mass disaster scenario in which mixed fragments of human maxillaries had to be identified.

The activities and behavior of the participants as a whole group and within the teams were observed by the teaching staff that was present throughout the course.

Each participant received a written evaluation form aimed at assessing some general features of the course, such as overall organization and the usefulness and quality of the provided information. In addition, each participant was asked to define his or her motivation in attending this type of training. Last but not least, each participant had to assess his or her readiness to become involved in the management of a real mass disaster event on short notice and for an indefinite period of time. Every questionnaire distributed to the participants was returned to the organizers for thorough analysis.

The presentation consists in a critical assessment of the course organization, follow-up and the feedback that was received.

Odontology, Mass Disaster, Teaching

PATHOLOGY/BIOLOGY

G1 Decapitation Due to Car Accident: Description of a Case and Review of the Literature

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The occurrence of complete decapitation as consequence of car accident is an extremely rare event, while suicidal decapitation by hanging has been reported sporadically in forensic literature. The goal of this presentation is to describe a case of decapitation with complete degloving injury of the neck in a man involved in a traffic accident and we review other similar cases reported in literature.

This presentation will impact the forensic community by demonstrating how in such deaths, the concordance of crime scene investigations, autopsy findings and the presence of eyewitnesses if any, should be the ideal asituation to achieve a reliable medico-legal analysis.

The occurrence of complete decapitation as consequence of car accident is an extremely rare event, while suicidal decapitation by hanging has been reported sporadically in forensic literature. Decapitation is usually seen in pedestrians run over by trains, and also in motorcyclists who impact against the tail board of trucks. Complete transection of pedestrians and occupants of cars is seen in road accidents with vehicles traveling at a high speed. In a recent report, Kibayashi has described a case of decapitation of a front seat passenger in a single vehicle accident. Another report described the vertical iron bar of a grill fence penetrating the neck and decapitating the driver of a two-wheeler scooter. Here we describe a case of decapitation with complete degloving injury to the neck, of a man involved in a traffic accident, and we review other similar cases reported in the literature.

A 55-year-old Caucasian man was driving his car at a speed of about 120 km/h near the city of Rome when the vehicle skidded off the road, hit another vehicle coming from the opposite direction, and finally impacted the road barriers. The decapitated body of the victim was extracted from the driver's seat, and the head was recovered outside. The immediate police report found that the victim was not wearing a seatbelt. At the autopsy, the body was that of a Caucasian man, decapitated at the first cervical vertebrae. The decapitation site had irregular, ragged and contused margins. Multiple abrasions on the face along with closed fractures of the facial bones and mandible were present. Internal examination of the head revealed diffuse subscalpular hemorrhages, and multiple fractures of the skull bones. The brain was edematous and slight subarachnoid hemorrhage was of the left temporal lobe. There were compound fractures of both humeri, multiple fractures of the ribs on both sides, and closed injuries of the shaft of left femur. Toxicological analysis revealed the presence of alcohol at the following blood concentration 2g/L. No other drugs were detected. Death was instantaneous owing to complete severing of vital neck structures.

Topography, morphologic nature of the wounds, and severity of the injuries of car occupants depend on several factors such as speed at the moment of impact, nature of the collision, active, and passive protection of the occupants, and sitting position. Several efforts and experimental studies have been made to explain the possible mechanisms provoking decapitation following vehicle accident. This injury, in the majority of cases, has been associated with failure to use seat belts, fast driving speed, and road barriers. In this case, it is plausible that because of the high-speed crash, the decapitation was provoked by an external object, such as road-barriers or structural elements of the vehicle being pushed back into the cabin and acting as a sharp-force to the neck. It is believed that in such deaths, the concordance of crime scene investigations, autopsy findings, and the presence of eyewitnesses, if any, should be the ideal situation to achieve a reliable medico-legal analysis.

Road Accident, Decapitation, Neck Injuries

G2 Unusual Gunshot Wound Death of a Sex Offender on the Way to Jail in the World of CSI

Karen B. Looman, DO, Tidewater Office of the Chief Medical Examiner, 830 Southampton Avenue, Suite 100, Norfolk, VA 23510*

After attending this presentation, attendees will learn to assess an unusual case where the evidence at the scene makes it difficult for the medical examiner to decide homicide, suicide or accident and to evaluate peculiar scene circumstances involving ballistic evidence.

The presentation will impact the forensic community by showing how important it is to look at all the evidence at a scene and at an autopsy before making a decision about the manner of death.

A 36-year-old man was dropped off by his wife at a bus stop. He was taking the bus to jail for a nine year sentence in a juvenile sex offender case. He was found two days later on the back road of a rural area. He was sitting in the driver seat of the family car that had been in storage, suffering from a gunshot wound to the leg. He had a tourniquet tied around the injured leg. He had been dead for an unknown period of time and had started to decompose in the summer heat.

Crime technicians noted an unusual finding. Although there were no bullet holes through the car, there was a handgun on the ground outside the driver's door. There was a wooden dowel taped to the barrel of the gun, and a nylon string was tied to the trigger guard of the gun with the other end tied to the steering wheel. Lastly, there was an athletic sock covering the handle of the gun.

The autopsy was routine. The deceased was a healthy man, in the early stages of decomposition. There was a gunshot wound to the right thigh that entered the anterior medial thigh and exited the posterior medial thigh. Dissection revealed that the bullet transected both the femoral artery and vein. The cause of death was exsanguination from a gunshot wound to the leg.

The manner of death was less clear. What was the reason for the wooden dowel and the gun with the sock over the grip? There are several scenarios possible. The first scenario is that the man was attempting suicide because of his conviction and because his relationship with his wife was troubled, but did not want his death to look like a suicide. He used the sock to hide fingerprints and had the dowel taped to the gun so that he could hold the gun far enough away to look like a distant shot. Since he was holding the gun by the taped dowel he needed the string to pull the trigger and then he may have intended to jettison the gun, string, and dowel.before dying. He successfully shot himself in the leg, but died in the driver seat of the car before he could get rid of the evidence.

The second scenario is an attempt to look like a holdup or an assault. The individual again knows about fingerprints, gunshot residue and range of fire determination. He rigged the gun to pull the trigger and shoot himself in an attempt to look like someone else shot him. Perhaps he wanted to go to the hospital and delay the start of his jail sentence or obtain sympathy from his wife. But he shot himself in the wrong area of the thigh and although he put a tourniquet on the leg, he bled to death before he could get help.

The third scenario is an accident. Perhaps he was doing something with the string and the dowel that could never be understood, unless the victim himself explained it, and he was accidentally shot. He lost too much blood to drive himself to get help, and he died at the scene.

Questions remain unanswered as to what his motive was. Also, why was the string tied to the steering wheel? Did he use some of the string to make a tourniquet and tie the end of the string to the steering wheel just to prevent the string from blowing away? Why wasn't he able to get help in time? Why was he in this rural area? It is also unclear where he acquired his knowledge of ballistics, but the complex scenario suggests familiarity with the world of CSI.

These are questions that may never have a final answer. But this is a good example of the need for thorough scene examination, background investigation, and straightforward autopsy technique. This presentation will discuss the evidence for each manner of death in this unusual gunshot wound case.

Range of Fire, Ballistics, Unusual Death Scene

G3 The Effect of Clothing on Decomposition Rate: A Teaching Model

Phillip L. Watson, PhD, Ferris State University, 808 Campus Drive, 2004 ASC, Big Rapids, MI 49307*

The goal of this presentation is to illustrate the difference in decomposition rates and insect colonization under identical environmental conditions.

The presence or absence of clothing can alter the decomposition rate. This is a difficult concept to teach unless there is a method that can be duplicated to show both conditions under identical conditions. This study will impact the forensic science community by determining the rate of decomposition of a clothed and unclothed pig as a function of summer environmental conditions.

The presence or absence of clothing can alter the decomposition rate (Anderson 2001, Kelly 2006). This is a difficult concept to teach unless there is a method that can be duplicated to study both scenarios under identical conditions. This study was conducted to determine the rate of decomposition of a clothed and unclothed pig as a function of summer environmental conditions. Insects were collected twice a day until the dry-remains stage occurred, and climate consisting of temperature, relative humidity, rainfall, and wind speed data was collected on an hourly basis. The data show increased activity of forensically important insects to be a function of both temperature and clothing. The delay of the clothed victim to reach the dry-remains stage was significantly different than the victim without clothing. The stages of larvae collected from the clothed victim were also significantly smaller than the larvae collected from the unclothed victim at all collection dates until the unclothed victim was no longer attractive to forensically important flies.

Data collection to be demonstrated will be larva size and species composition on each pig over time. Comparisons were done as an ANOVA test and a species-diversity comparison for all days. Results will be used to set up teaching mock crime scenes to illustrate the effects of clothing on PMI calculations.

Clothing, Decomposition, Flies

G4 Improved Estimation of Time Since Death With Multiple Protein Markers and Automated Analytical Methods

Behnoush Memari, MS, Kenneth G. Furton, PhD, and Alberto Sabucedo, Florida International University, 11200 South West 8th Street, Miami, FL 33199*

After attending this presentation the attendee will learn how degradation of cardiac Troponin I (cTnI) and Troponin T (cTnT) analysis can help forensic scientists narrow their estimate of postmortem interval.

This presentation will impact the forensic community by improving the precision and rate of postmortem interval (PMI) estimates using an automated analytical method to better assist law enforcement in many criminal, civil, and forensic investigations.

Knowledge of the time since death (PMI) has enormous legal, criminological, and psychological impact; but currently suffers from uncertainties on the order of days to weeks without mathematically defined confidence information and a lack of technological advances. The main principle of the determination of the time since death is the calculation of a measurable date along a time-dependent curve back to the start point. Characteristics of the curve slope and the start point are influenced by internal and external, antemortem and postmortem conditions which need to be taken into consideration. Current methods utilize temperature-based algorithms intended to model the cooling of the body after death in order to estimate the postmortem interval which introduces considerable inaccuracy due to influencing factors. Livor mortis, rigor mortis, and to a lesser degree, algor mortis also have been used to estimate the postmortem interval. Forensic pathologists agree that these characteristics only provide "postmortem windows." Quantitation of the vitreous fluid potassium level has been of some value in evaluating the early postmortem interval, but the accuracy of this method is dependent on external conditions, the availability of vitreous fluid and the purity of the sample. For practical purposes, a simple, relatively inexpensive assay performed on readily available cardiac tissues, less dependent upon external factors, and providing data that could be plotted on a reproducible control curve would be of value in determining the postmortem interval accurately.

Cardiac Troponin I (cTnI) and cardiac Troponin T (cTnT) are proteins found in heart tissue as selective markers of cardiac muscle damage, and investigation of these proteins for determining time since death shows great promise in mammalian heart tissue. These proteins are good substrates for several enzymes released in cardiac tissue upon death (necrosis); the proteolytic breakdown of theses proteins in postmortem cardiac tissue can be exploited to determine the PMI. This technique takes a small sample of cardiac tissue that is homogenized and the proteins are then extracted with magnetic microparticles, separated by SDS-PAGE and visualized by Western blot, which is probed with mouse monoclonal antibodies against cardiac TnI and TnT. This step is followed by labeling and precipitation with a colored substrate to monitor degradation patterns. The area of the bands within a lane is quantitated by scanning and digitizing the image using commonly available scanners. This methodology is also migrated to more automated capillary electrophoresis.

The results show a linear relationship between the percent protein degraded and the log of the postmortem time. A fresh "reference" human heart tissue obtained at time T_0 was incubated to obtain a temporal degradation profile. Comparison of human cardiac tissue samples with unknown time of death can be evaluated qualitatively against the "reference" human heart tissue. The time of death can be estimated by matching the "degradation fingerprint". Similarly, a calibration curve ($r > 0.95$) can be obtained with the percent cTnI degraded plotted against the log of the time postmortem using the reference human heart tissue. This curve can be used to estimate the time of death relative to the "reference" tissue based on the percent degradation. The data indicate that the degradation of cTnI in heart

tissue shows very specific bands during a postmortem interval of a week. The Troponin T is a more stable protein in comparison to Troponin I, so the degradation of cTnT takes longer. Combining the data obtained from the cTnI and cTnT can then be used for extended PMI estimates. Frozen human cardiac tissue samples at known times of death were analyzed by both the semi-quantitative and the qualitative techniques and both show similar agreement with the known time of death. Overall, the data demonstrates that this technique represents a major advance in time of death determination providing a fast and reliable semi-quantitative biochemical marker from a protected organ versus other measurements. Tissue cardiac Troponin I and Troponin T shows excellent characteristics as a time of death marker in the extended postmortem interval which is difficult to estimate with current methods.

TnI (Troponin I), TnT (TroponinT), Postmortem Interval (PMI)

G5 The Effect of Environmental Degradation on DNA With Respect to Time and Conditions

Matt Buettner, BS, Kerry Opel, BS, Bruce R. McCord, PhD, International Forensic Research Institute, Department of Chemistry, Florida International University 11200 SW 8th St, Miami, FL 33199; and Lee Jantz, PhD, 250 South Stadium Hall, Knoxville, TN 37996*

The goals of this presentation are to show the effects of environmental degradation of DNA due to environmental conditions and exposure over time and to show the development of degradation curves and a degradation timeline based on type of burial.

This presentation will impact the forensic community by providing an estimation of decomposition of rates of nuclear DNA and provide information concerning the best method for recovery of information from degraded samples.

The goal of this presentation is to show the effects of environmental degradation on DNA with respect to time and environmental conditions in order to develop a better understanding of these effects on the analysis of tissue and bone samples. Ultimately these studies will assist an analyst in determining the relative age of an individual sample, whether a lack of PCR activity is due to degradation or PCR inhibition, and what quantity of DNA must be recovered from the sample in order to generate an optimal genetic profile.

This study will examine the rate of decomposition of human remains under a variety of conditions, focusing on the quality and quantity of DNA that can be recovered over time. Control blood samples will be utilized to provide a clear estimate of initial quality of the DNA. The effect of different types of burial environments on DNA will then be investigated. Three types of samples will be obtained: above ground, in water, and underground burials. The focus of this study will be to determine the rate of degradation of DNA between samples based on the type of burial and the environmental conditions. Both real time PCR and STR amplification will be used to estimate these effects. Due to the advances in rtPCR techniques and the development of mini STR kits, current capabilities for the analysis of such samples have greatly improved. However, laboratories need guidance on when to use specialized analytical systems for degraded samples and when more traditional large multiplex kits can be used. Ultimately it is expected that these experiments will provide guidelines on how such samples should be prepared and analyzed.

Tissue, blood, bone, and nail samples have been obtained from the University of Tennessee Anthropological Center and extracted using QIAGEN Blood and Tissue kits and amplified using an Alu based Real-Time PCR method. The 25mg Lfor samples tissue samples typically yielded concentrations of well over 1ng/µL less than 4 weeks old. For samples 4 to 6 weeks old, a yield of between 1.0ng/µL and 0.1ng/µL was observed. More highly degraded samples obtained after 8 weeks yielded even lower concentrations of DNA. A variety of amplicon sizes were used with real time PCR to next examine the relative levels of DNA degradation and these results were compared with profiles of the extracted samples generated from an ABI Prism® 310 Genetic Analyzer. Comparisons made between bone, blood and tissue samples and corresponding non-degraded blood samples were used to estimate relative rates of degradation. Studies on the effects of inhibitors on these samples will also be discussed.

The results of this study indicate that there is a timeline that degradation follows as samples that were 8 weeks or older have, when compared to more recent remains, a substantial reduction in the amount of extractable DNA. This study also indicates relative rates of decompositions based on sample conditions and helps provide a comparison of different extraction and amplification procedures using real samples with known history.

DNA, Degradation, Environmental

G6 The Role of Scene Investigation in Uncovering Staged Suicides

Jerri McLemore, MD, and Steven Tvrdik, BS, Iowa Office of the State Medical Examiner, 2250 South Ankeny Boulevard, Ankeny, IA 50023*

After review of this presentation, the audience will understand the need for careful documentation of a death scene and retaining a healthy dose of skepticism when investigating apparent suicides. The audience will also understand the need for good communication between agencies in relaying discrepant findings and their potential significance in these investigations.

This presentation will impact the forensic community especially death scene investigators by emphasizing the need to adhere to standard guidelines when investigating all death scenes and to treat each scene as a potential homicide. This presentation will also impact the medical examiners' offices that must provide justification for performing autopsies on suicides.

Scene investigation is a vital component along with findings from a postmortem examination in ascertaining the cause and manner of death. Failure to approach a scene with an open mind where the cause and manner of death seem obvious results in an inability to recognize subtle discrepant clues or leads to irrevocable loss of valuable information. Careful investigations of death scenes where homicide is obvious are almost second nature for law enforcement officials and medical death investigators. Similar careful investigations may be lacking where the manner of death looks like suicide, natural or accident especially when investigators have determined the manner of death before analyzing the scene. Such an approach to scene investigation may lead to erroneous conclusions in homicides that have been staged to look like suicides. Although these staged deaths have been discussed in the forensic literature, most of these cases involved the perpetrator staging the scene to look like a hanging.

Two case studies of homicides that appeared to be suicides will be presented. One death involved a woman who had recently been diagnosed and surgically treated for cancer who was found dead in bed with a gunshot wound to her head. The other case involved a woman who was having marital difficulties and was found in her vehicle while the engine was running in her closed garage. In both cases, the investigators recognized inconsistencies and processed each scene as if they were dealing with a potential homicide. In the case of an apparent self-inflicted gunshot wound to the head, the investigator's concern over blood stain patterns that were inconsistent with the information that this investigator was obtaining from the home-health nurse and decedent's grandson led to the appropriate work-up of the scene and, eventually, to the prosecution of the grandson for homicide. An investigator's observation that a woman's blouse was on backwards in the apparent carbon monoxide poisoning, aided in the correct determination of manner of death due to a more thorough examination of the vehicle, remainder of the house, and decedent at the scene. Communication of the investigators' suspicions to the forensic pathologist in both cases enabled an even more careful examination and documentation of injuries.

Death Investigation, Suicide, Blood Stains

G7 Intrauterine Sudden Death: Study of the Fetal Morphological Substrates

Emiliano Maresi, Antonina Argo, Pierangela Fleres, Paolo Procaccianti, and Michele Spicola, Palermo University, Via del Vespro, n. 127, Palermo, 90100, ITALY*

After attending this presentation, attendees will understand the risk factors, causes, and prevention of many fetal deaths as well as ancillary studies utilized for proper diagnoses.

This presentation will impact the forensic community by serving as an educational resource through discussing sudden fetal death in such cases as funicular thrombosis due to anticardiolipin antibodies, chorioamnionitis, deciduitis, cervicitis, and intrauterine Botallo's duct clousure due to aspirin

Healthy pregnancy derives from the anatomic and functional relationship between all the components of the pregnancy including, the fetus, placenta, and the mother. If the normal relationship between these elements fails because of intrinsic or extrinsic factors, a pathological pregnancy leading to fetal death may occur. To evaluate the morphological substrates leading to sudden death, an accurate evaluation of the fetal autopsy and examination of the placenta, together with the determination of chromosomal pattern, serological and microbiological evaluation, and total body X-rays are mandatory for a correct diagnosis of the death. An exact diagnosis of fetal sudden death may help prevent the event from recurring in future pregnancies.

For a pregnancy, to be normal, it needs a complex anatomical-functional cooperation between three different biological systems: fetus, placenta, and pregnant mother. The interruption of this kind of connection, due to intrinsic or extrinsic causes, produces a pathological pregnancy that can result in fetal death. In olden times, fetal deaths were not considered a competence of obstetricians, pediatricians, or pathologists, so it was not possible to establish the cause of death and identify the death-risks for subsequent pregnancies. On February 2, 2006, the Italian government issued a law establishing the role of pathologists in the sudden fetal death after 25th week. According to this rule, the pathologist must identify all the anomalous morphologic substrates, by performing a careful autopsy examination, with total body X-rays of the fetus, serological/ microbiological tests, and placental screening tests, in doing so to promote primary and secondary prevention. An essential role is obtaining an accurate medical history.

This retrospective study describes the causes of 1836 fetal deaths occurring after the 25th week, from January 1987 through December 2006. 314 sudden fetal deaths (38.8%) were observed. In this group there were 176 males (56%) and 138 females (44%), ranging in age from 26 weeks to 42 weeks of pregnancy; 127 (40.5%) fetal deaths occurred before the 37th week of pregnancy. 258 of 314 fetuses showed maceration due to intrauterine death. Some fetuses of this group showed signs of distress. Maternal risk factors were identified in 251 (80%) of the fetal deaths including hypertension (35%), diabetes (20%), bigeminal pregnancy (18%), and central placenta previa (7%).

The fetal sudden deaths were due to placental causes in 283 (90%) cases, fetal causes in 16 (5.1%) cases, maternal causes in 10 (3.4%) cases and unknown causes in 5 (1.5%) cases.

The placental causes were: 130 (46%) funicular disorders; 54 (19.2%) amniotic membrane disorders; 99 (35%) chorionic villi disorders.

The fetal causes were: 12 cardiomyophaties; 4 intrauterine Botallo's duct closure.

Maternal causes were: 7 mother's sudden deaths due to amniotic and thrombotic pulmonary embolism; 3 uterus ruptures.

Most of sudden intrauterine fetal deaths are caused by funicular and chorionic villi disorders. It is possible to prevent sudden fetal death in cases of funicular thrombosis due to anticardiolipin antibodies, chorioamnionitis, deciduitis, cervicitis, and intrauterine Botallo's duct clousure due to aspirin. Genetic tests are important in the deaths due to cardiomyophaties. The sudden fetal deaths, occurring after 40° week, are related to maternal risk factors so it's important advance the delivery.

Fetal Sudden Death, Autopsy Guidelines, Prevention

G8 Fatty Acid Methyl Ester Profiling of Bacterial Spores for Microbial Forensics

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After attending this presentation, attendees will be familiar with the use of fatty acid profiling to determine the source of bacterial spores grown on several different culture media and the forensic applications of gas chromatographic (GC) techniques for examining the fatty acid composition of the membranes of organisms isolated from biological evidence.

This presentation will impact the forensic community by introducing a technique that may assist investigators in determining the culture methods employed to produce a microbial agent used in a biocrimes or act of bioterrorism.

Fatty acids are components of bacterial membranes that can be regulated by the cell in response to the types of available nutrients present in the culturing media. Therefore, genetically identical bacteria that are grown on different media substrates can vary in their fatty acid composition. Previously, fatty acid methyl ester (FAME) profiling has been used in clinical settings for bacterial strain identification, but has not yet been applied for forensic applications.

In this research, three hypotheses were tested. First, whether a clinical method for FAME profiling of bacterial cells can be adapted for use with bacterial spores. Second, can reproducible FAME profiles be produced from minimal amounts of evidence (<3mg spores). Third, can a database of FAME profiles of spores grown under a variety of well-established conditions be used to reliably identify the medium used to grow the spores of an unknown sample.

For this work, 22 different culture formulations were used to prepare and process *Bacillus cereus* T-strain (BcT) cultures. Fatty acid extraction and GC profiling were performed on spores from each media preparation using two different analytical techniques: (1) the clinical FAME method ("Rapid Method") which requires approximately 30 mg of biological material and two hours to process, and (2) the more forensically relevant method ("Instant Method") which requires only 1 mg of biomaterial and approximately 15 minutes of processing time. The effect of media substrate on spore fatty acid composition was examined using Cluster Analysis (CA) and Principal Component Analysis (PCA) of all generated profiles.

FAME profiles from both methods and each media substrate were used to construct two BcT strain spore databases. Similarity indices calculated between FAME profiles with the Sherlock Microbial Identification System (MIDI) software were used to evaluate the variability and reproducibility of the spore database data.

The results of this research suggest that FAME profiles from spores grown on most of the surveyed media substrates can be statistically distinguished using CA and PCA. Oleic Acid appears to be specific for Columbia Blood Agar and Tryptic Soy Agar with Blood indicating that certain fatty acids may be diagnostic for specific media types. In addition, reproducible fatty acid profiles were generated from less than 1mg of dry spores using the "Instant Method." Results will be presented for comparison of 'blind' spore profiles against the profiles in the BcT spore-media databases. These studies will demonstrate the potential usefulness of FAME profiles for forensic microbiology.

Fatty Acid, Bacillus, Bioterrorism

G9 Suicidal Intoxication by Copper Sulphate

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The goal of this presentation is to present a case of suicidal intoxication by an unusual chemical compound.

This presentation will impact the forensic community by demonstrating how Intoxications (accidental, suicidal or homicidal) with copper sulphate are rare, as can be seen in the few cases described in forensic literature.

Introduction: Portugal is traditionally an agricultural country; therefore intoxications by pesticides are very common, especially with paraquat and organophosphorous. Copper sulphate is a fungicide used to control bacterial and fungal diseases of fruit, vegetables, nut, and field crops. It can also be applied in water treatment systems to control algae. This pesticide is available as dust, wettable powder, and liquid concentrate. In Portugal its major application is in vine plantation.

Copper sulfate solutions may irritate eyes, skin, respiratory and mucous membranes. Poisoning by this compound may affect the central nervous system, liver, kidneys, and capillaries, frequently causing renal failure and haemolytic anaemia.

Despite Portugal's major wine production, intoxications (accidental, suicidal, or homicidal) with this compound are relatively rare, as can be seen in the few cases described in forensic literature.

An 81-year-old male, diabetic with chronic renal insufficiency was admitted at the hospital with suspicion of voluntary ingestion of copper sulphate. Four days later he died. He was admitted in the Nephrology unit with acute renal failure and anaemia, and was treated with intensive hemodialysis and blood transfusions. Later on, he developed metabolic acidosis and there was a worsening of his anaemia. During admittance a 1.5 mg/L copper concentration was detected in his blood.

At the autopsy, it was possible to see a green coloration of the nails, ascitis, and pleural effusion on the right side. Samples from heart, kidneys, lungs and liver were taken for histopathological examination. The major microscopic changes were bilateral severe lesions of chronic pyelonephritis, renal arterioarteriolosclerosis, epithelial cytoplasmic vacuolization, and basophilic discoloration of the renal proximal convoluted tubules, perivenular hepatotoxic lesions with necrosis, and mainly mononuclear sinusoidal and portal inflamatory cell infiltration.

Clinical features indicative of acute intoxication by copper sulphate were renal failure, anaemia, and high copper concentration in blood (the normal concentration being 1 mg/L). Nevertheless, autopsy findings weren't significant; the most common features like gastric and esophageal erythema or ulceration were absent. The diagnosis was based on the microscopic alterations. In fact, not only was there evidence of renal histologic changes related with diabetes and chronic renal insufficiency (arterioarteriolosclerosis, chronic pyelonephritis), but also lesions suggesting copper sulfate poisoning: epithelial cytoplasmic vacuolization and basophilic discoloration of the renal proximal convuluted tubules. Furthermore, the histopathologic lesions observed in the liver were another clue to determining the diagnosis.

Copper Sulphate, Intoxication, Suicide

G10 Visceral Leishmaniasis in Turkey: Sociocultural Issues in Forensic Epidemiology

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After attending this presentation, attendees will appreciate how sociocultural and epidemiological issues are integrated into forensic sciences.

This presentation will impact the forensic community by demonstrating how a forensic scientist can participate in enlightening socio-cultural problems encountered by a developing nation.

Forensic epidemiology has been an emerging forensic science discipline dealing with diseases that create legal issues. Recognition of any parasitic infections requires an understanding of factors such as clinical symptoms and anamnesis, migration, and geography of the human settlement. Among the parasitic diseases, Visceral Leishmaniasis (VL) is one of the most difficult agents to identify and control and in turn is an important disease for the population as a whole. Therefore to control its effect on people, among the initial steps is to track the course of the disease and to plan the therapy. Furthermore, elapsed time during the diagnosis of the illness should be limited to a minimum. Because when the diagnosis is delayed the treatment may take longer. This situation may kick back as a serious problem about the illness of the patient and the application of the treatment. In the meantime, problems encountered during treatment such as difficulties in diagnosing psychosocial disorders and inability to identify the problems in every health center, must be solved.

The purpose of this presentation is an epidemiological assessment of VL encountered by patients during the course of the illness and its sociocultural impact on their lives.

The study includes nineteen patients (with a range of 1-17 years with a mean of 7.5 years) who were initially diagnosed as suffering from VL. From each patient, blood samples (5 ml), bone marrow and a personal health history (anamnesis) were obtained. The blood and marrow samples were analyzed using standard diagnostic tests designed for VL.

Results of the diagnositic tests indicated that eleven (7 males, 4 females) of the nineteen patients showed VL. Of these affected people, six were from Istanbul, two from Kastamonu and the remaining from the cities of Kütahya, Izmit and Hatay. Migration (change of residence) history was not known for six (2 male and 4 female) patients. History was known for five (4 males and 1 female) patients who moved to a different town. However, before moving to a different town, children were first taken to a local hospital for diagnosis. This visitation may have taken anywhere from 1.5 to 8 months. Some parents were not content with the results and did not get the help they needed. Eventually, these families moved their residence to a place (with a distance of 100 to 1,000 km from hometown) where they thought there were better treatment facilities (state or university hospitals). In two cases families changed their residence three times; one from Kütahya, Afyon and then to Istanbul and the other from Bursa, Canakkale, and back to Istanbul). Parents of three (affected by malaria, leptospirosis) of the remaining eight children also moved their household to Istanbul where there are better healthcare facilities. However, the decision to change residence from the eastern and southeastern towns to Istanbul is a commonly seen migration pattern in the country. Otherwise, almost all hospitals are well equipped to cope with malaria and leptospirosis.

With the improvement in socioeconomic level and income, it has become easy to change residence to far away places in Turkey. Yet such migration has also made the transmission of disease agents relatively simple. The study shows that VL is sporadically present in many parts of country. There is no clear evidence of the transmission of this blood parasite from a

host to a person. In one case in Istanbul the host was thought to be a wild street dog living in a relatively poor residential area. The study indicates that the disease is haphazardly handled primarily due to a lack of medical procedure and guidelines to follow in dealing an infectious disease. Some parents of such victims seem to have spent their life's earnings to search for a remedy for their children by moving from one town to another in search of a better hospital or treatment center. In conclusion, it should be stated that infectious diseases are extremely serious and must be handled by a state medical procedure. As an important aspect of forensic epidemiology, such information must be communicated to all medical centers in and around the country. This procedure in dealing with an infectious disease is also important for doctors to avoid potential legal issues arising from wrong diagnoses and causing hardship for the patient and family.

Forensic Epidemiology, Medical Guidelines, Visceral Leishmaniasis

G11 Child Abuse: Practical Case of Autopsical, Radiological, and Anatomo-Pathological Studies

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The goal of this presentation is to illustrate the potential of postmortem multislice computed tomography (MSCT) and magnetic resonance imaging (MRI) in cases of death secondary to child abuse.

This presentation will impact the forensic community by providing an example of forensic application of the MSCT and MRI.

A 17-month-old male baby was discovered pale and unconscious in his bed by her mother at home. An attempt of cardio-pulmonary massage was immediately begun by the father of the child. The medical rescue team was called by the mother. The reanimation attempt was unsuccessful and the rescue physician could only objective the death of the child. The reanimation performed was slight, with oxygen mask apposition and cardiac massage. No injection was performed. The external examination performed at home revealed that rigor mortis was already present and revealed the presence of numerous ecchymoses. The explanation of the parents was thought to be inconsistent with the corpse examination. The police investigators discovered that the family of the baby was known by the social services. Furthermore, a brother of the dead child had already been taken away from his family because of neglect. The dead child had been hospitalized one month prior because of a left humeral fracture. The parents explained that the child suffered form minor beta thalassemia and heterozygous drepanocytosis. The circumstances of home death of this baby were unclear and a medicolegal autopsy was ordered. Postmortem multi-slice computed tomography (MSCT) and magnetic resonance imaging (MRI) examinations were performed in order to determine cause of death of the baby and make an exhaustive visceral and skeletal study.

Imaging study:

- A full body MSCT exploration was performed the day of death. Axial MSCT was performed with a 16 x 0.75 mm collimation on a Sensation 16 unit (Siemens, Erlangen, Germany). Two- (2D) and three dimensional (3D) reconstructions were obtained on a Leonardo workstation (Siemens, Germany). 2D reconstructions were obtained using Multi Plane Reconstruction (MPR) and Maximum Intensity Projection (MIP) modes. 3D reconstructions were obtained using Volume Rendering Technique (VRT) mode. Image interpretations were performed by a board-certified radiologist.
- A focused cerebral postmortem MRI was also performed the day of death. Axial acquisitions were performed in spin-echo T1-weighted, T2-weighted, and T1-weighted gradient echo sequences. Image interpretations were performed by a board-certified pediatric neuroradiologist.
- A postmortem full body radiological study was performed in the medico-legal department. This study consisted of skull radiographs (antero-posterior and lateral incidences), thorax, abdomen and pelvis radiographs (antero-posterior incidence), upper and lower member radiographs.

Autoptical and anatomo-pathologic studies: autopsy was performed by two board-certified forensic pathologists. All three body cavities (cranium, thorax, and abdomen) were examined. Anatomo-pathology was performed after a fixation in 10% formalin.

Results of the different explorations were finally compared:

Imaging study:

- *MSCT:* On cranial CT, diffuse oedema was visible with loss of the gray/white matter differentiation. Spontaneous pericerebral hyperdensities were visible in left frontal and right temporo-parietal areas. No skull or face fracture was visible.
  > On thoracic CT, no pleural or pericardic effusion was noted. Lungs appeared oedemato-congestive. Bone analysis revealed presence of 4 left rib fractures, with different MSCT aspects. One fracture concerned the posterior arch of the 6th rib, with osteosclerosis of its edges, attesting of the beginning of its consolidation. Two concerned the anterior arc of the 7th and 8th rib with a MSCT visible callus, attesting to their old productions. The last fracture was on the 9th rib, displaced, without MSCT consolidation sign.
  > On abdominal and pelvic level, no bone traumatic lesions were visible. No visceral lesion was clearly visible, but the natural contrast due to lack of internal fat (as is commonl in adult cases) was obviously bad. However spontaneous intra hyperdensities were visible within the mesenteric root and in intra peritoneal situation behind the abdominal anterior wall. They were interpreted as possible fresh blood.
  > The appendicular skeleton exploration confirmed the presence of a right humeral fracture with a callus, attesting to its old production.
- *MRI:* Bilateral subdural haematomas were visible in sub-fronto-parieto-temporal areas with varying signal intensities. They appeared as acute hematomas, with spontaneously hyper- and hyposignals on T2-weighted images. Subdural pericerebral hypersignal on gradient echo images were visible in left frontal and right temporo-parietal areas. A right frontal meningeal hemorrhage was also present. Inter pedoncular and intra ventricular haemorrhages were also noted. Petechial haemorrhages within the posterior part of the corpus callosum were suspected.
- *Plain X-rays exploration:* It confirmed the callus of the right humeral shaft. Three left ribs fractures were noted, affecting the 7th, the 8th and the 9th ribs. No other bone traumatic lesion was noted.

External inspection:

The body was thin stout build, naked, measuring 79 cm tall, weighted 8.6 kg. An immobilisation of the right upper member was noted, secondary to the fracture and the hospitalisation dating from one month. Anthropomorphic measurement revealed an increase cranial perimeter of 48 cm. Numerous ecchymoses were noted one the body. Red ecchymoses were noted on the face, in peribuccal localisation,

and bi frontal regions. Ruptures of fraenulum, the tongue, and the superior lip were noted. Red ecchymotic lesions were also visible on both lower members. Brown ecchymoses of 0.5 cm in diameter were noted at the anterior face of the left hemi thorax.

Autopsy and anatomo-pathology:

The scalp had a large hemorrhagic infiltration at its deep part, in right fronto-parietal regions, more limited in left frontal and right occipital regions. The right temporal muscle presented a hemorrhagic infiltration. No endo or exo cranial skull fracture was visible. However, a bilateral subdural hematoma was noted in fronto-parietal areas. A hematoma was also visible around the posterior fossa. The cervical spine was surrounded by epidural hematomas.

The chest exploration revealed presence hemorrhage around the 6th, 7th, 8th, 9th left ribs. Three calluses were found for the 7th, 8th, 9th left ribs. A consolidated callus was noted for the 6th rib. The inferior part of the right lung presented a hemorrhagic infiltration.

A periumbilical ecchymosis at the deep part of the anterior abdominal muscles was present. Many small bowel loops presented a superficial hemorrhagic infiltration.

A hematoma of the right kidney artery was found, continued by a retro peritoneal hematoma. A limited hemorrhagic intra peritoneal effusion was present.

Microscopic studies confirmed the existence of the rib fractures. The fracture located to the 6th rib presented a remodelling bone callus. The fractures of the 7th, 8th, 9th ribs presented cartilaginous callous. The right humeral shaft presented an ossifying cartilaginous callus.

Haemorrhagic infiltration was confirmed around the aorta, within the mesenteric root, the tongue, and within the anterior abdominal wall. The peri aortic, peri ombilical, and left flank haemorrhages were antemortem, contemporary of the death. The tongue lesions consisted of recent and old haemorrhages. The mesenteric root haemorrhage was antemortem, with inflammatory elements, permitting determination that it dated from several hours before death.

The subdural hematoma was confirmed to be acute. It presented polymorphonuclears and ischemic neuronal damage associated with a recent cervical spine epidural haemorrhage.

Several authors have compared postmortem imaging and autopsy results in neonatal death. MRI offers high resolution images of the entire neonate while leaving the body intact. Compared with other imaging techniques such as conventional x-ray and CT scan, the high spatial resolution and the high tissue contrast that can be generated by MRI are advantages. The different tissue contrasts that T1-, T2- or proton density weighted MR sequences provide can give additional information about the lesions or disease processes. Compared with autopsy, postmortem MRI has proven to be especially useful in the evaluation of the central nervous system. The high water content of the neonatal brain makes it difficult to handle during autopsy, even when adequately fixed. Subdural haemorrhages are the commonest type of injury found and this is in keeping with pathological evidence and studies using computed tomography. They are caused by damage to the bridging veins, which drain from the cortex into the superficial venous sinuses. It is important to note that different signal intensities of subdural haematomas do not necessarily indicate repeated bleeds at different times. Subtemporal blood is not well seen on CT, especially with its decreased multiplanar imaging capability. Extra-axial fluid collections can have the same density as cerebrospinal fluid on CT, and it is difficult to differentiate enlargement of the subarachnoid spaces and subdural effusions. MR is superior to CT when differentiating these extra-axial collections. Isolated subarachnoid haemorrhages can be difficult to detect on MR studies. MRI is useful at postmortem to direct the autopsy and brain cutting to focal areas of axonal injury.

Hart et al. in 1996 investigated the correlation between postmortem MRI of the head and autopsy findings in suspected child abuse. Autopsy was more effective in detection of subarachnoid hemorrhage, suture separation, extracranial injuries and very small hematomas. According to these authors, MRI findings were useful in directing the autopsy and brain dissection to focal areas of abnormality. They found that postmortem MRI and autopsy were complementary and that each may disclose abnormalities missed by the other. In half of the eight cases of child abuse examined in this study, the combination of MRI and autopsy added valuable information compared with the results of autopsy alone.

In this case, combination of MRI and MSCT were able to determine the diagnosis of child abuse. Indeed, multiple fractures, of different ages were diagnosed. Skeletal fractures were suggestive of non accidental injuries because of their localisations: posterior arch of one rib, and association of recent and old fractures. Presence of an old right spiral humeral fracture was suggestive of child abuse; spiral fractures are classically secondary to torsional force. Cranial MRI was highly suggestive of intentional trauma. The MRI aspects of peri-cerebral hematoma are clearly visible compared to MSCT images. This exploration confirmed the pericerebral bleeding and objectified lesion not visible at the autopsy time as intra ventricular hemorrhage.

Limits of the MSCT are well illustrated by this case: the lack of tissue contrast because of the lack of fatty tissue is the highest limit of the technique. It does not permit a correct examination of the visceral trauma and lesions. However, diagnosis of intra peritoneal bleeding was possible and confirmed by autopsy. For skeletal trauma evaluation, MSCT was more efficient in our case than plain X-Rays. However, Cattaneo stated that radiology detected only 47%, autopsy 65%, while CT scans detected 34% of rib fractures. Rib fractures are quite unusual even in the setting of severe accidental trauma in infants and rarely if ever result from vigorous cardiopulmonary resuscitation. These injuries are usually clinically occult and typically result from excessive anteroposterior compression of the chest during shaking or with impact. Involvement of the posterior arc of the rib is most common, although fractures occur at all rib sites in abuse. Rib fractures tend to occur at multiple levels at similar points along the arcs of adjacent ribs, are often symmetric, and most frequently involve the middle ribs.

In this case, the autopsy was superior to imaging for the diagnosis of hematoma of the right kidney with a retro peritoneal hematoma and cervical epidural spine hemorrhage. The anatomo-pathology study did not confirm the suspected petechial haemorrhage within the posterior part of the corpus callosum.

This case report illustrates the potential of MSCT and MRI concerning battered child exploration in terms of determination of cause of death, visceral and skeletal evaluations, and age determination of lesions thus permitting the diagnosis of child abuse.

AAFS, Forensic Sciences, Radiology

G12 Posterior Rib Fractures in Infants Associated With Cardiopulmonary Resuscitation

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The goals of this presentation are to: (1) describe the recommended method of chest compressions for infants by the American Heart Association, (2) describe the proposed mechanism causing posterior rib fractures due to child abuse, and (3) describe how chest compressions during cardiopulmonary resuscitation in an infant could cause posterior rib fractures.

This presentation is intended to educate the attendees that posterior rib fractures in infants can occur in circumstances other than child abuse; specifically they can be associated with chest compressions performed during cardiopulmonary resuscitation (CPR). This study will impact the forensic community and humanity by demonstrating that posterior rib fractures can be related to CPR chest compressions and should not automatically assumed to be a result of abuse without supporting evidence and investigation.

A commonly held belief by forensic pathologists, pediatricians and pediatric radiologists is that posterior rib fractures in infants are highly specific for child abuse and rarely if ever result from chest compressions during cardiopulmonary resuscitation. Those who concede that rib fractures may very rarely occur due to CPR contend that the injuries involve the anterior or anterior/lateral aspects of the rib. This issue is of particular importance as rib fractures in small children are most commonly the result of non-accidental injury and therefore may be strong evidence in support of child abuse. A complete autopsy and a thorough investigation of circumstances are critical in determining the manner of death in infants. Misclassification due to over-interpretation of a single finding could have devastating effects on caregivers who may be falsely accused of abuse and therefore face litigation.

The normal immature infant skeleton has increased plasticity compared to the adult skeleton making it relatively resistant to fracture unless there are congenital or acquired disorders of the collagen matrix or mineralization. However, with enough force applied to the costovertebral angle, minute fractures of the rib head and neck can occur. Current American Heart Association guidelines suggest that CPR for infants given by health care providers be performed using the two-handed method with thumbs on the sternum and fingers encircling the chest and back. In this manner, direct pressure not only depresses the sternum but also can lever the posterior ribs at their articulation with the vertebral column at the transverse processes of the thoracic vertebrae. In instances where untrained individuals provide CPR, improper technique may also contribute to fractures. As acute fractures in many cases are quite subtle and nondisplaced, they may be missed on antemortem and postmortem radiographs even when critically examined. These fractures may also be missed at autopsy particularly if the parietal pleura is not removed. In fact, the true incidence of infant rib fractures may be underestimated due to the difficulty in their detection.

Presented here are the gross, radiographic, and microscopic findings from four hospitalized neonates and infants, aged 1 day to 3 months, who died of natural causes but were noted to have posterior rib fractures at autopsy. Three cases showed evidence of acute fractures after terminal CPR attempts. In one case, remote fractures with callous formation were identified in an infant with multiple previous CPR episodes due to complications resulting from his premature birth. These infants and neonates spent the majority of their lives within the hospital. In all cases the infants had no history of abuse, no outward evidence of inflicted injury, and no additional internal injuries consistent with child abuse. It is imperative that the presence of posterior rib fractures in an infant not be ascribed impulsively to child abuse until a thorough investigation is conducted including assessment of resuscitative techniques.

Posterior Rib Fractures, Cardiopulmonary Resuscitation, Child Abuse

G13 Role of Preoperative 3D-CT Reconstruction in Depressed Skull Fractures Treated With Craniectomy: A Case Report of Forensic Interest

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The goal of this presentation is to describe a new approach to cranial trauma treated with craniectomy: 3D-CT reconstruction based on preopertaive scanning.

This presentation will impact the forensic science community by demonstrating how new radiological techniques and reconstruction can be utilized to assist the forensic pathologist in assessing cranial trauma after surgical intervention.

Patients affected by cranial trauma with depressed skull fractures and intracranial pressure increase generally undergo neurosurgical intervention. Since craniotomy and craniectomy remove skull fragments and generate new fracture lines, they complicate forensic examination and sometimes prevent a clear identification of skull fracture etiology.

To overcome this kind of problems a 3D reconstruction based on preoperative CT scanning, giving a picture of the "*status quo*" ante neurosurgery, can help the forensic examiner in identifying skull fracture origin and their means of production.

The authors report the case of a 41 year-old-man assaulted by his pusher: he presented at the emergency room with severe cranial trauma with a depressed skull fracture at the vertex, bilateral subdural hemorrhage, and multiple intraparenchymal contusions. The rapid impairment of GCS (Glasgow Coma Score) from 14 to 8 forced the surgeons to perform a craniotomy; despite such intervention neurological conditions kept on worsening (GCS of 4) and after a few hours a craniectomy was performed. The patient died after 40 days of hospitalization in an Intensive Care Unit (ICU) for multi-organ failure (MOF).

The forensic autopsy revealed the absence of various bone fragments at the vertex (consequences of the craniectomy), bilateral fractures at the anterior and medial fossa, bilateral cortical contusions at the frontal and parietal lobe, and a smaller cortical contusion at the right temporal lobe. Histological examination showed focal necrotic and hemorrhagic lesions surrounded by gliosis and several hemosiderin-laden macrophages, dating the trauma at about 30-50 days before autopsy.

Because of the absence of various bone fragments at the vertex the necroscopic examination didn't allow a precise analysis of the skull fractures. Thus a 3D-CT reconstruction of the preoperative scanning was performed with SSD (surface shaded display) and MIP (maximum intensity projections) technique.

A comparative study between necroscopic and radiological data differentiated the surgical from the traumatic lesions, which were produced by a cylindrical blunt object with a reduced area of impact.

A fit-matching analysis between virtual blunt objects and the skull fractures found out that the pusher had beaten the victim using a baton with a diameter of 3 cm and a length of about 1.50 meters.

These findings helped the police officers in searching for the crime weapon, which was found hidden in a bush not far from the site of the assault.

Computed tomography techniques with tridimensional reconstruction have been developed over the last 10 years and have found various applications in the forensic field. The most recent development is multislice computed tomography combined with photogrammetry-based surface optical scanning and image rendering techniques. The combination of these different techniques can be used to produce three-dimensional images of injury patterns for comparison with suspect weapons.

This technology is generally used in postmortem examination to complete or replace forensic autopsy (Virtopsy®).

However, when patients suffering a trauma undergo surgical intervention, which modifies wound morphology and complicates forensic examination, a 3D-CT reconstruction based on preoperative scanning gives a picture of the "*status quo*" before surgical procedures and thus helps the forensic examiner in identifying wounds etiology and their means of production.

Depressed Skull Fractures, 3D-CT, Craniectomy

G14 Subway Train Related Fatalities in New York City: Accident vs. Suicide

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This study aims to describe the characteristics of subway train-related fatalities, including scene investigation, police investigation, autopsy, medical and psychiatric history, and toxicology studies.

This presentation will impact the forensic science community by contributing to literature by attempting to identify factors which will be helpful in differentiating accidental from suicidal deaths.

Determination of the cause of death in subway train-related fatalities usually is obvious. However, determination of the manner of death can be challenging. A common dilemma is the differentiation between accidental and suicidal death. In order to accurately determine the manner of death, all relevant factors must be considered, including: eyewitness accounts, physical injuries, medical and psychiatric history, scene investigation, and toxicology results. The characteristics of subway train-related fatalities were examined in order to determine which factors may be helpful in differentiating accident from suicide. Subway train-related deaths with homicide and undetermined manners also are included.

A computerized search of all medical examiner death certificates issued between January 1, 2003 and May 31, 2007 was performed for the words "subway", "train", or "tracks" to identify all subway train-related fatalities. The autopsy data, scene investigation report, police report, toxicology results, and other relevant documents in the OCME file were reviewed for each case.

Two-hundred and eleven (211) consecutive subway train-related fatalities were investigated by the Office of Chief Medical Examiner of the City of New York during the study period (approximately 1 per week). Of these 211 deaths, 175 underwent autopsy and 36 were examined only externally. External examination without full autopsy usually was done pursuant to a religious objection which must be honored under New York law unless there is a suspicion of homicide or an imminent threat to public health. The distribution of deaths by manner was: suicide (111), accident (76), undetermined (20), and homicide (4). The causes of death were either blunt trauma (206) or electrocution (5). The average age was 44 years with a range of 14 to 85, and a male to female ratio of approximately 5 to 1.

Witness accounts were available in 66% of the accidental deaths and 95% of the suicidal deaths. Ethanol was detected in 42% of the accidental deaths with an average blood alcohol concentration of 0.20 gm%, compared to 14% of suicides with an average blood alcohol concentration of 0.16 gm%. Antidepressant medications were detected in 8% of the accidental deaths compared to 21% of the suicides. Cocaine and/or benzoylecgonine were detected in 25% of the accidental deaths, compared to 3% of the suicides. Head, torso, and extremity injuries occurred in 84%, 70%, and 62% of accidental deaths compared to 90%, 80%, and 77% of suicides, respectively. There were skull fractures in 53% of accidental deaths compared to 65% of suicides. Decapitation and torso transection occurred in 1% and 3% of accidental deaths compared to 7% and 8% of suicides, respectively.

There were 20 deaths with an undetermined manner; all due to blunt trauma. Only 35% of the undetermined deaths were witnessed. There were four homicides of which two victims were pushed into the path of a subway train. In one homicide, the victim was chased into a tunnel and subsequently struck by a train. The remaining homicide involved an un-witnessed assault followed by a fall onto the subway tracks and electrocution by contact with the third rail.

Eyewitness accounts are the most helpful factor for determining the manner of these deaths. The finding that suicides have a higher rate of eyewitness accounts than accidents may be a reflection of the requirement to demonstrate intent in order to certify a death as a suicide. Without evidence of clear suicide intent, these deaths typically would be certified as accidents or undetermined manners. A suicide note, prior expression of intent, and prior suicide attempt are other helpful factors. Physical injuries and toxicology findings are, by themselves, non-specific, but in conjunction with other factors, may be helpful. Torso transection and extremity amputation were more frequent in suicides, but occurred in accidental deaths as well. Antidepressant medications were more frequently detected in suicides, whereas cocaine and ethanol were more frequent in accidents. These factors should not be interpreted in isolation when determining the manner of death. Although there is no pathognomonic autopsy finding that determines the definitive manner of these deaths, these results may be weighed in the context of the entire evaluation along with other circumstantial and investigative findings. In un-witnessed deaths where additional information is unavailable or discrepant, the most appropriate manner of death usually is undetermined.

Subway, Accident, Suicide

G15 Cardiovascular Trauma in Motor Vehicle Collisions: A 20 Year Retrospective Study and Review of the Literature

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The goal of this presentation is to identify and classify cardiovascular trauma and injuries sustained in motor vehicle collisions. The audience participants will be able to determine cause of death due to cardiovascular injuries in motor vehicle collisions and become familar with injury patterns and the corresponding motor vehicle collision scenarios. In addition, autopsy techniques applicable to motor vehicle collsions will be reviewed.

The motor vehicle collision has been, is, and will remain a major cause of death in the United States and internationally. Previous studies of motor vehicle collsions have led to significant advances in automobile saftey and safety precautions. This presentation will impact the forensic science community by demonstrating how it is essential to continue to study motor vehicle collisions, so that even greater saftey advancements and initiatives can be developed.

The motor vehicle collision (MVC) is the major cause of accidental injury and death in the United States and developed countries. Previous studies of traumatic injuries sustained in MVC have led to significant advances in safety precautions and devices. Resultant cardiovascular trauma resulting in death includes great vessel rupture, cardiac rupture, cardiac contusion, commotio cordis, and coronary artery dissection. The authors retrospectively reviewed all cases referred to the Forensic Pathology Section of the Medical University of South Carolina (Charleston, SC) over a twenty-year period from January 1988 through December 2007. Cases of MVC autopsies were examined for the presence or absence of any cardiovascular trauma. Cardiovascular trauma was defined as trauma to the heart proper as well as to the pulmonary arteries, vena cava, aorta, and major tributaries of the aorta. Other variables reviewed were the type of vehicle, number of vehicles involved, location in the car of the decedent, seat belt usage, element of ejection, airbag deployment, type of collision, site of vehicle impact, decedent demographics, injury-to-death time interval, cause and manner of death, and toxicological findings. Cases in which the cardiovascular trauma was the cause of death were further examined. Useful autopsy procedures and ancillary studies are discussed.

Motor Vehicle Collision, Cardiovascular Trauma, Autopsy Techniques

G16 Right Ventricular Lipomatosis and Fibrous Tissue in Cases of Non-Cardiac Deaths and Arrhythmogenic Right Ventricular Cardiomyopathy

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Upon attending this presentation, the audience will have a better appreciation for the fat and fibrous tissue content of the normal right ventricular myocardium, as compared to cases of arrhythmogenic right ventricular cardiomyopathy, and also appreciate the importance of selective sampling of the right ventricle to properly assess fat and fibrous tissue content.

This presentation will impact the forensic community by highlighting the regional differences normally present in the heart, which significantly impact upon the diagnosis of arrhythmogenic right ventricular cardiomyopathy, particularly in the posterior basal right ventricular myocardium.

Arrhythmogenic right ventricular cardiomyopathy (ARVC), defined as variable replacement of the myocardium of the right ventricular (RV) free wall by fatty or fibrofatty tissue with degenerative changes in entrapped myocytes, is a form of cardiomyopathy that is often familial and typically presents as sudden death in young healthy individuals. Currently, a definitive pathologic diagnosis of ARVC diagnosis is often difficult because a certain amount of fat is always present within the RV myocardium that tends to increase with age, particularly in the anterior and lateral apical regions. We aim to quantitatively establish a normal range for regional RV lipomatosis and fibrous tissue to provide a basis for the pathologic diagnosis of ARVC. Anterior, lateral, and posterior regions of apical and basal RV myocardium were sampled from autopsy cases where deaths were due to non-cardiac causes (control; n=10; age = 21-84 years) and from individuals who had documented ARVC (ARVC; n=10; age = 15-60 years). Area fractions of RV myocardium (%) occupied by myocytes, fat, fibrous tissue, or blood vessels were measured on trichrome-stained slides by computer-assisted point counting, excluding epicardial adipose tissue and subendocardial trabeculations.

The results highlight significant regional differences in lipomatosis normally present in the heart, with apical regions having significantly more lipomatosis than corresponding basal regions of Control cases ($p<0.05$). The anterior apex showed the most lipomatosis ($29.9 \pm 4.2\%$), whereas the posterior base had the least lipomatosis ($3.8 \pm 1.1\%$). Comparatively, ARVC cases had a significantly greater amount of fat than Control cases ($p<0.05$), which was most apparent between corresponding posterior regions, particularly in the basal RV myocardium, which showed a seven-fold increase in lipomatosis ($26.4 \pm 8.5\%$; $p<0.05$). The large content of fat normally present in anterior and lateral apical RV myocardium indicates that diagnosis of ARVC may be difficult if based solely upon lipomatosis in these areas. Significant regional differences in fibrous tissue were not seen in Control hearts, but the amount of fibrous tissue within the posterior base of ARVC hearts was significantly higher than that of Control hearts ($20.9 \pm 3.7\%$ and $12.2 \pm 1.6\%$, respectively; $p<0.05$). Thus, the substantial amount and regional variation of lipomatosis that exists in normal RV myocardium indicate that changes in lipomatosis in posterior RV myocardium, particularly at the base, are the most reliable means of making a definitive diagnosis of ARVC. This interpretation also has relevance to cardiac imaging as it relates to diagnosis of ARVC.

Arrhythmogenic Right Ventricular Cardiomyopathy, Lipomatosis, Right Ventricle

G17 Sodium Channelopathies Linked to Sudden Cardiac Death (SCD) - What is the Meaning of Carrying a Genetic Mutation?

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The goal of this presentation is to describe the use of genetic testing directed toward identifying sodium channel mutations linked to Sudden Cardiac Death as a diagnostic tool in the forensic field.

This presentation will impact the forensic community by developing guidelines on how to approach the results of postmortem molecular analysis of Sudden Cardiac Death Cases and the immediate consequences of genetic testing of the relatives.

Mutations in the SCN5A gene have been linked to a variety of diseases causing sudden cardiac death, with important variability in expression and phenotypic overlap. With the availability of postmortem molecular analysis and genetic testing of family members, it is now possible to identify carriers based solely on the presence of the genetic defect. Clinical decision making in this situation is complex and generates important ethical and medico-legal issues.

Two families, 24-328 and 24-588, originally diagnosed with Brugada syndrome after the probands experienced cardiac arrest. Clinical and genetic analysis in their members were performed. Both families had members with various electrocardiographic abnormalities including some with Brugada syndrome, long QT syndrome and conduction system disease. Both families had an important family history of sudden cardiac death. Direct sequencing of exons and exon-intron boundaries of the sodium channel gene SCN5A identified mutations in both families.

These two families illustrate an increasingly common scenario when encountering families with ion channelopathies. Because defibrillator is the only available therapeutic option at present in Brugada syndrome, physicians and forensic pathologists will be faced with extremely difficult therapeutic decisions that also have important legal, social and ethical implications, especially in children. These data indicate the need to develop guidelines on how to approach the results of postmortem molecular analysis and genetic testing of the relatives as well, especially in asymptomatic individuals.

Sudden Cardiac Death, Genetics, Brugada Syndrome

G18 SCN5A Gene Mutation Associated With Acute Myocardial Infarction

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The goal of this presentation is to describe the first sodium channel mutation to be associated with the development of an arrhythmic storm during acute ischemia.

This presentation will impact the forensic science community by presenting findings which suggest that a loss of function mutation in SCN5A gene (cardiac sodium channel) may predispose to ischemia-induced arrhythmic storm and sudden cardiac death.

Ventricular tachycardia and fibrillation (VT/VF) complicating Brugada syndrome, a genetic disorder linked to SCN5A mutations, and VF complicating acute myocardial infarction (AMI) have both been linked to phase 2 reentry. Because of these mechanistic similarities in arrhythmogenesis, the contribution of SCN5A mutations to VT/VF complicating AMI were examined.

Nineteen consecutive patients developing VF during AMI were enrolled. Wild-type (WT) and mutant SCN5A genes were co-expressed with SCN1B in TSA201 cells and studied using whole-cell patch-clamp techniques.

One missense mutation (G400A) in SCN5A was detected in a conserved region among the cohort of 19 patients. A H558R polymorphism was detected on the same allele. Unlike the other 18 patients who each developed 1-2 VF episodes during acute MI, the mutation carrier developed six episodes of VT/VF within the first 12 hours. All VT/VF episodes were associated with ST segment changes and were initiated by short-coupled extrasystoles. A flecainide and adenosine challenge performed to unmask Brugada and long QT syndromes were both negative. Peak G400A and G400A+H558R current were 70.7% and 88.4% less than WT current at -35mV ($P \leq 0.001$). G400A current decay was accelerated and steady-state inactivation was shifted -6.39 mV ($V1/2 = -98.9 \pm 0.1$ mV vs. -92.5 ± 0.1 mV, $P \leq 0.001$). No mutations were detected in KCNH2, KCNQ1, KCNE1, or KCNE2 in the G400A patient.

The first sodium channel mutation to be associated with the development of an arrhythmic storm during acute ischemia is described. These findings suggest that a loss of function in SCN5A may predispose to ischemia-induced arrhythmic storm and sudden cardiac death.

Sudden Cardiac Death, Myocardial Infarction, Ventricular Fibrillation

G19 Arrhythmogenic Right Ventricular Dysplasia/Cardiomyopathy a Not So Infrequent Cause of Sudden Death - A Danbury Hospital Five Year Experience (June 2002 - June 2007)

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The goal of this presentation is to increase the database of deaths due to arrhythmogenic right ventricular dysplasia/cardiomyopathy in USA.

This presentation will impact the forensic science community by illustrating the victim, scenario, and autopsy findings of arrhythmogenic right ventricular dysplasia/cardiomyopathy deaths so that proper cause and manner of death can be classified and the epidemiology understood.

Ten(10) cases of ARVD/Cardiomyopathy were reviewed that were autopsied at Danbury Hospital, CT, since June 2002 until June 2007. This number represents 3.75% of the total (270) adult full autopsies performed in our institution during the same period.

Age, sex, and ethnic background were noted. Associated cardiac and non cardiac related diseases were reviewed.

Medications, social and family history (sudden death of sibling), as well as body habitus (obesity) were tabulated. Prior symptoms (fainting episodes, palpitations) and pre-terminal circumstances (place of death) were examined.

Autopsy findings (cardiovascular and systemic) were correlated. Conclusions are compared with recent literature including review articles.

Arrhythmogenic, Right Ventricle, Dysplasia

G20 Sudden Cardiac Death in Professional Sports Persons: Natural vs. Anabolic Steroid Induced Lesions and Experimental Rabbit Model

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This presentation will increase awareness of anabolic steroid-induced cardiac lesions in professional sports-persons and illustrate comparative lesions in the rabbit model.

This presentation will impact the forensic science community by demonstrating that because controlling or banning doping in professional sports is not feasible in the present state of affairs, treating with apoptosis inhibitors might hold out hope of limiting the incidence of severe evolutive cardiac lesions.

Out of 15,000 forensic autopsies performed on coroner's orders over a 24-year period (Jan 1981-Dec 2003) in the area of Lyon, France (population: 2,000,000), WHO criteria identified 2,250 cases of unexpected sudden cardiac death. Among these, 120 were found to have occurred during recreational sport and 12 in professional sports persons. In the latter category, the associated cardiac lesions were primitive: natural in 6 cases, and, according to inquest findings, induced by anabolic steroids in the other six. To shed light on the induced lesions, animal experiments were performed, administering Norethandrolone to rabbits which were then sacrificed and subjected to pathologic examination and caspase-3 assay by fluorometry on cardiac fragments.

The natural primitive lesions were classical for such cases. The anabolic steroid-induced lesions comprised coronary thrombosis associated with left ventricle hypertrophy and lesions analogous to toxic or adrenergic myocarditis. The same lesions were found, to varying degrees, in the rabbit models, which showed significantly elevated Caspase-3 activity as compared to controls.

Anabolic steroids would seem, to varying degrees, to induce lesions analogous to those found in myocardiopathy and toxic myocarditis. Their elevated Caspase-3 activity makes these lesions apoptotic in nature.

Doping, Cardiac Lesions, Apoptosis

G21 Cocaine Induced Intracerebral Hemorrhage in a Patient With Cerebral Amyloid Angiopathy: A New Risk Factor for Stroke in Cocaine Users

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The goals of this presentation are to: (1) understand the association between intracerebral lesions and cocaine use, (2) recognize amyloid angiopathy, it's relationship with stroke as well as age, and it's immunohistochemical detection, and (3) recognize amyloid angiopathy as a possible contributing factor for hemorrhage in cocaine use.

Because this case represents the first reported association between cocaine-induced hemorrhage and cerebral amyloid angiopathy, this presentation will impact the forensic science community by bringing to light that amyloid angiopathy may be an under-recognized but significant risk factor for hemorrhage in older cocaine users.

Hemorrhagic stroke is a common complication of recreational cocaine use. The precise mechanism of hemorrhage in such patients is unclear, although vasospasm, ischemia, vascular thombi/thromboemboli, elevated blood pressure, and vasculitis have all been implicated. Systemic hypertension and saccular aneurysms are generally accepted as predisposing factors for cocaine-induced stroke. The authors report the case of a 62-year-old woman who suffered left parieto-occipital intracerebral hemorrhage with herniation and death, following a cocaine binge. In addition to the gross neuropathological findings, microscopic examination showed marked cerebral amyloid angiopathy in the vicinity of the hemorrhage as well as cortical areas. To explore the issue of chronic cocaine use as a risk factor for cerebral amyloid angiopathy per se, we additionally studied brain tissue in eight patients between the ages of 60 and 80 who were positive for cocaine metabolites at autopsy, with the presumption being that patients in this age group with evidence of cocaine use at autopsy were most likely chronic cocaine users. None of these additional subjects had vascular deposits of amyloid-beta by immunohistochemistry.

In conclusion, to the best of our knowledge, this report represents the first case of cerebral amyloid angiopathy-associated intracerebral hemorrhage precipitated by cocaine. It is suspected that other cases occur but go under-reported, on the one hand because cocaine-induced stroke is widely recognized and additional predisposing factors (e.g., amyloid angiopathy) may not be specifically sought, and on the other because cocaine may not be suspected in the advanced age at which amyloid angiopathy typically presents. It is further suggested that cerebral amyloid angiopathy occurs independently of the effects of cocaine, as no vascular labeling was found for amyloid-beta in eight older subjects who were cocaine users.

Cocaine, Amyloid Angiopathy, Intracerebral Hemorrahge

G22 Can Immunohistochemical Stains Aid to Rule Out Pitfalls in Suffocation Deaths?

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The goal of this presentation is show the quantitative and qualitative expression of selected markers in specimens of tissues that are affected by various degrees of hypoxic insult using immunohistochemical methods.

This presentation will impact the forensic community by providing data that may be helpful in determining the presence of early hypoxic tissue damage via immunohistochemical methods.

In forensic practice, the identification of mechanical asphyxiation is often very difficult, especially in cases of attempted masking of the homicide, or because of putrefactive alterations of the body. In addition, postmortem dissection artifacts of the neck and their differentiation from ante-mortem bruises sometimes leave doubts at the pathologist examination.

The target of current research is focused on detecting severe tissue hypoxia by a great battery of techniques now avalaible. However, even this limited objective has not been yet obtained with the degree of reliability required for legal purposes.

Cell death, expecially in neurons or myocytes, due to hypoxic damage is the most common focus for research. However, the main problem, in the forensic context, is that a considerable period of hypoxia – usually a minimum of many minutes or even hours - is needed before changes can be detected. In autopsy samples the postmortem and agonal changes may interfere with the early changes of hypoxic damage.

Quantitative and qualitative expressions of selected markers in specimens of tissues that are affected by various degrees of hypoxia insult were evaluated by immunohistochemical method. The relationships between the expression of selected markers and temporal evolution in human tissues were evaluated: the antibody HIF-1α, as a marker of early myocardial ischemia, due to asphixia. HIF-1α is the major trascription factor involved in adaptative cardiac response to hypoxia, whose expression can be a useful tool in those cases with short survival period (as recently shown by Pampin and Coll).

The authors also attempted to use TGF-β expression in neck skin, as a marker of a vital lesion and duration of survival period. TGF-β plays a general function in skin response to injury, both in inflammation and in tissue repair; and it shows different immunohistochemical expression patterns in relation to post-injury time interval.

Finally, the number of pulmonary macrophages with CD68 immunohistochemical stain was estimated.

The results were evaluated considering the possibility of false negative immunohistochemical staining in tissue with putrefactive alteration.

A total of thirteen cases of suffocation death were studied: 5 cases of strangulation, 6 of hanging, 2 of choking. Negative controls were gained from cases of precipitous death in young people and positive controls from cases of confirmed asphyxial deaths. HIF-1α was tested in myocardial tissues, TGF-β in neck skin samples and CD68 in lung samples.

The results of the retrospective analysis encourage the authors to continue this study in further cases in order to evaluate the applicability of these tests in routine forensic practice.

Axphyxial Death, Putrefactive Alterations, Immunohistochemistry

G23 Alcohol Related Accidental Drowning in Virginia: An Epidemiological Review

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The goal of this presentation is to give viewers an understanding of the epidemiology of alcohol related accidental drowning in the Commonwealth of Virginia over a ten year period. Viewers should understand the cohorts at increased risk, which may benefit from targeted prevention strategies.

The impact of this poster on the forensic community and humanity is to identify those groups at most risk of alcohol associated accidental drowning. Targeted preventative measures may reduce from three hundred and sixty-three, the number of Virginians to die potentially preventable deaths over the next ten years. This data may also be used to develop studies and/or preventative strategies in other jurisdictions.

Certain racial, gender, and/or age groups are at higher risk of alcohol-related accidental drowning.

The Office of the Chief Medical Examiner of Virginia database was queried for cases in which the fatal agency was drowning, resulting in 1129 cases from January 1997 to December 2006. Of these, 972 were accidental in manner. Data was collected from the database on the sex, race, age, alcohol presence, and blood alcohol level of those drowning accidentally. Rates were calculated only for Virginia residents and based on population data obtained from the Virginia Department of Health Office of Vital Statistics. The 2006 population data was estimated based on changes in the population groups for the previous nine years.

Accidental drownings comprised 86.2% of the total cases studied. Of those, 37.3% were associated with alcohol. Males accounted for 92.3% of these cases. The highest number of alcohol associated accidental drownings occurred in whites (63.3%), followed by blacks (29.8%), and Hispanics (5.5%). Those aged 35 to 45 years represented 25.6% of alcohol associated accidental drownings, those 45 to 54 years 19.8%, those 25-34 years 17.4%, and 20 to 24 years 10.7%. Of those aged 18 to 64 years, 61.3% had a blood alcohol concentration at or above the Virginia legal limit of 0.08%w/v (for driving a motor vehicle).

Of all alcohol associated accidental drowning, the great majority occurred in males. Those aged 35 to 44 years comprised 25.6%, while 61% occurred in those aged 20 to 54 years. This group may over-estimate their ability to function safely around water while under the influence of alcohol. Although the majority of these individuals had blood alcohol concentrations at or above 0.08% w/v, 38.7% did not. Preventative measures should target this potentially over looked cohort, and emphasize abstaining from alcohol while engaging in water-related activities.

Drowning, Accidental, Alcohol

G24 Cytomegalovirus Enteritis With Profuse Gastrointestinal Bleeding Diagnosed at Autopsy: A Case Report and Review of the Literature

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The objectives of this presentation are to discuss the causes of gastrointestinal hemorrhage and gastroenteritis with specific emphasis on the diagnosis of CMV enteritis and its potentially fatal outcome.

This case report and review of the literature will impact the forensic community by helping the medical and forensic community become aware of the potentially fatal outcome of CMV enteritis.

A diverse group of pathologic factors can produce profuse gastrointestinal hemorrhage. Common causes include peptic ulcer disease, esophageal varices, arteriovenous malformations, and Mallory-Weiss tears. Aortoenteric fistulas, chemical ingestions, tumors and viruses are among the rare entities that are associated with gastrointestinal hemorrhage. Often, when gastrointestinal hemorrhage is encountered at autopsy, the causality is straight forward. However, at times, the cause of hemorrhage is more obscure and the pathologist must consider those possibilities that are less common in order to identify the etiology.

We report a case of a 74-year-old African American female who succumbed to profuse gastrointestinal bleeding secondary to cytomegalovirus (CMV) enteritis. The decedent had a history of end stage renal disease secondary to Wegener Granulomatosis. She had recently been diagnosed with inflammatory bowel disease and diabetes. She was HIV negative. Prior to her death she was hospitalized after undergoing right hip hemiarthroplasty for a right femoral fracture. Her immediate post operative hospital course was uneventful. However, while hospitalized she developed bilateral arm tremors, weakness, and decline in her mental status. She was given the preliminary diagnosis of encephalopathy and it was felt that this was due to her chronic renal failure and a metabolic derangement. In the proceeding days, her blood pressure became labile, and despite full medical treatment she died. At autopsy profuse gastrointestinal hemorrhage and multiple gastrointestinal ulcerations were found. Microscopic examination revealed transmural necrosis and mucosal erosion of the large intestine and ulceration with chronic inflammation penetrating to the muscularis propria of the small intestine. In addition, scattered intestinal epithelial cells demonstrated "smudged" nuclear chromatin suggestive of viral infection. Subsequent special staining for cytomegalovirus was positive. Causes of profuse gastrointestinal hemorrhage and cytomegalovirus enteritis are discussed.

Gastrointestinal Hemorrhage, Cytomegalovirus (CMV), Autopsy Ancillary Studies

G25 Ethyl Chloride Toxicity in a Case of Unsuspecting Abuse

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The goal of this presentation is to present a case study to increase the awareness about the compound ethyl chloride, its medicinal and industrial uses, its abuse and potential toxicity to those who choose to abuse it, and its postmortem detection in blood and tissue samples.

This presentation will impact the forensic community by emphasizing that ethyl chloride is a potentially harmful and fatal chemical when abused and can be mistaken for ethanol intoxication and may not be anticipated because of its uncommon association with death.

Ethyl chloride is a colorless gas with general anesthetic properties in humans and animals. Its use as a general anesthetic was discontinued because of its flammability, cardiotoxicity, and possible severe respiratory depression. Its major uses are for tetraethyl lead production and as a solvent, alkylating agent, refrigerant and topical anesthetic.

Ethyl chloride has gained increasing popularity since amyl nitrite and other volatile alkyl nitrite substances have been removed from the lay market because of their high abuse potential. The three most common means of inhalation of ethyl chloride are "sniffing", "huffing", and "bagging". Sniffing is perhaps the most popular means of inhalation in those who are episodic abusers. The individuals who chronically use inhalants prefer bagging because of the higher concentration of the substance being inhaled. Ethyl chloride can be purchased without prescription at underground establishments, on the internet and at places selling drug paraphernalia. It is sold as a video head cleaner, which is a legitimate use, but it is also marketed as a means of experiencing a euphoric feeling and enhancement of sexual pleasure. Many of the products containing ethyl chloride have provocative

names such as Rush, Jungle Juice Plus, Maximum Impact, Black-Jac, and Macho and are generally referred to as "poppers". Acute exposure results in feelings of euphoria, drunkenness, ataxia, dysarthria, nystagmus, confusion, dizziness, hallucinations, impairment of short-term memory, and unconsciousness. The long term effects of ethyl chloride in humans are unknown.

The case presented is that of a 38-year-old Caucasian man found dead in an adult video store viewing room. Review of the store time records revealed that the man visited the store and returned to his vehicle six minutes later. After being at his vehicle for one minute, he returned to the store again. He was found alone in the viewing room approximately five hours later. No bottles or aerosol cans were found inside of the viewing room or on his person. Inspection of his vehicle revealed miscellaneous clothing, food containers, aerosol cans, construction equipment, and two child car seats. Several bottles of exercise supplements were in the center console of the car. It is unknown if any of the aerosol cans inside the vehicle contained ethyl chloride. There was no known prior illness or substance abuse history. His social history was unknown except the obvious visit to an adult video store.

An autopsy was performed approximately eight hours after death. His autopsy findings consisted of pulmonary congestion and edema (combined lung weight 1300 grams). The left ventricular wall of the heart was hypertrophied (1.4 – 1.5 centimeters in width). The major branches of the coronary arteries were without significant atherosclerotic change (less than 10% stenosis).

Ethanol, methanol, isopropanol and acetone were tested for by head space injection on a dual column gas chromatograph (Restek BAC-1, BAC-2). An unidentified peak with a set time of 1.156 minutes on the BAC-2 column eluted at 1.243 minutes on the BAC-1 column as an overlying peak with the same retention time as ethanol. Gas chromatographic/mass spectrometric analysis of blood and liver identified this substance as ethyl chloride. An alcohol dehydrogenase method (DRI Ethyl Alcohol Assay, Microgenics) was used for the quantitation of ethanol in the heart blood (0.09 g/dL), the urine (0.8 g/dL), and in the vitreous humor (0.07 g/dL). Cocaine metabolite(s), benzodiazepines, barbiturates, phencyclidine, amphetamine/methamphetamine, opiate(s), and methadone were not detected.

This case illustrates the importance of careful toxicological analysis and scene investigation in an instance where inhalant abuse was not suspected. Although ethyl chloride inhalation is not a common cause of death, it can be lethal when abused. The forensic community needs to be aware of its potential toxicity especially in cases such as this where there was no known history of "sniffing" or "huffing" and no obvious evidence of inhalant abuse at the scene.

Ethyl Chloride, Inhalant, Poppers

G26 Motorcycle Fatalities in the State of Vermont: 1995-2005

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The goals of this presentation are to: (1) investigate the etiology and demographics of motorcycle fatalities in the state of Vermont via review of Office of the Chief Medical Examiner (OCME) forensics reports and Fatality Analysis Reporting System (FARS) Web-Based Encyclopedia, (2) to provide recommendations on how to reduce motorcycle fatalities and/or serious motorcycle injuries in Vermont, and (3) to provide a model for similar analysis of motorcycle fatalities in other states.

This presentation will impact the forensic community by illustrating that nationwide motorcycle fatality trends are not necessarily the same as those seen at the state level. Analysis of motorcycle fatality data from the state of Vermont provides a practical example of how trends can be identified, and recommendations derived.

Motorcycle rider fatalities have been increasing nationwide since 1997, according to the National Highway Traffic Safety Administration reports. In the State of Vermont, the number of endorsed motorcycle operators increased by 7,550 from 1995-2005, and the number of motorcycle fatalities reported to the Office of the Chief Medical Examiner (OCME) doubled (8 vs. 16 cases). Through a combination of review of medical examiner reports, death certificates, hospital medical records, police reports, and Fatality Analysis Reporting System (FARS) Web-Based Encyclopedia, the OCME analyzed the 73 motorcycle fatalities who expired in Vermont from 1995-2005.

The majority of decedents (71%) held valid motorcycle licenses. None had completed the Vermont Rider Education Program (VREP) – a voluntary training program to improve motorcycle operator safety established in 1990—though one decedent had attempted, but failed the course. The state of Vermont has had a universal motorcycle helmet law since 1968, and the majority of decedents (89%) were wearing helmets. Three of these helmets, however, were not Department of Transportation (DOT) approved models. Of those with no helmets, drug and/or alcohol screens were positive forty percent of the time. Overall, thirty-eight percent of decedents had positive drug and/or alcohol screens. The average blood alcohol concentration (BAC) was 0.15%: in four cases, the BAC was less than the legal intoxication limit of 0.08%. Six decedents had a history of prior DWI convictions, and of these, five had elevated BACs at death. When examined in terms of decades, the largest group of fatalities occurred in the 20-29 year old population, though the 40-49 year olds represented the fastest growing group.

The majority of motorcycle fatalities were not attributable to poor visibility/weather, as most occurred during summer daylight hours on dry blacktop roads. Neither did traffic play a major role: in 86% of motorcycle fatalities, the roadways were classified as rural rather than urban, and in greater than two-thirds of cases, the rider was lone rather than in a group. In 51% of cases, the collision was with a stationary object (e.g. guardrail, tree, bridge). In 41% of cases, the primary impact was with other motor vehicles. In 3% of cases, an animal was involved (e.g., deer, moose), and in 6% of cases the primary impact site remains unknown. Excess speed and road curvature showed a positive correlation with fatalities: per police report, 52% of decedents were driving too fast for road conditions and/or legal limits, and greater than 70% of accidents occurred at road curves. In all cases, the cause of death was blunt impact injury—usually to the head—although concurrent spinal, thoracic, abdominal, and extremity injuries were often seen.

While many factors contribute to motorcycle fatalities, those which are most important in Vermont appear to be operator-dependant. Excess speed and drug/alcohol use are two major modifiable risk factors for motorcycle fatalities in Vermont. All operators should be strongly encouraged to enroll in rider safety courses where they can receive appropriate risk education. Public safety advertising should be targeted toward the 20-29 and 40-49 year old age groups.

Motorcycle, Crash, Fatal

G27 Progressive Isolated Hypoglossal Nerve Palsy and Sudden Asphyxial Death

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The goal of this presentation is to illustrate the direct connection between sudden asphyxial death and isolated hypoglossal nerve palsy secondary of his dissection resulting from cranial trauma.

This presentation will impact the forensic community by illustrating sudden death due to cranial nerve damage.

Unilateral hypoglossal nerve palsy is a rare clinical entity due to the lesions of the nerve in one of its segments (medullar, cisternal, of the base of the skull, carotid, sublingual). A Caucasian male who, during a struggle, received severe stab wounds to his head from a screwdriver resulting in hemorrhage of the perimesencephalic cistern and the frontal portion of the left cerebral ventricle. He was operated on to empty the cisternal hemorrage. He had a normal postoperative course but showed considerable deglutition's incapacity and dysarthria. A few months after surgery, the man died while eating secondary to asphyxia due to sudden obstructive lingual palsy; authopsy showed a hemorrhagic dissection of the hypoglossal nerve on his bulbar brainstem. This case report appears to be unique because the unilateral hypoglossal nerve palsy is not resulting from postoperative pneumocephalus (most frequently reported in literature), but rather from progressive axonal dissection just distal to its bulbar origin, caused by a cisternal hematoma resulting from cranial trauma. The resulting ipsilateral tongue palsy caused dysarthria and deglutition incapacity and occlusion of the proximal third of larynx by alimentary bolus. Incoordination of the muscles innervated by the hypoglossal nerve resulted in fatal acute asphyxia.

Stab Wound, Isolated Hypoglassal Nerve Palsy, Sudden Death

G28 Medico-Legal Importance of Posttraumatic Hypopituitarism

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The goal of this presentation is to inform the public of existance of hypopituitarism after traumatic brain injury and possible significance for both criminal and civil cases.

This presentation will impact the forensic community by demonstrating how some form of hypopituitarism occurs in 35% of patients with moderate to severe head injury.

Recent studies have demonstrated that different forms of hypopituitarism are common among survivors of traumatic brain injury (TBI) tested several months or years following trauma.

The results of endocrine evaluation in a group of 109 patients (68 male and 41 female, mean age 37.9±1.4 yrs.; body mass index (BMI) 24.8±0.5 kg/m^2) who had suffered moderate to severe TBI (Glasgow Coma Scale ≤13), at least one year prior to the assessment (mean 3.4±0.5 yrs) are presented. After fasting overnight, at 08:00, serum samples were taken for T4, TSH, FSH, LH, tesosterone (men), cortisol, and prolactin. GH/IGF-1 axis was evaluated by a provocative GHRH+GHRP-6 test and IGF-1 measurement, and results were compared with those from 85 healthy control subjects (59 male and 26 female, mean age 36.5±1.4 yrs, BMI 24.2±0.4 kg/m^2).

Three groups of TBI patients were formed based on the established normal peak GH cut-off (>20 mg/L) and cut-off for severe GH deficiency (<10 mg/L). These groups are defined as *severe GH deficient* (GHD, n=16, mean GH peak: 5.6±0.7 vs. 46.1±1.9 mg/L in healthy subjects; p<0.01), *GH insufficient* or the so called "grey zone" group (GHI, n=17, mean GH peak: 15.9±0.7 vs. 46.1±1.9 mg/L; p<0.01), and those with *normal GH secretory capacity* (GHS, n=76, mean GH peak: 44.4±2.4 vs. 46.1±1.9 mg/L; p>0.05). Results show that lower GH responses during the provocative test were associated with older age (p<0.01), higher BMI (p<0.01), lower IGF-1 (p<0.01) and the time since trauma (p=0.024), but unrelated to GCS scores (p=0.095), sex (p=0.628) or presence of traumatic subarachnoid haemorrhage (p=0.615). These results also indicate that 6.4% of TBI patients had hypogonadism, 2.8% had hypothyreosis and 2.8% had hypocortisolemia; also 5.5% had hypoprolactinemia and 2.8% hyperprolactinemia.

A significant number of patients (33.9%) express some form of hypopituitarism after traumatic brain injury, which is not related to severity of injury. From medicolegal point these observations might be significant both for criminal and civil cases.

Posttraumatic, Hypopituitarism, Medico-Legal

G29 Massive Fat Pulmonary Embolization Secondary to a Liposuction Procedure With Tumescent Technique Diagnosed Postmortem in an Embalmed and Buried Body

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After attending this presentation, attendees will understand that all deaths occurred during whatever medical surgical procedure where death is not expected should undergo a medico-legal autopsy and how to avoid problems and complications produced by previously embalmed and buried bodies with marked external and internal postmortem changes that obscure the true cause and manner of death. Attendees will additionally understand that, though an autopsy initially was not performed, a thorough, methodical postmortem investigation may be able to find the true cause and manner of death in many cases.

This presentation will impact the forensic community by serving as a methodical parameter in the evaluation and investigation of cases where the deceased was previously embalmed and buried without an autopsy initially being performed.

A case of massive fat pulmonary embolization diagnosed 80 days postmortem in a previously embalmed and buried body of a 32-year-old woman who underwent an elective liposuction plastic surgery with tumescent technique is presented. The patient received a pre-surgical medical and laboratory evaluation by a cardiologist who considered that the patient was healthy enough for the elective surgery. General anesthesia was administered and the liposuction procedure was performed without complications; however, at the end of the surgery the patient developed sudden cardiac arrest. Cardiopulmonary resuscitative measures were done with no response; simple chest x-rays were performed and showed suggestive changes of a thromboembolic pulmonary process. The patient was declared dead and the surgeon erroneously signed the death certificate with the cause of death was a cardio-respiratory arrest. The body was embalmed with formaldehyde and buried the next day with no performance of an autopsy. The plastic surgeon was sued for medical malpractice and the body was exhumed and autopsied 80 days later as evidence. In spite of the deceased being embalmed and buried previously with marked external and internal postmortem changes, the macro micro pathological findings correlated well with clinical symptoms, radiological changes, and toxicological studies and revealed that the cause of death was a massive pulmonary fat embolization, an inherent risk of the surgical procedure.

Pulmonary Fat Embolism, Fat Embolism, Liposuction

G30 Lethal Inhalation of Isomers of Butylene: A Case Report

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The goal of this presentation is to clarify the pathophysiology of butylene induced damage in humans by means of histological, histochemical and immunohistochemical investigation.

This presentation will impact the forensic community by serving as an educational resource on the pathophysiology and dangers of inhaling butylene isomers

There has been a steady increase in the number of deaths resulting from inhalation of volatile substances, which can be a suicide or an unintended consequence of "sniffing abuse". Intentional inhalation of a volatile substance indeed is an under-recognized form of substance abuse in children and adolescents with a high morbidity and mortality.

Fatal outcome of inhalant abuse has been discussed due to several mechanisms: suffocation, trauma after dangerous behaviour, vagal inhibition, respiratory depression and the "sudden-sniffing death syndrome" following cardiac arrhythmia. However, the reason of sudden death related to volatile sniffing is rarely clear even after toxicological analysis. In most cases, reported aerosol propellants, n-propane or n-butane or mixtures of n-propane, n-butane, and isobutane are involved.

Sudden death due to the inhalation of butylene isomers has not yet been described in forensic literature.

There are four isomers of butylene (α-butylene, cis-β-butylene, trans-β-butylene, isobutylene), which are all gases at room temperature and pressure, but can be liquefied by lowering the temperature or raising the pressure on them, in a manner similar to pressurized butane. These gases are colourless, but do have distinct odours, and are highly flammable. Although not naturally present in petroleum in high percentages, they can be produced from petrochemicals or by catalytic cracking of petroleum. There are few reports on the toxicology of this compounds in animals and humans; it is not clear if isomers of butylene can produce direct damage on lung endothelial cells or myocardial tissue like butane does, or if the injury is mediated by other mechanisms.

A 20-year-old male was found dead in his jail cell where a plastic bag and a portable cooking stove were present.

Forensic autopsy revealed cerebral edema, hemorrhagic edema of the lungs, and acute congestion of all inner organs. Histology (E&E) confirmed autopsy's results.

Toxicological analysis on the cooking stove gas and on biological specimens (blood and tissues) were performed. The cooking stove gas was formed by α-butylene (71%), cis-β-butylene (17%) and trans-β-butylene (12%). Lormetazepam (85 ng/ml), GHB (800 ng/ml) and isomers of butylene (α-butylene = 550 ng/ml; cis-β-butylene = 130 ng/ml; trans-β-butylene = 270 ng/ml) were determined in blood samples collected during autopsy.

The histochemical (Van Gieson and Azan Mallory) and immunohistochemical (myoglobin, actin, and desmin) investigations on myocardial samples showed interstitial fibrosis with acute necrosis and myocardial contraction bands.

The immunohistochemical examination (CD-34 and VIII factor) on lung specimens did not reveal endothelial damage.

These results suggest an acute electrical myocardial death due to adrenergic overdrive as a pathophysiologic mechanism of butylene induced sudden death.

To the authors knowledge, this is the first case study of sudden death due to the inhalation of isomers of butylene described in literature. The lack of knowledge of the exact biological effects of this compounds and the steady increase in the number of deaths resulting from inhalation of volatile substances need further investigations in toxicological and pathological fields.

Isomers of Butylene, Lethal Inhalation, Toxicology

G31 Lethal Neglect: A Case of Extreme Intrafamilial Child Torture

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After attending this presentation, attendees will have an understanding of some peculiar aspects of intrafamilial child neglect ending in death from starvation.

This presentation will impact the forensic community by providing forensic evaluation of lethal child neglect as a consequence of combining forms of malnutrition, maltreatments, and psychological abuse levied by parents.

Deliberate starvation of an infant/child is a severe and rare form of child abuse, especially in industrialized countries. The goal of this presentation is to highlight the importance of forensic assessment in complex cases of child homicide.

Child neglect can be defined as the failure of a caregiver to provide a child with the necessities of life, including physical safety and protection, food, hydration, clothing, shelter and medical care. Failure to fulfil these responsibilities may constitute active or passive neglect. Forensic investigation of lethal child neglect requires complete autopsy findings, full investigation of scene and case history, past medical records, family history, and social background.

This presentation reports a case concerning a female infant aged 16 months who was brought to the Emergency Department where physicians established she was already dead. They noted the child cachectic state and multiple bruises over the whole body. The child's mother stated she had not been eating well in the last week.

Autopsy showed the child weighed 5700 grams (12.6 pounds) for a length of 76 cm (29.9 inches); she was severely dehydrated with the muscles of head, face, trunk, lower and upper extremities flaccid, redundant, wrinkled skin, and resultant prominent bones. The orbital adipose tissue was essentially absent leaving sunken appearing eyes. Examination of the head revealed multiple abrasions and ecchymoses at varying healing stages and focal alopecia.

Multiple cutting stab wounds were present on the left auricle and on the neck. There were bruises located on the chest and on the upper extremities; radiographic examination revealed fracture of left forearm overlaying an old arm contusion. Decubitus ulcers were located on the lumbar area and pelvis.

The thymus had atrophied. The stomach and large intestine were empty and exhibited some ulcerative lesions; there was a very little stool in the rectum. The weights of most of the child's organs were markedly less than normal averages.

Microscopic findings showed acute bronchopneumonia, hepatic fibrosis and no glycogen in the liver on PAS (para-amino-salicylic acid) stain.

The child lived in a reconstituted family. The mother had two children from the first marriage and another one from the present husband. The victim was conceived during a brief affair between the mother and a man who left her soon after she got pregnant.

The other children were healthy and well nourished.

Home inspection revealed the victim spent all day sitting in a stroller located in the parents' bedroom and placed in front of the wall.

The parents confessed they fed her intermittently with water and sugar, small portions of milk occasionally adding breadcrumbs. Sometimes she ate leftover food from the other children. When the victim cried because she was hungry, the "caregivers" would beat her or throw objects (biberon, toys, etc.) from their bed at her head. The parents pled guilty and received life sentence.

In cases of malnutrition/starvation, only a complete forensic investigation may reveal that the caregivers history of the child not eating well for a few days, is hiding a case of extreme intrafamilial child abuse.

Starvation, Child Abuse, Parental Rejection

G32 Multiple Histories: A Statistically Significant Indicator of Non-Accidental Injury in Children

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After attending this presentation, attendees will be able to describe circumstances under which multiple histories are provided by caregivers and describe the validity of using multiple histories as a marker of non-accidental injuries in children.

This presentation will impact the forensic science community by allowing forensic scientists to have a scientific basis for the use of multiple histories as a marker of non-accidental injuries in children.

Forensic pathologists are increasingly being asked to state the bases for conclusions. How do we know that multiple histories are a marker of non-accidental injury in children? The early descriptive studies have shown that many shifting histories are associated with the "Battered Baby" syndrome, recently described as non-accidental or inflicted injuries in children. In individual cases, more than one history provided by the caregiver is excused as the result of a caregiver feeling "upset" at the child's injury and death, or simply a matter of providing an initially incomplete history. The usefulness of considering the number of caregiver histories in a variety of causes of death can be assessed by reviewing a group of child death investigations.

Examining the causes and manners of death, and the number of trauma histories for a group of 169 child deaths provides additional support for suspicion raised by multiple histories. Cause and manner of death and the number of trauma histories was gathered as part of investigations of a group of 169 randomly selected child deaths examined over a seven year period. The child deaths occurred as the result of non-accidental injury as well as motor vehicle collisions, falls, drownings, various asphyxial deaths, and natural diseases. Non-accidental injury was distinguished from accidental injury, undetermined causes, and natural disease by investigation of medical and social history, and circumstances surrounding collapse as well as autopsy findings.

The causes of death included: 11 asphyxias (6.5%), 13 central nervous system diseases (7.7%), 80 head injuries (47.3%), 8 drownings (4.7%), 3 heart diseases (1.8%), 5 infections (3.0%), 2 other disease deaths (one each: volvulus and dehydration, 1.2%), 11 respiratory diseases (6.5%), 13 Sudden Infant Death Syndrome (7.7%), 13 blunt force injuries of trunk (7.7%), and 10 undetermined (5.9%).

Only two of the asphyxial deaths were non-accidental injuries and in both, one trauma history was provided. In one it was a confession, the other was unrelated to the cause of death. Most of the head injury deaths, 61, were non-accidental. In 11, no history was provided. One and two histories were given in 21 and 22 cases respectively. "Multiple histories" (more than two) were found in seven death investigations: four cases had three histories, two cases had four histories, and one case had five. The 2nd through 5th histories were closer approximations of mechanisms of sufficient magnitude to produce the injuries found at autopsy. All of the trunk injury deaths were non-accidental. Five cases had no trauma history, six cases had one trauma history which was usually inadequate to account for the injuries found, but only two provided a second history.

Most (six) of the nine accidental asphyxial deaths had one adequate history to explain the injuries. In two cases no one knew what had happened, and in one other misinformation provided two histories. Most (sixteen) of the accidental head injury deaths had one adequate history. In three others a second history was needed to conclude that the explanation was adequate. All eight drownings had one adequate history.

Only two of forty-one natural deaths had even one trauma history. One child with a medulloblastoma had fallen off the couch a week prior to his collapse. The other child suffered a spontaneous subarachnoid hemorrhage and hit her head when she collapsed.

In this group, 31/76 (40.8%) with non-accidental deaths had two or more histories. For accidental and natural deaths (omitting the ten undetermined deaths), 4/83 (4.8%) had more than one trauma history. In a 2x2 table more than one history had a sensitivity of 40.8% for non-accidental injury deaths. The specificity of fewer than two histories and accidental or natural disease was 95.2%. The predictive value of non-accidental injury when many histories were provided was 88.6%. The predictive value of finding accidental or natural disease when fewer than two histories were provided was 64.8%. A Yates corrected Chi square is 23 with a P value of $<<0.01$ and odds ratio of 0.11 (with confidence interval of 0.04-0.58) for non-accidental injuries being found when fewer than two histories are provided by the caregiver.

Non-Accidental Injury, Multiple Histories, Child Abuse

G33 Recognizing Classic Metaphyseal Lesions in Child Abuse: An Autopsy Technique

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The educational objectives of this presentation are to review the difficulties associated with recognizing classic metaphyseal lesions in infants and to present a new autopsy technique which enables the visualization and documentation of these fractures.

This presentation will impact the forensic community by introducing a new autopsy technique developed to improve the recognition and documentation of injury pattern in child abuse.

Complete recognition and documentation of injury pattern is key in the diagnosis of child abuse. Classic metaphyseal lesions (CML) in infants are highly suggestive of child abuse but difficult to recognize. A CML is a planar fracture through the most immature portion of the metaphyseal primary spongiosa. It may occur as a partial or complete fracture and results in the epiphyseal cap separating from the metaphysis. In infants the primary spongiosa or newly formed trabecular bone at the chondro-osseous junction (COJ) is the weakest point of the long bone. The rapid rate at which the growing bone lengthens generates relatively thin and weak metaphyseal trabeculae. With age the growth rate decreases and the metaphyseal trabeculae become thicker and stronger. CML is typically the result of torsional and tractional forces applied in a direction perpendicular to the long axis of the bone as an infant is pulled or twisted by a limb, also by the acceleration and deceleration as an infant is shaken (Kleinman 1998).

A CML is difficult to recognize both in radiographs and at autopsy. Radiographically, a CML may appear as a radiolucency in the sub-physeal region of the metaphysis. However, it may not be visible in all views or if the trabecular disruption is insufficient (Kleinman 1998). Crawford and Al-Sayyad (2003) note that most distal tibia metaphyseal fractures are diagnosed as ankle sprains or strains on initial radiographs because no definite fracture can be identified. Furthermore, CML rarely causes hemorrhage at the fracture site or in the surrounding tissue. Subperiosteal new bone formation is not prominent at a healing fracture site. Histologically, a CML appears as a series of microfractures at the mineralized

regions of the distal zone of hypertrophic chondrocytes of the physis and a thin portion of the metaphyseal primary spongiosa, a difficult section to read (Kleinman 1998). In the healing bone, the CML may appear with chondrocytes deeper than expected within the primary spongiosa or as a broad region of thickened hypertrophic zone (Kleinman 1998).

As a result of the difficulty to recognize a CML, a new autopsy technique has been developed. The first step is to expose and visually examine the COJ of the long bones by cutting the muscle from the long bone ends and reflecting the periosteum. An acute CML appears as either an open fracture or a slight line of hemorrhage. A healing fracture may appear as an oddly shaped COJ. When a fracture is suspected but not obvious, the end of the long bone is removed and processed by soaking it in a water soap bath at a steady but elevated temperature (~60C) for 24 hours. The result is a metaphysis without the epiphyseal cartilage or periosteum. Partial and complete CMLs are completely visible grossly. This technique is far more invasive and time intensive than standard flaying of the dermis but yields excellent results and eliminates any question about the presence of a CML. This technique is recommended for all infant deaths in which a non-accidental traumatic cause of death is suspected.

Classic Metaphyseal Fractures, Child Abuse, Autopsy Techniques

G34 Comprehensive Molecular Genetic Testing for the Cardiac Channelopathy Genes in 42 Cases of Sudden Infant Death and Sudden Unexplained Death in the City of New York Revealed High Mutation Rate

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The goal of this presentation is to investigate the mutation rate of the channelopathy genes in the SIDS/SUDS population.

This presentation will impact the forensic science community by highlighting the importance of implementing molecular genetic testing for the channelopathy genes in routine SIDS/SUDS investigations to assist medical examiners in the determination of cause and manner of death.

Sudden infant death syndrome (SIDS)* and sudden unexplained death syndrome (SUDS)* are vexing challenges in the field of Forensic Pathology. SIDS and SUDS are recognized as complex and multifactorial, requiring interaction between genetic and acquired risk factors during sensitive developmental stages or growth phases. It has been reported that 2-5% of apparent SIDS/SUDS cases are in fact due to a group of cardiac arrhythmia syndromes, collectively called channelopathies, where at least eight causative genes are known. Since the channelopathies affect the cardiac electric conduction system and cause arrhythmias, the diseases leave no structurally demonstrable autopsy findings. Currently, the only available means to allow postmortem diagnosis of channelopathies is through the use of molecular genetic testing to detect mutations in the causative genes.

In order to investigate the mutation rate of the channelopathy genes in the SIDS/SUDS population, our laboratory has validated methodologies in genetic mutation analysis. Presented in this study is a comprehensive mutational analysis of multiple channelopathy genes: a cardiac sodium channel gene, *SCN5A*; three cardiac potassium channel genes, *KCNE1*, *KCNE2, and KCNQ1*; and a cardiac ryanodine receptor gene, *RyR2*. The study population consisted of 42 cases with the cause of death certified as "SIDS" or "undetermined" by the New York City Office of Chief Medical Examiner. The methods utilized were designed to be highly sensitive, specific, reproducible, cost-effective and high throughput. This was accomplished using DNA-based PCR and cycle sequencing analysis to detect any nucleotide changes in the protein coding region. Heart, liver and spleen samples were used.

In testing the *SCN5A* gene, five cases carried a known pathogenic missense mutation, S1103Y; one case carried a known pathogenic missense mutation L619F; two cases carried an unknown, but likely pathogenic missense mutation, P656L; and one case carried an unknown, but likely pathogenic missense mutation, I1837T. In testing the *KCNE 1&2* genes, we found that two cases carried two different known mutations, D85N (in *KCNE1*) and Q9E (in *KCNE2*). These two mutations previously have been shown to be associated with acquired Long QT syndrome. In testing the *RyR2* gene, the authors found that one case carried an unknown, but likely pathogenic missense mutation, G4471R. Genetic testing for *KCNQ1* gene is still in progress. All of the mutations identified in this study are heterozygous. Collectively, the pathogenic mutation rate is about 28% (12/42). Specifically, the mutation rate is most frequent in *SCN5A* gene 21% (9/42), while the mutation rates in other genes are less common.

This study highlights the importance of implementing molecular genetic testing for the channelopathy genes in routine SIDS/SUDS investigations to assist medical examiners in the determination of cause and manner of death.

* SIDS is defined as the sudden death of an infant under one year of age, which remains unexplained after a thorough investigation, including performance of a complete autopsy, examination of the death scene, and review of the clinical history.

* SUDS is the sudden death of an individual over one year of age and like SIDS, the death remains unexplained after a thorough case investigation, which includes performance of a complete autopsy, examination of the death scene, and review of the clinical history.

Molecular Genetic Testing, Channelopathy, SIDS/SUDS

G35 Primitive Neuroectodermal Tumor (PNET) Masquerading as Non Accidental Head Trauma in an Infant: Lessons for Multiple Disciplines

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After attending this presentation, attendees will understand the process of evaluating intracranial pathology in an infant and how to identify spontaneous as well as traumatic causes of intracranial hemorrhage, specifically, hemorrhage resulting from a supratentorial primitive neuroectodermal tumor.

The ability to discriminate not only between nonaccidental and accidental head trauma, but also between spontaneous and traumatic etiologies of intracranial hemorrhage, while keeping an open mind to all of the possibilities during the descision-making process, is among the most challenging of intellectual tasks that confront the froensic pathologist.

The appropriate recognition and accurate documentation of fatal nonaccidental craniocerebral trauma in infants and young children are among the most important contributions to be made by a forensic pathologist. Equally crucial, however, is the ability to identify both accidental causes of head trauma and spontaneous (nontraumatic) etiologies of intracranial pathology.

A rare cause of spontaneous intracerebral, subarachnoid, and subdural hemorrhage in a 3-month-old child resulted from a supratentorial primitive neuroectodermal tumor (PNET) with glial differentiation, emphasizing that not all forms of intracranial pathology are inflicted, or even traumatic. Furthermore, because the various interpretations of the imaging studies created significant controversy and disagreement regarding the assessment of the disease process findings, the potential problems that exist with neuroradiologic interpretations of lesions in this age group are emphasized.

An 11-week-old male infant presented to the MUSC Pediatric Emergency Department (ED) with a 2-day-long history of lethargy, decreased oral intake and urine output, and favoring of the left side of his

face. His mother stated that his left eye had appeared "abnormal" for the past few weeks. In the ED, he was found to have a bulging fontanelle and a fixed and dilated left pupil with a minimally reactive right pupil. Of note, prenatal history was unremarkable; he was born at 39 weeks gestation with 1- and 5-minute Apgar scores of 9 and 9. He had been essentially healthy up to his current presentation. A head CT scan demonstrated obstructive hydrocephalus and transtentorial herniation, prompting admission to the Pediatric Intensive Care Unit (PICU) with ventriculostomy placement for elevated intracranial pressure (ICP). However, he succumbed to refractory intracranial hypertension and was declared clinically brain dead on the 7th hospital day. Reports from imaging studies were notably discordant, with one interpreting the findings as "multiple trauma of varying ages", the other as a "mass". Autopsy revealed an extensively necrotic and hemorrhagic, supratentorial mass with resultant swelling, softening, and hemorrhage of the adjacent brain parenchyma bilateral thin-layered subdural hemorrhages accompanied by thin-layered subarachnoid hemorrhage, both overlying the cerebral convexities; subgaleal edema and hemorrhage confined to the ventriculostomy site; and anasarca with bilateral serous pleural effusions (15 mL each), and serous ascites (30 mL). There were no other injuries. The eyes were not examined. Microscopic examination of the subdural hemorrhage revealed predominantly red blood cells with rare fibroblasts, and sparse hemosiderin-laden macrophages, consistent with a recent origin (of ~6 days' duration). Sections of the mass demonstrated sheets of spindled to epithelioid cells with large, eccentric nuclei, punctate, "salt and pepper" chromatin, and inconspicuous nucleoli; some cells contained eosinophilic, smooth, "glassy" cytoplasm. The mass was accompanied by scattered hematoidin pigment and extensive, confluent necrosis. There was no significant nuclear atypia or vascular endothelial proliferation. An immunohistochemical battery employing antibodies to glial fibrillary acid protein (GFAP), synaptophysin, chromogranin A, vimentin, smooth muscle actin (SMA), pancytokeratin (AE1/AE3), low-molecular weight cytokeratin (CM 5.2), CD99, and epithelial membrane antigen (EMA) showed the tumor cells to express only GFAP and none of the other antigens. The collective histopathologic features and immunohistochemical profile of the tumor were most compatible with a PNET manifesting purely glial differentiation.

Sound critical thinking and an open mind on the part of the forensic pathologist when confronted with significant intracranial pathology in an infant is of great importance. Although the impressions of the imaging studies and the presence of bilateral thin-layered subdural and subarachnoid hemorrhages appropriately raised the suspicion of inflicted) head trauma, the identification of a reasonable underlying etiology for the hemorrhage, the absence of injuries to suggest a pattern of repeated abuse, and the mother's description of neurologic signs entirely consistent with increasing ICP collectively provided strong evidence of a nontraumatic etiology for this baby's condition.

Primitive Neuroectodermal Tumor, Nonaccidental Head Trauma, Infants and Children

G36 Sudden Death of a 17-Year-Old Boy Due to Suspected Williams Syndrome - A Case Report

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After attending this presentation attendees will be well acquainted with the external and internal findings/characteristics of the rare genetic syndrome – Williams syndrome which can cause sudden death in young population.

The presentation will impact the forensic community by the fact that every case of sudden death must be scrutinized carefully both by reveling all the circumstances of the case with collecting relevant heteroanamnestic data and need to perform thorough examination of the body (external and internal). Finally, in order not to have only suspicion on some genetic disorder such as Williams syndrome, but to confirm it with the highest certainty, it is necessary to assign the task to develop genetic tests like FISH.

Sudden and unexpected death is one of the frequent problems in common medicolegal practice, which attracts special attention when it pertains young and previously apparently healthy individuals. One of the potential causes of such death could rarely be Williams syndrome (WS) due to specific cardiovascular abnormalities. This syndrome was initially described by Williams et al. in 1961, and Beuren et al. explained the phenotype. WS is a sporadic genetic syndrome, with an estimated incidence of 1 in 20.000 live births, caused by a deletion of elastin gene and other contiguous genes at chromosome 7, with variable phenotypic expression, associated with dysmorphic facies, neurological manifestations, idiopathic hypercalcemia, and cardiovascular features, particularly supravalvular aortic stenosis. Namely, more than 90% of the patients with WS exhibit a submicroscopic deletion spanning at least 114 kb, at 7q11.23. Hemizygosity of the elastin gene could account for all connective tissue, especially the vascular, abnormalities seen in WS.

The case concerns the 17-year-old boy who was playing with his brother in the yard of their family house during wintertime, when he suddenly fell down to the snow and died shortly after. Hetero-anamnestically, his mother stated that in his childhood, the boy suffered from abdominal pains periodically, denying however, any illness diagnosed by the physicians. In addition, she mentioned his constant problems with learning and relationship with his friends as well (slight mental retardation and nervousness). Since the boy had not been medically examined, no other clinical data could be obtained. At the autopsy, external examination revealed elfin face with short and slightly upturned nose, long filtrum and very bad dental condition – black-greenish coloration of the crowns of the front teeth. There were no signs of mechanical injuries on the body. Internal examination showed severe narrowing (the circumference 4 cm) of the ascending aorta, some 4 cm above the semilunar valves (supravalvular aortic stenosis) with mild enlargement of the heart, weighted 340 grams and significant thickening of the left ventricular myocardium, measured 2,3 cm. With exception of hypertrophy of the myocardial fibers, the histological findings disclosed no pathological abnormalities in all other organs. Toxicological screening was negative. Primarily based upon the internal findings along with case circumstances, in the autopsy record it was inferred that death of the teenager was of natural manner, the most probably due to inherited cardiovascular abnormalities (narrowing of the aorta and hypertrophy of the left ventricular myocardium). Regardless the fact that the case had been solved concerning manner and cause of death, yet the forensic pathologists posed a question to themselves – what might be the origin of such peculiar combination of external and internal autopsy findings. The attention was focused on his specific facial appearance together with the cardiovascular status and obtained heteroanamnestic data, which raised a suspicion on Williams syndrome.

Since WS is a genetic disorder, besides the above mentioned clinical manifesations and morphological findings, for definite diagnosis it is necessary to perform specific genetic analysis - the FISH test, which is a type of specialized chromosome analysis utilizing specially prepared elastin probes. Unfortunately, at the moment, neither the Institute of Forensic Medicine in Novi Sad, nor that in Belgrade is equipped for such test.

Williams Syndrome, Sudden Death, FISH Test

G37 Sudden Cardiac Death in Professional Sports Persons: Natural vs. Anabolic Steroid Induced Lesions, and Experimental Rabbit Model

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The goal of this presentation is to report the anabolic steroid-induced cardiac lesions in professional sports-persons and in experimental study (rabbit model).

This presentation will impact the forensic science community by demonstrating how controlling or banning doping in professional sports being unfeasible in the present state of affairs, however, associating apoptosis inhibitors might hold out hope of limiting the incidence of severe evolutive cardiac lesions.

Anabolic steroid-induced cardiac lesions in professional sport-persons are compared with a rabbit model. Out of 15,000 forensic autopsies performed on coroner's orders over a 24-year period (Jan 1981-Dec 2003) in the area of Lyon, France (population: 2,000,000), WHO criteria identified 2,250 cases of unexpected sudden cardiac death. Among these, 120 were found to have occurred during recreational sport and 12 in professional sports persons. In the latter category, the associated cardiac lesions were primitive: natural in 6 cases, and, according to inquest findings, induced by anabolic steroids in the other 6. To shed light on the induced lesions, animal experiments were performed, administering Norethandrolone to rabbits which were then sacrificed and subjected to pathologic examination and caspase-3 assay by fluorometry on cardiac fragments.

The natural primitive lesions were classical for such cases. The anabolic steroid-induced lesions comprised coronary thrombosis associated with left ventricle hypertrophy and lesions analogous to toxic or adrenergic myocarditis. The same lesions were found, to varying degrees, in the rabbit models, which showed significantly elevated Caspase-3 activity as compared to controls. Anabolic steroids would seem, to varying degrees, to induce lesions analogous to those found in myocardiopathy and toxic myocarditis. Their elevated Caspase-3 activity makes these lesions apoptotic in nature.

Doping, Cardiac Lesions, Apoptosis

G38 Cocaine Skin Popping: A Fatal Case

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The death of a "skin popper" cocaine abuser is presented. Postmortem findings and cocaine distribution in fluids and tissues are discussed. The goal of this paper is to show an unusual fatal case of cocaine consumption.

This presentation will impact the forensic community in the contribution of a careful crime scene investigation, toxicological and histological examinations in drug-related death in order to clarify the exact mechanism of the death.

The most common routes of cocaine abuse are by inhalation, snorting, and intravenous injection. Cocaine skin inoculation is rare and it's used to ovoid track marks or when peripheral veins are sclerosed and the addict, unable to access a peripheral vein, injects substance by mistake or deliberately, in subcutaneous tissue and muscle. Deliberate subcutaneous injection (skin popping) is also used to avoid track marks which represent stigmata of drug addiction.

On 3 September 2006 at 5 p.m., a car was discovered in a parking isolated area in the outskirts of Foggia, Italy, far from urban traffic. A dead man was seated in the driving seat, he had seatbelt fastened, and he lay down on the right hip. The deceased, a young adult man, was fully and tidily dressed, and was identified as a 29-year-old local resident. The car engine was turned off. The car keys were in the ignition in the "off" position, the windows were closed and the doors were locked from the inside: no damage was observed inside or outside the car. On the floor of the car near the anterior right seat, there were five empty small packages; a cigarette filter; a syringe full of 1 milliliter of brownish liquid, its needle was smeared with dried blood. Remote from the body, near his head, on the anterior right seat, there were a small metallic spoon, a needle plastic cap, and two other plastic packages full of white power. The thanatological data recorded by the forensic pathologist called to the scene (5:30 p.m. of 3 September 2006) stated that at the time of discovery, the cadaver showed rigor mortis, and hypostasis that was partly mobile on digital pressure, but congruous with the position.

At the external examination, the left arm showed a round atrophic scar and left forearm an healing ischemic ulcer. The right antecubital fossa had pigmented pop-scars and swelling of the soft tissue with a necrotic area and two needle punctures; the upper one was surrounded by an extensive ecchymosis, the entire area measured cm 7x5.5.

A complete autopsy was performed 48 h after death. Internal examination revealed that the heart weighed 450 g, measured 14x13.5x5cm. The coronary arteries, the myocardium and the valvular apparatus were normal. All the other organs did not show specific alterations except for an intense vascular congestion.

Routine histological investigations, applying hematoxilin and eosin staining, were performed on all organ samples. Lung sections showed massive pulmonary oedema. Myocardium presented foci of fragmentation of entire myocytes in anomalous cross bands formed by segments of hypercontracted sarcomeres and myofibrillar rhexis. The histological examination of the skin section, collected in right cubital fossa, showed a loss of the upper epidermal layers and accumulation of leukocytes, in particular polymorphonuclear neutrophils, and erythrocytes in deeper epidermal and dermal layers. All these skin findings suggested for typical necrotizing ulcers. The examination of other organs was unremarkable except for brain edema and generalized haemostasis.

Cocaine was detected in the subject's urine through immunoenzymatic screening. Toxicological analysis by solid–liquid extraction and gas chromatography–mass spectrometry (GC–MS), was carried out to identify and quantify the individual substances present in the biological fluids and organs. Total cocaine concentrations were as follows: blood 4.08 mcg/mL/g, liver 10.19 mcg/mL/g, brain 6.19 mcg/mL/g, urine 57.00 mcg/mL/g, and bile 17.72 mcg/mL/g. No other drugs or alcohol were detected.

The toxicological analysis of empty and full packages demonstrated that the white power was cocaine and quinine (used as an adulterant), and the brownish liquid in the syringe, collected in the car, was positive only for cocaine. According to the crime scene data, autopsy and histological and toxicological findings, death was attributed to a fatal arrhythmia during cocaine skin inoculation.

In cocaine skin inoculation, cutaneous necrosis and necrotizing ulcers may develop as a result of several combined factors, including "skin popping", toxicity and the irritant properties of the drug and adulterants, vascular thrombosis, and infection. Quinine used as an adulterant has known caustic effects. In addition cocaine has potent vasoconstrictive and thrombotic effects. Various mechanisms such as cocaine-related increase in plasma lipids, direct and indirect increase in endothelial permeability, higher prevalence of mast-cells and other inflammatory cells in plaques may contribute to the lesions. Typical are round atrophic scars, clustered predominantly on the arms and legs, frequently seen in intravenous drug abusers, particularly cocaine abusers. These may represent healed abscesses, healed ischemic ulcers due to vasoconstrictive effect of cocaine, or the direct toxic effects on capillary endothelium.

Cocaine, Skin Popping, Necrotizing Ulcer

G39 Erroneous Diagnosis of Cadmium Poisoning Based on Postmortem Toxicology

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The goal of this presentation is to investigate the interpretation of cadmium levels in postmortem blood specimens.

This presentation will impact the forensic science community by demontrating how the observed evaluation of elevated levels of cadmium in postmortem specimens may lead to an interpretation of accidental or intentional poisoning for what is actually a poorly described artifact of cadmium pharmacokinetics. Lack of knowledge of this artifact can lead to various effects ranging from unnecessary exhumations to civil and criminal legal cases.

In 2004, county coroner (County A) in Pennsylvania ordered a heavy metal screen on an autopsy case to investigate a case of suspected poisoning. The only analyte that was abnormal was markedly elevated cadmium. Suspicion of either accidental or intentional poisoning caused the coroner to order 26 additional postmortem heavy metal studies as well as an exhumation. A comparative population study of cadmium levels was performed on a representative living population in the same community, along with a postmortem study of a similar autopsy population. These studies confirmed that the observed elevations of cadmium were postmortem artifact.

The laboratory results of cadmium were compared for the following study groups: (1) twenty seven (27) cases of postmortem cadmium analysis performed for the Coroner of County A as part of his investigation of possible poisoning, (2) nine (9) analyses of a separate autopsy population in a nearby county (County B) that has a similar demographics and incidence of possible industrial cadmium exposure, and (3) forty seven (47) analyses of a living out-patient population at the major medical center in County A.

The average measured cadmium values were as follows:

- Coroner's cases of County A - 110µg/L
- Coroner's cases of County B - 66.6µg/L
- Control (Out patients County A) - 1.5µg/L

Applying a t-test to these results reveals no significant difference between the two autopsy populations. The difference between the postmortem studies in County A and the living control population of the county is significant to a p-value of 0.003.

Cadmium is a well described human toxic agent. Almost one hundred years of research based on industrial exposures has allowed precise and extensive knowledge of toxicology of the compound. Cadmium is associated with renal and pulmonary toxicity and is considered to have carcinogenic effects. Chronic environmental exposure in Japan, in the 1950's, led to the development of *itai-itai* disease. Normal ranges for cadmium are from 0.3-1.2µg/L in non-smokers to 0.6-3.9µg/L in the smoking population. The 1991 OSHA standard for cadmium defines a blood cadmium value of 5.0µg/L as an action limit for exposed workers. Despite its chronic toxicity, cases of acute poisoning due to cadmium are exceedingly rare and occur mostly in the context of acute fume inhalation in industry or suicidal ingestions. Even in these cases measured blood cadmium levels rarely exceed 30µg/L. Thus all the evidence suggests that the observed, massive elevation of postmortem cadmium was an artifact. This has been described only once before in the medical literature, in an environmental journal. It is mostly likely due to a postmortem disassociation of cadmium from its *in vivo* transport protein metallothionein.

Forensic practice relies heavily on the interpretation of postmortem chemistry values for the determination of cause and manner of death. Although this can often be a straight forward process, it requires knowledge of numerous artifacts. In the case at hand, an erroneous interpretation of these cadmium values could have easily led to considerations of either intentional or accidental poisonings.

In this particular part of the country, cadmium is still used in industrial processes and the possibility of environmental contamination was considered. A well controlled and efficient population study confirmed that the observed values were a postmortem artifact.

Cadmiun, Artifact, Postmortem

G40 The Continued Role of Over the Counter Drugs in Drug Related Deaths

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After attending this presentation, attendees will better understand the epidemiological characteristics of over-the-counter (OTC) drug deaths.

This presentation will impact the forensic community and public health agencies by: (1) serving as a reminder of the continued dangers of the publicly-perceived safe OTC drugs, and (2) the epidemiological trends of who is most likely impacted by these drugs which may help in creating public health safety messages and prevention strategies.

All cases from 2001-2005 in which OTC drugs contributed to the decedents' deaths were analyzed. The OTC drugs, in order of prevalence, were diphenhydramine, acetaminophen, dextromethorphan, chlorpheniramine, salicylate, ethylene glycol (not an OTC drug but included in analysis), ibuprofen, methanol, ephedrine, and naproxen. All 292 cases were investigated by the Virginia Office of the Chief Medical Examiner (OCME). The data extracted from the OCME database included age, sex, race, manner of death, residency, and toxicological results. OTC deaths were categorized into 5 types: OTC alone, OTC with prescription drug(s), OTC with illicit drug(s), OTC with prescription and illicit drugs, and OTC with carbon monoxide. Virginia residents were analyzed separately to obtain rates.

Considering all drug poisonings, males tend to shoulder the burden of drug-related deaths with an overall ratio of 1.8 to 1 compared to females. For accidents the ratio is 2.4:1 for males to females. Males and females have a similar amount of suicides via drug poisonings (1:1.1). These trends change when looking at the role of OTC drugs. The female/male ratio is 1.45:1 and this ratio stays very similar when examining both accidents and suicides.

Suicides accounted for 51.4% of the OTC deaths, accidents for 46.6% and undetermined for 2%. The combination of OTC with prescription drugs accounted for 66.8% of OTC deaths. Interestingly, OTC alone deaths were almost 3 times higher in suicides than accidents while OTC with illicit or OTC with prescription and illicit drugs were 5 and 4.2 times higher, respectively in accidents than in suicides. Ethanol involvement was found to contribute to death in 16.1% of cases, in 50% of the OTC with illicit drug deaths and in 17.2% of the OTC alone deaths.

Virginia residents accounted for 95.2% (N=278) of the OTC drug deaths. The rate of all OTC drug deaths is 7.5 per million Virginia residents with female rates of 8.9 per million compared to 6.1 for males. Whites carried the burden of these deaths with a rate of 9.1 per million, which was 3.4 times that of blacks and 5.2 that of Asians. The highest burden of OTC deaths was in the 35-34 and 45-54 age groups with almost 2 times the rate of any other age group. Remarkably, the rate for the infant age group (<1 year old) was 4 per million.

While most of the OTC drugs were all found in accidents, suicides, and undetermined cases, some OTCs were detected in a higher percentage of a particular manner than the others. Acetaminophen (70.9%), salicylate (77.8%) ethylene glycol (85.7%), and ibuprofen (88.9%) were found more frequently in suicides than accidents. Additionally, women were 3 and 1.8 times more likely to have used ibuprofen or acetaminophen, respectively than males as all or part of their suicidal drug poisoning. However, males were 3 times more likely to use ethylene glycol than women and also accounted for all the suicides due to diphenhydramine, alone or in combination. Chlorpheniramine (70.8% of all usage) and dextromethorphan (66.7%) were more frequently associated with accidents than suicides. Males were two times more likely to accidentally use ephedrine than females.

In conclusion, OTC drugs continue to be a source of both accidental and suicidal deaths. Women are at a higher risk than men of dying from OTC drugs either alone or in combination with other drugs. Whites also have a higher rate of using a lethal amount of OTC drugs than other races.

OTC Drugs, Drug Deaths, Virginia

G41 Exceptional Suicide by Sharp Force During Mefloquine Therapy: A Case of Drug Induced Psychosis?

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The goal of this presentation is to present a case report about a special suicide.

This presentation will impact the forensic science community by assisting in the understanding of drug-induced psychosis.

Suicide by stabbing to the head and/or driving sharp objects into the skull is of extreme rarity. This paper reports the case of a 27-year-old man, who committed suicide by multiple knife stabs and cuts to the head, torso and upper limbs.

A 27-year-old man was found dead at home, lying on his bed. Doors were locked from the inside, and there was no evidence of violence in the flat. The deceased was completely naked, with abundant bloodstains on the whole body surface. The 10-cm long handle of a kitchen knife, also stained with blood, was present near the corpse with the blade broken at *ca.* 1 cm from the guard. The rest of the blade was apparently missing. According to cadaveric signs and police findings, death was likely to have occurred the day before. Autopsy showed two superficial cuts at the lower, anterior part of the neck, two stab wounds in the right temple, one stab wound in the precordium area, one cut at the top of right shoulder near the acromion, one cut at the anterior side of right forearm, one deep complex cross-shaped incised wound at the anterior side of left forearm and wrist a perforating wound of the skull, the 10-cm long broken blade of the knife being still embedded in the right temporal lobe of the brain. The deceased had no history of psychiatric illness but was currently treated by mefloquine, a quinine derivative associated with a high rate of psychiatric side-effects. Toxicology confirmed a recent intake of mefloquine together with chloroquine, another antimalarial drug.

Acute psychiatric reactions, in particular depressive disorders, have been reported as a side-effect of a wide array of medications, including non-steroidal anti-inflammatory drugs, antihypertensive drugs, anticonvulsants, steroids, or antimalarials. Among this latter group, Mefloquine distinguishes itself by a high prevalence of various psychiatric side-effects pointed out during the early postmarketing period. In 1989, the World Health Organization commissioned an investigation that confirmed the existence of such complications, with a prevalence estimated at 4.2/1000 treatments. In 60% of reported cases, disorders appeared after the first intake of mefloquine. Serious complications were noticed only for curative treatments with doses equal to or greater than 1000 mg. To the authors knowledge, this is the first report of a completed suicide with very strong evidence of mefloquine implication. In the present observation there is a very strong presumption that mefloquine was a causative, or at least contributive, factor in the victim's suicide. This statement is supported by the extraordinary method used to commit suicide, the absence of psychiatric history in the victim, whereas most suicides par sharp force to the head have been reported in mentally disturbed patients and prison populations, the close temporal relationship between suicide and mefloquine intake, as documented by the detection of the drug in postmortem samples. In the present observation a contributive role of chloroquine coingestion is difficult to assess because psychiatric side-effects encountered with this drug are much more unfrequent than with mefloquine. However it may be noteworthy that at least one severe reaction, including paranoia, hallucinations and suicidal ideation, has been reported in a subject without psychiatric history and successively treated by mefloquine then by chloroquine. Discussion focuses upon mefloquine-induced psychiatric disorders and highlights the importance of performing toxicological investigations in cases of 'unusual' suicides.

Although such events fortunately remain quite infrequent, forensic pratictioners should keep in mind the possibility of drug-induced psychoses and depression, and toxicological analyses should be the rule in 'unusual' suicides especially in subjects with no known psychiatric history.

Mefloquine Psychosis, Suicide, Sharp Force

G42 Determination of β — Phenylethylamine Blood Levels in Carbon Monoxide Intoxicated-Related Fatalities

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The goal of this presentation is to study the β-Phenylethylamine (PEA) blood levels and its metabolic enzyme, an oxygen-dependent monoamine oxidase B (MAOB), during the hypoxic status induced by carbon monoxide intoxication cases with or without oxygen resuscitation.

PEA, a specific substrate of MAOB, is a biogenic amine that acts as a sympathomimetic amine through its release of dopamine. The rate-limiting step of the MAOB activity of monoamine deamination is a highly oxygen-dependent phenomenon. Carbon monoxide (CO) has a high affinity for hemoglobin that is about 200 times greater than oxygen. CO causes a decrease of the oxygen-carrying capacity of the blood and induces a hypoxic, irreversible status even after re-inhalation of oxygen during resuscitation. The hypothesis is that reduction of the activity of MAOB during the hypoxic status could cause an accumulation of PEA and may be associated with the duration of hypoxic and agonal status. Elevation of PEA blood levels in asphyxia-related fatalities may be related and can be reversed after additional oxygen resuscitation.

A retrospective study consisting of 67 cases of carbon monoxide poison-related fatalities and 121 control cases of CO-unrelated asphyxia and cardiogenic fatalities were collected from the Institute of Forensic Medicine, Ministry of Justice during a medicolegal investigation in Taiwan. Gas Chromatography/Mass Spectrometry was performed to determine the PEA concentrations of each victim's blood. Carboxyhemoglobin (COHb) saturation was determined by Oximeter. Data are reported as mean ± standard error mean (SEM). The statistical analyses were carried out with ANOVA by SPSS and p values of less than 0.05 were considered to be statistically significant in this study.

Base on COHb saturation levels, PEA blood levels of groups of COHb 20-50%, 50-70%, and higher than 70% were 140.72±41.81 (n= 16), 107.34±25.63 (n= 26) and 66.36±18.03 (n= 25) ìg/ml, respectively. The PEA blood levels of asphyxia cases (including strangulation and suffocation) recognized as non-CO intoxicated-related fatalities with and without resuscitation were 1.6 ± 0.4 ìg/ml (n= 11) and 31. 7 ± 6.3 ìg/ml (n= 48), respectively. The PEA blood levels of CO poison related fatalities with and without resuscitation were 64.75 ± 32.42 ìg/ml (n= 9) and 105.49 ± 17.47 ìg/ml (n= 58), respectively. The mean PEA concentrations in the blood of strangulation and suffocation cases were 83 and 98 fold higher than those of control values, respectively.

In comparison with medical rescue group with decreases in the PEA levels of non-CO intoxicated fatalities during oxygen resuscitation, the CO intoxicated cases with and without resuscitation both have significant elevations in the PEA level. These results reveal that the reversible MAOB activity during oxygen resuscitation can be blocked by the CO saturation of hemoglobin. The high affinity between CO and hemoglobin molecules and the sequential blocking of the oxygenation of hemoglobin can elevat the blood PEA of CO-intoxicated cases without reactivation of the MAOB activity after sequential oxygen re-inhalation. In conclusion, the PEA can play a crucial role of vital reaction in asphyxia-related fatalities. This study strongly supports that the pathological elevation of PEA in the blood during a hypoxic-agonal status can be reversed by oxygen resuscitation but not in CO-intoxicated fatalities.

β-Phenylethylamine, Asphyxia, Biomarker

G43 The Development of a Model to Assess the Effects of Conducted Electrical Weapons in a Stressful State

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This presentation will educate attendees on the safety of conducted electrical weapons (CEWs) that are used in a physiologically stressful state by examining their effects on swine that are hyperthermic, tachycardic, hypotensive and have elevated catecholamine levels.

The research findings presented will impact the forensic science community in guiding policy related to the use of CEWs in given operational scenarios. In addition, knowledge related to the physiological effects of CEW use in compromised individuals is useful to emergency medical personnel for determination of proper medical treatment and the development of treatment protocols.

Although the effects of CEWs on healthy, anesthetized swine appear to be transient, persons that are subjected to repeated exposures of a CEW are most likely in an agitated or combative state. This stimulation could lead to a phenomenon known as excited delirium. In order to determine whether severe physiologic stress in combination with the use of a CEW would cause a serious adverse physiological effect a controlled hemorrhage along with external warming was performed. The hemorrhage was conducted to induce tachycardia, hypotension and catecholomine release as a compensatory mechanism. These signs, along with hyperthermia, are associated with excited delirium.

Preliminary data was gathered in order to assess the effectiveness of the proposed methodology to simulate a state of excited delirium. Three male swine (44 kg +/- 0.8 kg) were included in the study and one additional "sham" (43.4 kg) to observe the effects of the stress only. Under a surgical plane of anesthesia (2%-3% isoflurane) the animals were instrumented and subjected to hemorrhage and hyperthermia. Hemorrhage was induced using the Wiggers model in which blood is removed from the pig until a predetermined mean arterial pressure (MAP) is reached. The average baseline pressure prior to hemorrhage was 70 mmHg. For the proposed effort, it was determined that a MAP of 45 mmHg was sufficient in causing a stress from the blood loss. The swine were covered in a warming blanket to bring their core temperature up to 108°F. The normal temperature for the swine is 101° - 103°F (2.4° - 4.4° higher than humans). This increase in core body temperature is consistent with the sign of hyperthermia often observed in the field and previously described. Exposures to a CEW were given 20 times (4 sets of 5 exposures) in 30 minutes. Cardiac and pulmonary parameters were continuously monitored and blood samples were collected before and after each set of exposures and at one hour intervals for four hours.

The MAP decreased from its baseline value to 39.8, 43.7 and 44.3 mmHg for each of the three animals subjected to exposures. Heart rate increased on average from 112 to 185 beats per minute after the hemorrhage for the three animals subjected to exposures while the sham increased from 100 to 168 beats per minute. As expected, the heart rate remained elevated for the entire study for all animals. The baseline pH (7.44), PCO_2 (41.4 mmHg) and lactate (0.79 mM/L) values recorded were within the normal average values previously reported for swine. The pH decreased slightly after hemorrhage for all in the exposed group to 7.38 and all three in the exposed group became acidodic during the exposures (average 7.25). Blood lactate increased above normal after the hemorrhage to 3.78 and increased further after each set of exposures to 8.93 mM/L. Compared to a previous study in which the same device was applied on healthy, anesthetized swine, these animals were more acidodic and had a greater increase in blood lactate.

This model successfully created a physiologically stressful state similar to excited delirium. The warming blanket induced an increase in core body temperature and the hemorrhage induced tachycardia, hypotension and dehydration. Epinephrine and norepinephrine were not directly measured in this preliminary study however, a compensatory mechanism of hypovolemic shock is a rise in these levels.

Electrical Weapons, Tasers, Less-Lethal Weapons

G44 Exsanguination Due to Disruption of the Left Popliteal Artery and Vein Due to Posterior Dislocation of the Left Knee Prosthesis: A Case Report and Review of the Literature

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The goal of this presentation is to report a case of a 75-year-old woman who died from an exsanguination due to disruption of the left popliteal artery and vein secondary to posterior dislocation of the left knee prosthesis.

This presentation will impact the forensic community because it is a unique case of unexpected death due to posterior dislocation of the knee prosthesis.

Dislocation after primary total knee arthroplasty is a rare but serious complication. Knee prosthesis dislocation results in disruption of soft tissue, palsy of the sciatic or common peroneal nerve and rarely disruption of the popliteal artery causing ischemia. Reported here is a case of a 75-year-old woman who received bilateral knee arthroplasty. Posterior dislocation of the left knee prosthesis occurred seven years after operation. Dislocation resulted in disruption of soft tissue and left popliteal artery and vein. She died from exsanguinations due to disruption of the left popliteal artery and vein.

Exsanguination, Total Knee Arthroplasty, Knee Prosthesis Dislocation

G45 What Lies Beneath: An Unusual Congenital Anomaly in an Assault Victim

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This goal of this presentation is to describe an unusual and unexpected cervical vertebrae anomaly in a victim of assault and discuss its significance in the setting of a homicide.

This presentation will impact the forensic community by reviewing the importance of a posterior neck dissection in blunt trauma victims and by illustrating the importance of on-site forensic anthropology services.

A 22-year-old black male was physically assaulted by another male after an incident on a roadway. The victim became unresponsive immediately after the assault in which he was struck multiple times on the head and torso by the suspect's fists. No other weapon was utilized and the fight was witnessed. The incident lasted only a few minutes and the suspect left the scene, unaware that his victim had collapsed. Emergency personnel responded to the scene within minutes and despite aggressive cardiopulmonary resuscitative measures, the victim was pronounced dead at the hospital shortly after arrival.

The victim was obese, weighing 309 pounds with a body length of 71 inches (body mass index of 43.1). External examination revealed a few facial and extremity abrasions and contusions. Internal examination revealed a 3½ inch subscalpular hemorrhage over the left parietal bone and no other traumatic injuries, specifically, no subarachnoid hemorrhage. Incidentally, the decedent was found to have a urogenital anomaly comprised of fusion of the kidneys which were located in the pelvis. The heart weighed 475 grams and was mildly dilated. The coronary arteries had a normal distribution and no atherosclerosis. A complete back dissection performed to delineate any subcutaneous hemorrhage that may have been obscured by lividity was negative. A posterior neck dissection was performed which revealed focal hemorrhage around the upper cervical spinal cord between the first and second vertebral bodies, which were abnormal due to the presence of lateral foramina at the level of the first vertebral pedicles. Further dissection ensued with the assistance and guidance of our on-site forensic anthropologist.

The first through third cervical vertebrae were completely excised in order to examine and document the course of the vertebral artery. A small

amount of adventitial hemorrhage was noted at the level of the second cervical vertebrae; however the artery wall was intact throughout. A small epidural hemorrhage was identified over the posterior aspect of the cervical spinal cord at the level of the first cervical vertebra. The vertebral arteries were removed and submitted for microscopic examination by the pathologist and the forensic anthropologist cleaned and examined the cervical vertebrae.

An atypical bilateral vertebral artery course was observed in the vertebrae. The vertebral arteries passed superiorly through the second vertebral transverse foramina, turned nearly 90 degrees and took a posterior course, doubled back at the level of the first vertebral laminae, then took a second 90 degree turn to pass through the first vertebral transverse foramina and continued superiorly into the cranium. The associated anomalous skeletal characteristics together result in an acutely angled course through which the vertebral arteries pass into the skull.

Microscopic examination of the vertebral arteries revealed fragmentation and degeneration of the elastic laminae, which was confirmed with an elastin stain.

This degeneration is felt to be a 'wear-and-tear' type phenomenon due to the abnormal course of the arteries through the vertebrae. Microscopic sections of the heart revealed myocyte hypertrophy and patchy interstitial fibrosis. Toxicology was negative.

Concomitant renal and cervical vertebrae anomalies are not uncommon and are seen in syndromes such as Klippel-Feil in which there are fused vertebrae and varying kidney abnormalities. The association between the urogenital system and the skeletal system occurs during the early embryonic stages of development. During the 4th and 5th weeks of development, the start of renal development occurs in the cervical region of the embryo and then extends caudally. Any interruption in this stage of development can result in anomalies involving the spine, kidneys and/or scapulae.

The vertebral artery course and microscopic appearance are quite abnormal; however are insufficient to account for the sudden death of this young man. Given the circumstances of the witnessed collapse following the physical altercation, the manner of death was ruled a homicide and the cause of death was determined to be sudden death following physical altercation.

Congenital Anomaly, Vertebral Artery, Cervical Vertebrae

G46 Forensic Pathology of the Rupture of an Enlarged Spleen

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The goal of this presentation is to demonstrate the importance of the complete autopsy examination of bodies in whom death resulted from the rupture of an enlarged spleen. The causes of the splenomegaly can be determined. The mechanism causing the rupture can be determined i.e., if the rupture was spontaneous of resulted from violence. The "thin skull'' iegal concept is relenent in these cases.

This presentation will impact the forensic community by drawing the attention of medical examiners to the various forensis medical aspects of deaths that can result from the rupture of enlarged spleens.The importance of complete autopsies in these cases will be clear. The autopsy will reveal the many different circumstances in which ruptures of the spleen are likely to occur.

Rupture of the spleen causes profuse intra-abdominal hemorrhage leading to hypovolemic shock, which, if undiagnosed and untreated, can be fatal. A medical examiner may occasionally be confronted by an autopsy finding of death due to complications following rupture of an enlarged spleen (splenomegaly). In such cases it is important to bear in mind that rupture of the spleen can occur spontaneously with no history or external signs of trauma to the left side of the chest or to the upper left abdomen.

It is however, vitally important to examine for signs of external injury which may have been caused by violence because, when splenomegaly is present, even light violence suffered by a victim, can be the cause of rupture of the spleen. The nature, site and extent of the external injury will indicate the severity of the violence inflicted on the body.

There is a clear analogy to the legal concept of the "paper-thin" skull, in which injury to an abnormally vulnerable part of the body can produce disastrous consequences, disproportionate to the results that would have resulted if the violence had been inflicted on an individual who did not suffer from the particular abnormality. The name of the concept derives from the classic example of a "paper-thin" skull in which a modest blow can produce permanent brain damage.

The importance of forensic medical evaluation is evident in cases where rupture of the spleen can be connected to an act of violence inflicted on the victim. In the presence of splenomegaly the severity of the act of violence must be assessed using the results of a complete autopsy and the special investigations to be recommended in this presentation.

The presentation will discuss diagnostic procedures that will facilitate the evaluation of the etiology of the splenomegaly and the pathological changes that predispose to rupture. The causes of splenomegaly are diverse, but they may be conveniently grouped into the following categories:

- Inflammatory splenomegaly: acute or chronic enlargement of the spleen that develops in association with various infections or inflammatory processes. e.g., infectious mononucleosis.
- Hyper plastic splenomegaly: due to work hypertrophy resulting from the removal of abnormal blood cells from the circulation or as the result of extramedullary hematopoiesis e.g., leukemia.
- Congestive splenomegaly: resulting from cirrhosis with portal hypertension, splenic vein occlusion (thrombosis), or congestive heart failure (CHF) with increased venous pressure .e.g., bilharzia, chronic alcoholism, cirrhosis caused by aflatoxin (from fungus aspergillus flavus and aspergillus parasiticus).
- infiltrative splenomegaly: caused by the engorgement of macrophages with indigestible materials (e.g., Gaucher`s disease or amyloidosis,) or by the infiltration by malignancy e.g., Lymphoma.

Splenic filtering of blood-borne pathogens, such as parasites or encapsulated organisms, may also lead to splenic enlargement (e.g., parasites causing malaria or kala azar (Leishmania).

A complete autopsy including a detailed description of the macroscopic appearance of all organs is essential. Special examinations must include:

- Histo-pathological examination of samples taken from the organs and selected soft tissue and bone.
- Toxicological examination to isolate toxic organic substances.
- Microbiological examination including isolation and identification of bacteria, viruses, or parasites.

Forensic, Splenomegaly, Rupture

G47 Clinical and Pathological Spectrum of Fatty Cardiomyopathy in Sudden Cardiac Death

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After attending this presentation, attendees will recognize the pattern of pathology findings as correlated to clinical information from cases within the spectrum of fat cardiomyopathy including arrhythmogenic right ventricular cardiomyopathy.

This presentation will impact the forensic community by reviewing clinical and pathological data for sudden cardiac death cases from the spectrum of fat 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 primary heart muscle disease characterized by fibrofatty replacement of the right ventricle (RV) that is commonly associated with sudden death. Infiltration of the RV by fat alone is also believed to be associated with sudden death. However, it is not yet fully known if both conditions are different or similar disease processes in the spectrum of fatty cardiomyopathy and to what extent fatty infiltration of the RV to contribute to sudden cardiac death. In this study, the authors set to characterize the clinical and pathological characteristics of thirteen necropsy hearts collected by the iCAPTURE Cardiovascular (CV) Biobank at St. Paul's Hospital/University of British Columbia and diagnosed with ARVC or right ventricular fatty infiltration from patients that died suddenly and unexpectedly. Each case was referred to a cardiovascular pathologist at the CV Biobank for consultation and patient data were obtained from medical records or the referring pathologist. The CV Biobank, established in 1993, is comprised of cardiovascular tissue specimens from surgery and autopsy (routine hospital and forensic) as well as accompanying annotated data which are securely stored in a database. This unique collection encompasses a wide array of cardiovascular diseases and is a powerful research and educational tool.

These thirteen cases were collected by the CV Biobank during the years 1993 to 2006 and represent approximately 14% of our sudden death cases over this time period. Each of the thirteen cases were assessed in terms of their macroscopic and microscopic features and were found to fit into one of two patterns. Nearly two-thirds demonstrated fibrofatty (six male, two female; age = 17-36 years) replacement of the right ventricular myocardium, while slightly more than ⅓ showed a pattern of predominantly fatty replacement (2 male, 3 female; age =15-64 years). Within the fatty replacement group, 80% of individuals died following non-strenuous activity and 20% died at rest. Patient histories for this group included one individual with history of fainting and clinical intervention for arrhythmia and one patient with a history of anorexia and bulemia. Within the fibrofatty replacement group, over 57% of individuals died following non-strenuous activity; 28% during strenuous activity and 14% at rest. Patient histories for this group include on individual with documented familial ventricular tachycardia for which he received treatment; one history of 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 in a subset of seven of the thirteen cases confirmed these two patterns. 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 pattern and localized to the anterolateral apex and lateral base in the fatty pattern.

Thus, fibrofatty replacement of the RV, characteristic of ARVC, and fatty infiltration of the RV alone are both significant findings in cases of sudden cardiac death evaluated at a regional cardiovascular pathology referral centre. The distinctly differing extent and distribution of involvement between the two morphological patterns supports the concept that they represent two different disease processes.

Fat Cardiomyopathy/ARVC, Cardiovascular Pathology, Sudden Cardiac Death

G48 Sudden Death and Fatty Liver Disease

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The objective of this presentation is to draw attention to the alarming prevalence of non-alcoholic fatty liver disease in the obese population and to a potential increase in sudden fatty liver deaths. The need for a thorough medicolegal investigation and autopsy will be emphasized, since a better understanding of the mechanism of death in such cases may have clinical consequences for both alcoholics and non-alcoholics with fatty liver disease.

The prevalence of non-alcoholic fatty liver disease in the general population may signal an increase in the number of sudden deaths in which fatty liver disease is the sole pathologic finding at autopsy. This presentation will impact the forensic community by. The forensic pathologist should be prepared to carefully investigate these deaths, since the opportunity to better understand the mechanism of death in such cases may induce clinicians to recommend routine EKG studies in obese patients and alcohol abusers.

The sudden death of a teenager with non-alcoholic fatty liver disease (NAFLD) prompted us to question the mechanism of death in individuals whose sole pathologic observation at autopsy is fatty liver disease. From a clinical stand point, NAFLD is recognized as a leading cause of chronic liver disease, and has been associated with obesity and insulin resistance. According to recent studies, the prevalence of NAFLD in the United States now exceeds 30% and probably mirrors the prevalence of obesity in the general population. One would therefore expect forensic pathologists to see a surge of NAFLD cases at autopsy, regardless of the cause and manner of death.

A 17-year-old morbidly obese female non-drinker with an unsubstantiated history of mild mental retardation, sleep apnea, and insulin resistance died suddenly and unexpectedly. She was found face down on her futon-style bed, clad in shorts and a tee-shirt. She was 5'5" tall and weighed more than 240 lbs. The only abnormal finding at autopsy was a 2490 g pale yellow-tan liver with greasy consistency. Microscopy showed marked fatty change with focal bridging fibrosis and spotty lobular inflammation. A toxicology therapeutic and abused drug screen was negative, and vitreous glucose was less than 20 mg/dl. In the absence of any other findings of significance, the mechanism of death was assumed to be a cardiac arrhythmia, and the cause of death was certified as "Sudden Death Associated with Non-alcoholic Fatty Liver Disease and Morbid Obesity". Forensic pathologists have long been familiar with cases of sudden, unexpected, non-violent deaths in alcoholics with autopsy findings limited solely to fatty liver. The mechanism of death in such cases is not well understood. In a review of the literature, one current theory proposes that a prolonged QT interval may be triggered by alcohol withdrawal induced hypoglycemia complicated by low potassium and magnesium concentrations.

The anatomic pathology of alcohol-related fatty liver disease and non-alcoholic fatty liver disease is the same. Absent any other factor contributing to death, the mechanism of death may also be the same.

A thorough medicolegal investigation of the circumstances of death and medical history, a careful autopsy, and of standardized histologic grading systems for fatty liver are recommended in all cases of sudden death with fatty liver disease as sole pathologic finding in order to better understand the mechanism of death. An increase in NAFLD deaths may justify the need for routine electrocardiograms in obese individuals and alcohol abusers of all ages.

Fatty Liver Disease, Prolonged QT Syndrome, Sudden Death

G49 Hypertensive Heart Disease May Compound the Risk of Death From Medication and Contrast Media-Induced Anaphylactic Shock

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After attending this presentation, attendees will understand some principles of the pathophysiology and epidemiology of lethal anaphylactic shock. Additionally, specific forensic autopsy findings related to anaphylactic shock will be reviewed.

This presentation will impact the forensic community because in this retrospective case review, all autopsied cases of individuals with medication or contrast media-induced anaphylactic shock included findings of cardiac abnormalities and, specifically, left ventricular hypertrophy was found in seven of eight cases.

The pathophysiology of anaphylactic shock is complex, involving cross-linking of IgE receptors on the surface of mast cells, causing massive degranulation and subsequent adverse effects on the cardiovascular and respiratory systems. Circulatory collapse results from impaired venous tone and venous return, as well as decreased cardiac output. Respiratory failure results from reactive airway changes as well as upper airway swelling and obstruction and pulmonary edema.

A review of several case series in the recent literature shows that deaths from medication and contrast media-induced anaphylaxis occur more often in elderly individuals, especially those with comorbid diseases, and are more common than deaths from anaphylaxis caused by Hymenoptera stings and food allergies. Postmortem measurement of serum tryptase, a marker for mast cell activation, has been found in several studies to be a sensitive and specific test that can support a diagnosis of death from anaphylactic shock. The purpose of this study was to determine whether a retrospective review of medical examiner cases in the greater St. Louis region would corroborate the findings of previous case series reported in the literature.

A computer search was utilized to find all cases in St. Louis City and surrounding counties in the past twenty years in which the sole immediate cause of death was listed as anaphylactic shock. Twenty-two such cases were found. In eleven cases, a complete autopsy was performed at the Medical Examiner's office; in one case, a complete hospital autopsy was performed; in one case, an external examination only was performed; and in nine cases, the body was released after review of the medical investigator's report.

Among the seventeen individuals with anaphylaxis induced by medication or contrast media, thirteen were over the age of fifty. By contrast, of the five individuals with "idiopathic" anaphylaxis or anaphylaxis related to Hymenoptera stings or food allergies, four were under the age of fifty. Of the twelve cases in which a complete autopsy was performed, three cases included individuals with a swollen tongue or lips; eight included findings of laryngeal edema; ten had cardiac abnormalities; seven had pulmonary abnormalities; and two had mild cerebral edema. In the five cases in which postmortem serum trypase levels were measured, four showed levels above the upper limit of the normal reference range (13.5 ug/ml) and all five showed levels above 10 ug/ml.

Many of the individuals who died as a result of medication or contrast media-induced anaphylactic shock suffered from comorbid diseases including obesity, diabetes, and atherosclerosis. Significantly, cardiac abnormalities were found in all of these cases in which a complete autopsy was performed. Specifically, the finding of left ventricular hypertrophy, which is strongly associated with hypertensive heart disease, was found in seven of eight cases.

The findings of this study corroborated those of previous case series, which reported that death from medication or contrast media-induced anaphylactic shock most commonly occurs in elderly individuals, many with comorbid diseases. Interestingly, in this case review, all of these autopsied cases included findings of cardiac abnormalities and, specifically, left ventricular hypertrophy was found in seven of eight cases. The association of hypertensive heart disease with death from anaphylactic shock merits further investigation and could have broad implications for the medical community if confirmed in larger studies.

Anaphylaxis, Hypertension, Hypertrophy

G50 Diffuse Axonal Injury in Medico-Legal Practice

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The goal of this presentation is to present data that will provide attendees with the important medicolegal and clinical characteristics of diffuse axonal injury in closed head trauma that may contribute ultimately to fatal outcome.

The presentation will impact the forensic community by the fact that in cases of closed head trauma, diffuse axonal injury (DAI) may contribute to overall brain damage and treatment outcome. On the other hand, these results indicate that in the cases of closed head injury, fatal outcome occurs over a shorter period if DIA is present without contusions of the brain.

Diffuse axonal injury (DAI) is a form of neural damage in close head trauma that may contribute to overall trauma severity as well as the prognosis and course. For that reason, an autopsy study was performed to analyze the extent and other important forensic and clinical characteristics of DAI.

The study was carried out prospectively during two years period when 3,012 autopsies were performed. According to defined criteria, 30 autopsy cases of closed head trauma were selected (study group), while a corresponding number of cases formed control group. Whole brain samples were fixed in formaldehyde and subsequently studied macroscopically and microscopically.

Data were obtained from medical records and autopsy findings. A contusion index (CI) was used for assessment of brain contusions. Tissue density, as a measure of myelin sheet damage, was analyzed on luxol fast blue (LFB) stained sections of corpus callosum (CC) by laser scan densitometry. The obtained results were analyzed by means of appropriate statistical methods.

Optic density of LFB stained CC slices depends on myelin quantity. Optic density of CC in controls was 1.02±0.05, while in studied subjects it was 0.96±0.08. Observed difference in optic density of CC histological slices was proofed to be of statistical significance ($t=4.0035$; $p<0.05$). In cases with higher CI, i.e., where contusion injuries were more severe, optical density of CC was slightly lower in comparison to the cases of less severe contusions, and cases where brain contusions were absent. Optical density of CC is significantly lower in cases with survival period up to 24 hours.

Medico-Legal Aspects, Diffuse Axonal Injury, Trauma

G51 Placental Site Trophoblastic Tumor (PSTT) With Lung Metastases as Cause of Death in a Young Patient: Autopsy Findings and Medico-Legal Implications

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The goal of this presentation is to present the autopsy and histological findings of placental trophoblastic tumor, which are very rarely described in the literature.

This presentation will impact the forensic community by demonstrating how medico-legal implications are related to the difficulties of the doctor who faced this rare condition.

Placental site trophoblastic tumour (PSTT) is a rare form of gestational trophoblastic disease (GTD) with unpredictable biological behaviour. It arises from the transformation of intermediate trophoblastic cells that normally play a critical role in implantation. PSTT was originally termed "atypical chorioepithelioma" by Marchand in 1895. In 1976, under the title "trophoblastic pseudotumor of the uterus", Kurman et al. recognized the entity as a form of trophoblastic disease, distinct from choriocarcinoma. Five years later, Scully and Young introduced the term "placental site trophoblastic tumor" to indicate possible malignant behaviour. Since the first report, approximately 90 cases of PSTT have been reported, formerly termed atypical choriocarcinoma, chorio-epitheliosis or syncytioma. PSTT can occur after a normal pregnancy, abortion, term delivery, ectopic pregnancy or molar pregnancy. It displays a wide clinical spectrum, and when metastatic, can be difficult to control even with surgery and chemotherapy. Unlike other forms of GTD, PSTT is characterized by low beta-hCG levels because it is a neoplastic proliferation of intermediate trophoblastic cells. Expression, however, of human placental lactogen (hPL) is increased on histologic section as well as in the serum. The most common presenting symptoms of PSTT are vaginal bleeding and amenorrhoea. Diagnosis is confirmed by dilatation and curettage and hysterectomy but meticulous evaluation of metastasis is mandatory.

A 21-year-old woman, (gravida 1, para 0) at 25 weeks of amenorrhea was admitted to the hospital for hyperemesis, hepatic problems, and important weight loss registered during the last few months. Routine laboratory tests such as liver function, haematics and coagulations markers were abnormal, whereas all fetal parameters were unremarkable. On examination, the patient was cachectic looking. The per-abdominal examination was unremarkable. Few days after the admission the patient suddenly died before the doctors can reach a diagnosis. A forensic investigation for medical malpractice was initiated. Microscopic examination of the samples collected from uterus revealed the presence of large trophoblastic cells with eosinophilic cytoplasm. Deposition of fibrinoid material was noticed between trophoblastic cells. Tumor cells dissected through the myometrium and invaded into the vascular spaces. Specimens of the lungs revealed numerous small neoplastic emboli into the vessels.

Placental site trophoblastic tumor is an uncommon member of GTD, with less than 100 cases having been reported in the English language literature. PSTTs behave in a benign fashion, whereas approximately 10 – 15% were clinically malignant. Predicting which patients will develop metastases is difficult. The outcome is usually excellent after the simple hysterectomy. Unfortunately at the time of diagnosis our patient presented metastasis beyond the uterus. The management of disease with metastasis can be very difficult, for the relative insensitivity to chemioteraphy. Other important adverse prognostic factors are age >40 years and mitotic count>5 mf/10 HPF. Gross autopsy and histological findings, which are very rarely described in the literature, are demonstrated. The medico-legal implications related to the great difficulties of the gynecologist who faced this rare condition in term of diagnosis and prediction of the biological behavior and outlining effective therapeutic approaches are discussed.

Placental Site Trophoblastic Tumor, Lung Metastas, Medico-Legal Implications

G52 Identification of Human Body Fluids: Comparison Between Two Commercial Kits for Detection of Semen

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The aim of our presentation is to show the results making a parallel study to detect human semen on old and recent traces with these two different commercial kits.

This presentation will impact the forensic science community by showing how it is possible to improve the knowledge about identification methods using new approach to detect traces.

The examination of living victims of sexual assaults is very important; the necessity to have markers to detect the presence of semen on clothes or body fluids could be helpful in forensic science. Semen is the most common form of body fluid evidence encountered in these cases; in screening or examining sexual assault evidence, semen or other body fluids can be present on a variety of surfaces including sample collection swabs, pieces of clothes, bed sheets, towel, flooring, condoms, and feminine products. The samples can also be stored for many years: testing for body fluid identification and DNA profiling should be able to reliably, and with high sensitivity detect semen from a variety of sources. In countries with sophisticated forensic science or laboratories, the pathologist will not be called upon to carry out actual techniques for detection of seminal fluids: he has to be a careful collector of samples and to be able to make an interpretation of the results, but sometimes even the pathologist has to be well informed and has to be able to make these tests by himself. The detection of semen depends upon many different methods as naked-eye and lens recognition; examination under ultraviolet light, enzyme reactions (acid phosphatase activity), immunological methods, FISH method.

Particularly the immunological methods are recently used in many laboratories and they detect the presence of some antigens that normally can be found also in seminal fluid: for example PSA and Semenogelin.

PSA or prostate-specific antigen is a glycoprotein produced by the prostatic gland and it is found in seminal plasma, male urine, and blood, it could be present also in tissue or fluid of the female body but the concentrations are very low. A positive PSA test is a reliable indicator of semen regardless the presence of spermatozoa or elevated acid phosphatase level.

The other test detect a different protein that is present on semen, Semenogelin: it is the major component of human semen and together with fibronectin, gives rise to he gel-like coagulum of newly ejaculated semen.

Both of them are immunochromatographic assay tests that use monoclonal antibodies specific for the antigen and they use a strip test that can be manipulate easily.

The aim of our presentation is to show the results we had in our Laboratory making a parallel study to detect human semen on old and recent traces with these two different commercial kits. This study has the purpose to test also the sensitivity of these new methods because of the importance they could have in forensic cases.

Identification, Human Semen, Immunological Kits

G53 A Brush With Death: Suicidal Ingestion of Toothpaste

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The goal of this presentation is to describe the gross findings and the physiologic derangement resulting in death in toothpaste/fluoride toxicity.

This presentation will impact the forensic community by making medical examiners aware of the potential acute toxicity of [widely-available] fluoridated toothpaste, its recognition and the high national incidence of non-fatal toothpaste poisonings

This poster presentation will permit the attendee to brush up on the toxic effects that accompany the ingestion of toothpaste with fluoride, an extremely common, if rarely fatal, poisoning event. After attending this presentation, the attendee will be able to describe the gross findings in acute fluoride poisoning, the circumstances in which toothpaste poisoning may occur and the physiologic derangement that results in injury or death.

A 51-year-old man was found unresponsive on his bed, by his wife, when she came home from work. The bedroom door was locked from the inside. There was a history of domestic abuse, and reportedly the wife had assaulted him three days earlier, resulting in visible contusions on the right eye and upper arm. Resuscitative attempts were unsuccessful and he was pronounced dead at the scene. There was no investigative evidence of acute trauma or foul play.

Past medical history was significant for bipolar disorder, hypertension and chronic back pain. The decedent was known to abuse cocaine and multiple burnt copper pad fragments were identified throughout the house.

Two weeks earlier, the decedent, who was noted by his wife to be depressed for several months, had uttered an isolated suicidal statement to the effect that when his medications arrived by mail he should "take them all". His medications (Depakote, bupropion and olanzapine) were irregularly out of count and some were in a pile on the bedside table, along with a Thermos. No note was found.

Autopsy revealed an overweight male (BMI 28.5 kg/m2) with cardiomegaly (600 grams), organized anterior infarct, marked concentric left ventricular hypertrophy and chronic lung disease with pulmonary hypertension. There was florid hemorrhagic necrosis of the entire gastric mucosa. The stomach contained frank blood (300 ml) and a 230-gram conglomerate of translucent blue-green paste (with a minty odor).

Follow-up investigation located an almost empty 119-gram tube of toothpaste as well as multiple partially full tubes of toothpaste in the outdoor trash. The wife indicated that the decedent had some level of sophistication regarding medications, had a sibling who was a pharmacist, and would be aware of the dangers of toothpaste ingestion, especially with the warning on the package.

Toxicological evaluation revealed the presence of cocaine and benzoylecgonine as well as bupropion and citalopram. A biochemical vitreous screen was unremarkable. Fluoride was not detected in femoral blood.

The cause of death was: gastrointestinal hemorrhage due to massive ingestion of fluoridated toothpaste, hypertensive heart disease, and cocaine intoxication were significant contributing factors.

Given the history of suicidal intent, the concealment of the toothpaste tubes and the noxiousness of ingestion, the manner of death was certified as suicide.

Gastrointestinal signs and symptoms usually predominate upon ingestion of toothpaste. Other observed effects have included headache, numbness, and electrolyte disturbances, especially hypocalcemia. Hypotension and dysrhythmias are evident in severe poisonings. Toothpaste often contains up to 5 mg of fluoride per teaspoon. The fluoride is the component of toothpaste associated with toxicity. In many cases, 3 to 5 milligrams per kilogram of elemental fluoride is a toxic dose. The mechanism for toxicity following the ingestion fluoride-containing substances is thought to be a reaction between the sodium fluoride in the toothpaste gastric acid, resulting in the production of highly corrosive hydrogen fluoride (HF). The HF causes adverse effects reported in large ingestions, including nausea, vomiting, diarrhea, abdominal pain, and acute hemorrhagic gastroenteritis.

According to Annual Reports of the American Association of Poison Control Centers, over 118 thousand poisoning exposures were reported to poison centers nationally during the five-year period ending in 2005. Of these, 91 percent were unintentional exposures; roughly 90 percent involved children less than six years old. This case is unique in the respect that it was the sole fatality attributed to toothpaste ingestion during this period.

Toothpaste, Fluoride, Poisoning

G54 Toxicological Implications in Heat Related Deaths in Phoenix, Arizona: Case Reports From the Office of the Medical Examiner

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After attending this presentation, attendees will be afforded a three year review of the statistics, toxicology, and pertinent scene findings associated with heat related deaths in the metropolitan Phoenix area.

This presentation will impact the forensic community by raising awareness of this public health issue.

The diagnosis of a heat related death rests on the importance of considering all factors involved for certifying the death when a person is found dead in a hot environment that can routinely be greater than 105 degrees during summer months. In recent years, media scrutiny of the number of deaths related to hyperthermia has reached headline proportions in our area, which has prompted much public awareness and activism. Although these headlines are accurate in reporting deaths have occurred, they do not typically reflect the true circumstances surrounding the deaths. This paper will discuss the headlines versus factual findings, retrospectively demonstrate the statistics, and discuss an algorithmic approach to unify the certification for more accurate compilation of county health statistics. Data was collected from May 1st to September 30th for years 2005 and 2006 (2007 data is still being collected). During this 2 year period, 168 deaths were certified as heat related. Of these deaths, 52 % (87) had negative toxicology findings and were attributed to heat only. Of the remaining 48% (81 cases): 14% (24) had positive toxicology screens for ethanol, 16% (25) had positive screens for stimulants (cocaine or methamphetamine), 5% (8) were positive for psychotropic drugs, and 14% (24) had positive results for more than one these categories. Toxicology also plays a vital role in electrolyte determinations. The levels of sodium, creatinine, and urea nitrogen must be considered, if possible, when evaluating potential heat related deaths. In conclusion, vitreous analysis, scene variables, and decomposition all affect the ability to evaluate results. The relevance of these findings in conjunction with other variables used to make the diagnosis will be discussed. The proposed algorithm will assist with the information gathering process and aid the forensic investigation by promoting categories for the deaths to be cataloged, so more accurate statistical, epidemiological and community prevention measures can be instituted. This retrospective analysis will demonstrate the multiple factors used to make a diagnosis of a heat related death and elicit common problems encountered in evaluating a decomposed body in a potentially hot environment. From these findings, an algorithmic approach will be proposed to further define the cause and manner of death in future investigations and improve public health reporting. It is hypothesized that the cause and manner of death could be more definitively diagnosed by using a more uniform information gathering process at the scene, during the autopsy examination and from the toxicology findings. Specific case findings and circumstances will be discussed.

Hyperthermia, Toxicology, Death

G55 Firearm Deaths by Law Enforcement in New York City

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Upon completion of this presentation, participants should obtain an overview of the circumstances and injury patterns seen with 42 police shootings.

This presentation will impact the forensic science community by demonstrating how although police shootings in which the decedent was unarmed and/or sustained numerous gunshot wounds are widely reported by the lay press, these types of shootings were not typical in our study.

The use of deadly force during law enforcement is a matter that compels public scrutiny. There were 42 gunshot deaths caused by police over a 4-year period in New York City. The decedents' average age was 31 years and ranged from 17 to 64 years. There were 41 males and 1 female; and 26 Black, 9 Hispanic, and 7 White decedents. The majority (90%) of the decedents possessed a weapon. There were 26 handguns, 6 knives, 1 axe, 1 metal pipe, and 1 toy gun (carried by an adult impersonating a police officer). Vehicles were used as weapons in two incidents. Ethanol and/or drugs of abuse were detected in 78% (31/40) of the decedents. The detected drugs of abuse included: 15 cannabinoids, 14 ethanol, 10 cocaine/BE, and 1 amphetamine. Seven decedents had a history of psychiatric illness.

The most common reason for the police presence was a response to a crime and for the shooting was the decedent's possession/use of a weapon. All but one of the decedents had injuries caused by handguns (one involved a handgun and rifle). A total of 177 bullets struck the 42 decedents. Fourteen decedents sustained single gunshot wounds, and the remainder had multiple gunshot wounds ranging from 2 to 21. In the majority of the cases in this study, the number of gunshot wounds of the body was 3 or fewer. There were 112 penetrating, 55 perforating, and 8 graze wounds. Thirteen decedents had at least one gunshot wound of the back or buttocks, accounting for 25 of the total 177 wounds, and four of the twelve had gunshot wounds of *only* the back. With the exception of the upper extremities, gunshot wounds of all locations were more likely to penetrate than perforate.

The location of the entrance wound is sometimes used as evidence to support or dispute the justification for the use of force. A shooting is a dynamic process with split second decisions and movements. It has been demonstrated that a person can turn the torso completely in the milliseconds that it takes for one to decide to fire a gun and pull the trigger. Our data show a wide range of entrance wound locations which would reflect this dynamic process.

Although these deaths may be high profile, the certification is typically straight forward and the cause (i.e., gunshot wound) and manner of death (homicide) are readily apparent. Since the medicolegal definition of homicide is death at the hand of another, the forensic pathologist is absolved of considering intent or the appropriateness of the use of force. Typically, those issues are left to the legal investigation (e.g., grand jury investigation). During this time, the medical examiner may play an important role in the corroboration of witness statements and other evidence by providing information on the direction of the wound tracks, range of fire, and opining on how the injuries may have affected the victim during the course of the event.

Although police shootings in which the decedent was unarmed and/or sustained numerous gunshot wounds are widely reported by the lay press, these types of shootings were not typical in our study. The vast majority of police-shootings occurred with the police responding to a crime in which the decedent was armed. In addition, most of the decedents had 3 or fewer gunshot wounds.

Forensic Pathology, Firearm, Police

G56 Postmortem Genital Examinations With Colposcopy in the Evaluation of Fatal Sexual Violence Against Women

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The goals of this presentation are: to help attendees better understand the nature and appearance of the anogenital tissues at various postmortem intervals; to compare the results from photocolposcopy at various magnifications vs. single lens reflex (SLR) photography; and to determine if toluidine blue dye is a reliable and/or useful adjunct in the postmortem genital examination.

This presentation will impact the forensic science community by improving the diagnostic acumen of the forensic examiner; avoiding ambiguity of interpretation of clinical findings in postmortem genital examinations; and providing a framework for the medical evaluation of fatal sexual violence against women.

This paper proposes to describe ongoing research on postmortem genital anatomy. These cases comprise a significant portion of a baseline study of postmortem genital examinations, to better study fatal sexual violence against women. To this end, a detailed analysis of anogenital anatomy at various postmortem intervals is being conducted.

The focus of the present discussion is to describe the initial results of cases drawn from the Donated Body Program, at University of California, Davis, California. A total of 30 cases will come from this population and will form a subset of the final, larger project sample. Analysis of results from these baseline studies will allow eventual comparison to genital injuries sustained by both sexual homicide victims and living sexual assault victims. Data accumulated during this project will provide the core information for a *Sexual Homicide Database* (Crowley, AAFS/1998;2000; JFS/2004).

The operations base of the Donated Body Program at the University of California, Davis, California, is at the Sacramento County Coroner's Office Morgue. Most donors are received by the Program $\leq$ 24 hours of death. All cases selected for this baseline study are fresh, or fresh-frozen, vs. embalmed. Cases are examined based upon availability, i.e., female gender, and received by the Program in a time frame compatible with examination by the primary investigator.

A paucity of data exists on the "normal" appearance of the genital anatomy during the postmortem interval. We lack data from scrutiny and photodocumentation of the postmortem anogenital tissues. In living sexual assault victims, specific anogenital sites have been well-studied (Slaughter, Brown, Crowley, and Peck, 1997). The use of colposcopy is well established for both adult and child *living* victims. During the autopsy, gross visualization alone may not allow the detection of the more subtle findings that usually constitute genital trauma in sexual assault. Crowley described a mobile system for postmortem genital examinations with colposcopy (JFS, 2004).

Previously, the use of 1% toluidine blue as an adjunctive tool in fatal abuse cases was limited to select case examples. This nuclear stain has been incorporated as a practice standard by many programs, for the medical legal evaluation of living sexual assault victims. A review of the original methodologies was presented earlier (Crowley, AAFS/2005; 2007). Toluidine blue is specific for zones of parakeratosis and results can be due to inflammatory, benign, or malignant vulvovaginal diseases. Following application of toluidine blue dye in vivo, false positive results may be caused by 23 benign vulvovaginal conditions, in addition to cervical mucous. In nongenital sites, toluidine blue dye has been shown to yield positive results in granulation tissue (Crowley, 2007).

Using Crowley's mobile system of technology, the clinical phase of this research project began in March, 2007, at the Donated Body Program at the University of California, Davis, California. The research project is an observational study, with a cross-sectional design. The examination methodology employs photocolposcopy at 7.5X, 15X magnification, or both, plus 35 mm photography via the colposcope. Additional photographs are taken with a 35mm single lens reflex (SLR) digital camera, for comparison. Inspection and photodocumentation of specific anogenital sites is employed,

prior to manipulation of the genital tissues. On select cases, concomitant application of a 1% solution of toluidine blue dye has also been incorporated, in order to evaluate the reliability of this general nuclear stain as an adjunct to the postmortem examination.

Available demographic data is collected on each case, which is assigned a unique identifier, for entry into a modified version of the *Sexual Homicide Database*. Eleven anatomic sites are routinely evaluated and documented on the postmortem worksheet. Inspection, labial separation, and labial traction are used to maximize visualization, in addition to speculum insertion and anoscopy. The nature and pattern of postmortem genital findings are described in a manner consistent with the proposed taxonomy for postmortem anatomy previously described by Crowley and Peterson (AAFS/2004).

Currently, a wide variation exists in the methodology for the examination of antemortem sexual assault victims. Protocols and procedures vary, especially with regards to adjunctive methods, e.g., application, timing, and interpretation of toluidine blue dye. Postmortem challenges are multifaceted; they may pose even greater significance than in living victims. Postmortem deposition of the victim's remains usually precludes the opportunity for a follow-up examination/re-evaluation. Moreover, when experts whose sole expertise is with the antemortem victim are asked to collaborate in a sexual homicide case, even greater challenges arise. The expert *must* consider working as a team member, not in a vacuum; their frame of reference cannot solely reside in the antemortem arena.

The higher magnification potential of the colposcope affords greater opportunity for careful scrutiny and photodocumentation. This improves both the diagnostic acumen of the examiner and the quality of the postmortem genital examination. Colposcopy facilitates peer review, salient to the scientific process and eventual applicability of the research endeavor.

It is certainly true that in equivocal cases, the Forensic Pathologist can simply remove en bloc, for dissection and microscopic evaluation, the tissues germane to genital findings. However, it may prove to be beneficial to have an initial in situ examination of the anogenital anatomy via colposcopy.

The ultimate goal is to better visualize, in order to improve our understanding of what is normal in the anogenital anatomy during the postmortem interval.

Forensic Clinical Nurse Specialist, Colposcopy, Donated Body Program

G57 The Serial Killer of Elderly Women: Analysis of a Multi-Victim Homicide Investigation

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After attending this presentation, the participants will learn: (1) the practical issues involved in investigating and analyzing the actions of a serial murderer, and (2) the motives, methods of operation, victim selection, injuries and body disposal scenarios highlighted through case examples never presented before.

This presentation will impact the forensic community by showing a little-known but noteworthy case of a serial killer murder of an elderly women occurring in Southern Italy ten years ago.

Ben Mohamed Ezzedine Sebai, is a convicted Italian serial killer. Originally from Kairouan (Tunisia), he immigrated illegally to Italy in 1990. In 1991 he was charged of attempted murder and rape and the police headquarters of Bolzano issued an expulsion order. He fled and took refuge in the province of Foggia (Southern Italy), where he worked as farm laborer. He begged for money and relied on voluntary organizations managed by religious institutions for food and shelter. Between 1994 and 1997, in the territories of Southern Italy, fifteen women aged over 70 were murdered. One victim in 1994, two victims in 1995, three in 1996, nine in 1997, but not all attributed to Sebai. Most of the victims were stabbed multiple times on the neck (min. 1, max. 20) with the exception of three cases in which the cause of death was manual strangulation. The assailant had sex with only one victim and sperm traces were recovered on the body. All the victims were found in their own apartments with no sign of break-in. However, the murders were connected to the theft of money and/or jewelry. The press alerted the public to the inability of the local police to seize the guilty party. In the meantime a criminal profiling was requested to aid the local police in refining their suspect list. The results showed that the murder pattern was completely inconsistent with the local criminal patterns, suggesting that the perpetrator could be an illegal immigrant sexually motivated or prior arrested for sex-related incidents. On the 15th of September, 1997, Sebai was arrested while attempting to catch a train after his last murder. Sebai was recognized by an 8-year-old child next-door neighbor of the victim while he was casting off his blood-stained clothing. He was convicted of four murders and given life sentence.

For the remaining homicides, other people were convicted; in most cases they were relatives of the victims spurred by economical reasons. In 2006, after nine years, Sebai admitted responsibility for the murders of four more elderly women, for which nine other people had already been convicted, among whom one had committed suicide in jail in 2005. The reasons of this posthumous confession are to be found in his willingness to clear these people of a groundless charge and hand over the crime weapon never found before. One year later, in 2007, he confessed to seven more murders,,with all 15 deaths occurring between 1994 and 1997. After first interviews with Sebai, a story of difficulty during childhood involving his grandmother; apparently she allowed his uncles to abuse him. His father was violent too. He hit Sebai on his feet after hanging him face down. Sebai's techniques were quite simple; once he studied the elderly women's habits, he made sure that nobody was in and he intruded under the pretext of a salesman of holy pictures then burst into the house. He deliberately chose the victims, having no prior personal connection with them at all. The neck was his favourite target because there the stab wounds can produce rapid death by exsanguination. With profuse bleeding, physical activity of the victim is also limited or lost rapidly preventing victims from screaming. He also confessed that at the end of each murder he used to ejaculate confirming the previous hypothesis of homicides sexually motivated. Sebai's criminal profiling is still going on and further developments of this case cannot be excluded.

Serial Killer, Multi-Victim Homicide Investigation, Criminal Profiling

G58 One Entrance Wound, Three Bullets, and Four Pulls of the Trigger: An Unusual Case of a Suicidal Gunshot Wound of the Head

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The goal of this presentation is to illustrate an unusual case of suicide with a revolver and multiple squib bullets.

This presentation will impact the forensic community by illustrating the need for close collaboration between the forensic pathologist and the firearm examiner when dealing with cases of unusual gunshot wounds.

Suicide is one of the most important public health issues in the United States. Suicide represents the eleventh leading cause of death in the United States. Suicides comprise approximately 12% of the caseload of the Allegheny County Medical Examiner's Office in Pittsburgh, Pennsylvania. Suicide rates for this country have been relatively stable over the past decade averaging approximately 10 per 100,000 populations. The most common method of suicide in the United States is the use of a firearm.

An elderly Caucasian male with a history of prostate cancer recently learned that his prostate cancer had metastasized to his pancreas. Family members relayed that he made comments that he did not want to go through radiation and chemotherapy treatment again. On the morning of his demise, the decedent told his wife that "It just ain't worth it anymore." Later that morning his elderly wife heard a thump in the adjacent room. The decedent was found in the fetal position on top of his overturned walker. The wife called her brother-in-law to help, at which time they found blood coming from his head and a revolver in his right hand.

The external examination revealed an elderly Caucasian male with a single contact penetrating gunshot wound of entrance to the right temple region of the head. Dense soot deposits were present on the skin and within the wound track. A faint muzzle abrasion was identified surrounding the entrance wound. Gunpowder residue was grossly visible on the left index finger. Radiographs of the head revealed three separate bullets. Autopsy revealed a single entrance with internal beveling of the right temple bone. The path of the bullets was leftward through the bilateral temporal lobes of the brain. One .38 caliber slug was recovered from the left temporal lobe and the other two slugs were recovered from the subcutaneous tissue of the left temporal scalp.

The firearms report found the Colt .38 special caliber revolver to be in good working order. The six shot cylinder of the revolver contained three spent cartridges and three live cartridges. Interestingly, the three spent cartridges were in positions 1, 2, and 4. In position 3 was a live round with its primer struck. The three slugs recovered from the decedent's head were .38 caliber lead wad cutter-type bullets that were found to be fired by the above Colt revolver.

Collaboration between the pathologist and firearms examiner concluded that the decedent used his right thumb to pull the trigger four times and his left hand was used to steady the revolver. The first two cartridges were squibs that lodged in the barrel of the revolver. The third cartridge was a dud; the primer was struck with the revolver's firing pin but it did not discharge. The fourth cartridge was live and when struck by the firing pin discharged forcing itself and the two lodged squib bullets out of the barrel of the revolver and through the skull and brain of the decedent creating one classic entrance wound and bullet path. The bases of the two squib bullets confirm this scenario along with the deformation of the nose of the first squib slug and the relative pristine nature of the fourth live round.

Suicide, Handgun, Squib Bullets

G59 Suicidal Shotgun Wound Using a Shotgun Barrel, a Shotgun Shell, and a BB

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After viewing this presentations individuals will be better able to recognize unusual patterns of suicide. These patterns include: homemade or improvised firearms, unusual firing positions, and disguise of the suicide as a murder.

This presentation will impact the forensic science community by providing another unusual example of the use of a firearm for suicidal purposes. It also stresses the importance of good investigative technique as well as maintaining an open mind throughout the duration of an investigation.

Suicidal gunshot wounds are common in the United States. Many of these cases involve handguns; however, the use of long guns such as rifles or shotguns is also prevalent. Occasionally, an individual will employ the use of a homemade firearm or 'zip gun'. Creative or elaborate mechanisms for pulling the trigger are sometimes devised. Some individuals go to great lengths to conceal the weapon, confusing the issue and making the suicide appear as a homicide. In this report, we describe an unusual suicidal shotgun wound, in which the victim used a shotgun barrel (without the rest of the gun), a shotgun shell, and a BB.

A 54-year-old man was found dead in the basement of his home by friends who were helping him move out of his home. He was lying on the concrete floor with an obvious wound to his lower left chest. Emergency medical personnel responded, as did police. He was pronounced dead at the scene. The coroner was notified. The police and coroner believed that the chest wound was the probable cause of death, and their initial impression was that it represented some sort of impaling wound. The basement was relatively empty, as the man and his friends had been moving his belongings out of the home. An old shotgun barrel was seen lying on the floor near the body, but it was not initially considered significant. Examination of the body at autopsy revealed the true nature of the wound: a non-contact shotgun wound with wad-petal abrasions and stippling. Close inspection of the shotgun barrel and scene disclosed a spent shotgun shell within the barrel, multiple small indentations on the base of the shell, including one on the primer, and a BB pellet on the floor near where the man and the shotgun barrel were discovered. It was surmised that the man, while bending at the waist and leaning over, held the barrel in a vertical position, with the muzzle end directed upward toward his chest and the opposite end, containing a loaded shell, toward the floor. By slamming the base of the shotgun shell on a BB on the floor, the man eventually hit the BB with the primer, causing the weapon to discharge.

The present case serves to remind death investigators of the importance of a thorough scene investigation as well as the importance of maintaining an open mind regarding the cause and manner of death. In this case, the initial concern was for a homicide with an impaling wound. Autopsy and subsequent investigation revealed the truth—a suicide employing a shotgun fired in a very unique manner. The case provides another example of how suicidal individuals can be very creative when it comes to discharging a weapon.

Suicide, Shotgun, Barrel

G60 Characteristics of Suicidal Gunshot Wounds to the Mouth in Women

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After attending this presentation, attendees will become familiar with the characteristics of suicidal gunshot wounds to the mouth in women, particularly relating to the circumstances in which the decedent shot herself.

This presentation will impact the forensic community by drawing attention to an unusual case and reviewing factors which may be used to distinguish homicide from suicide in female victims of oral gunshot wounds.

In 2003, an unusual case occurred in which the decedent, a 40-year-old woman, sustained a gunshot wound of the mouth in another person's residence, and in his presence. Her skirt had been removed and folded in her purse, and the crowns of her central incisors were chipped. An important forensic issue in this case was whether the mode of death was homicide or suicide.

In calendar years 2004-2006, the Los Angeles County Department of Coroner examined 755 victims of suicidal gunshot wounds. Of these, 80 (11%) were female. Of the female victims, 72 (90%) used handguns and 8 (10%) used rifles or shotguns.

The gunshot entry wound was located in the mouth in 24 individuals. The ages of these 24 victims ranged from 34 to 90. A suicide note or equivalent (telephone call, estate documents left out) was present in 14 cases (58%).

In virtually every case, the decedent was fully clothed (23/23 cases; one case where amount of clothing was unknown) and the gunshot wound was inflicted at the decedent's home (21/24 cases, 88%). The shooting was unwitnessed in 22 cases (92%).

In 20 cases, the decedent did not sustain chip fractures of the tips of the incisors by x-ray. In two cases the decedent was edentulous, and in two cases the presence of fractures could not be ascertained because of extensive destruction of the mouth by the firearm wound.

The caliber of the gun varied widely. There were two injuries with .22 caliber weapons, one with a .25 caliber weapon, one with a .32 caliber weapon, three with 9 mm weapons, five with .357 caliber weapons, nine with .38 caliber weapons, and one with a .45 caliber weapon. One decedent used a 12 gauge shotgun, and one used a 20 gauge shotgun.

Suicidal gunshot wounds of the mouth are unusual in women, occurring in 24/755 of our suicidal gunshot wounds in this series (3%). In the large majority of cases, the female victims of suicidal gunshot wounds to the mouth were fully clothed and committed suicide unobserved in their own residences. Chip fractures of the tips of the incisors were not seen in our cases. Most victims in this case used handguns rather than rifles or shotguns. On the other hand, presence of a suicide note and caliber of the gun were not distinctive features of this group of cases.

In determining the mode of death in a gunshot wound of the mouth in a female victim, it may be valuable to note the circumstances in which the injury occurred; particularly whether the decedent was clothed, whether the injury was observed, and whether the decedent was in her own residence.

Gunshot Wound, Suicide, Female

G61 Victimization of Children, Adolescents, and Young Adults by Physical and/or Sexual Abuse in Northwestern Greece: A Three Year Study

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After attending this presentation, attendees will become familiar with the epidemiologic, demographic, social and medical features of child, adolescent and young adult victims of physical and/or sexual abuse in Northwestern Greece.

This presentation will impact the forensic community by demonstrating the value of data collection and interdisciplinary research work as an important initial step in facing child abuse (either physical or sexual) effectively.

Child abuse is a worldwide problem, although its manifestations and extent in specific regions may vary. It is far more prevalent and detrimental than is generally recognized, having both short and long-term physical, psychological, and social consequences. In Greece mild physical punishment of children is considered to be a normal aspect of child rearing. Compared to other countries (e.g., USA, United Kingdom or Japan) the reported incidence of child abuse in Greece is minimal. It is probable, however, that the rate is underestimated because of the lack of mandatory reporting of child abuse, and also because of inadequate awareness among health care providers. A priori, these circumstances make any effort of estimating the true extent of child abuse in Greece even harder.

The incidence, gravity and the social and medical characteristics of the reported cases of child, adolescent and young adult abuse in Northwestern Greece were the parameters chosen to be investigated. A comparison was also done to the characteristics found in other areas of Greece and foreign countries. Data survey was performed through the retrospective analysis of child, adolescent and young adult abuse cases, for the period November 2004 to December 2006, based on the archive files (forensic reports) of the Patras Medical Examiner Office, which serves the entire region of North-western Greece.

Twenty-six (26) cases of child, adolescent and young adult abuse were reported. The age of the victims ranged between 1 and 20 years old for both sexes. From these 26 cases, 18 were identified as physical and/or sexual abuse. At the rest 8 cases neither physical nor sexual abuse findings were established. Six (6) cases concerned rape or sexual abuse, and the victims' age ranged between 5 and 15 years old. Four (4) victims were males and 4 were females respectively. The 18 established cases of physical and/or sexual abuse included 4 victims of rape (3 were females), and 14 children and adolescents physically abused. The significance of the injuries (see table 2) of 3 out of the 14 physically abused victims was characterized as dangerous (2 females, 1 male) and 11 as simple or light (9 females, 2 males). The families of 15 victims resided in urban centres and the rest 3 in the country, respectively. As far as the nationality of the victims is concerned, one family was Eastern European while the rest (17 families) were Greek. The above categorization of physical and sexual abuse was performed according to the Greek legal system (Greek Criminal Law).

Demographic and social characteristics of the victims included:

- Delay in Seeking Help: 38 (70%)
- "Difficult Child": 24 (44.4%)
- Unwanted Pregnancy: 21 (39%)
- Illegitimate Child: 7 (13%)
- Difficult Pregnancy and Delivery: 19 (35%)
- Premature Child: 8 (14%)
- Problem during the Neonatal Period: 15 (28%)
- Illness during the first months of life: 12 (22%)

Summarized medical findings in 18 cases of abused children, adolescents and young adults included:

- Blunt Force Injuries: 23 (42.5%)
- Craniocerebral Injuries (including fractures): 19 (35.2%)
- Fractures of Long Bones: 8 (15%)
- Burns and Scalds: 7 (13%)
- Sharp Force Injuries: 5 (9.2%)
- Developmental Disorders: 15 (28%)
- Psychomotor Retardation: 7 (13%)
- Congenital Malformations: 1 (1.8%)
- Other: 4 (7.4%)

* *Several victims were diagnosed with more than one finding.*

There is no doubt that child abuse and neglect is manifested in Northwestern Greece with characteristics similar to those described in other areas of Greece and in foreign countries. Nevertheless, in our study there was a high prevalence of females among the victims, an argument that comes in controversy with the standing esteems medical examiners have in Greece. The relatively low number of reported cases (26 cases, less than 9 per year) is primarily a result of lack of the Greek National Health System's organization, but may be also attributed to the nature of the Greek family which precludes the maltreatment of children. Indisputably, there is wide denial of a child abuse problem among professionals in Greece, especially in the medical profession. Notwithstanding, Greece is just making its initial steps in identifying and facing the phenomenon of child abuse and neglect, and we are very optimistic that the situation will be ameliorated in the near future.

Forensic Medicine, Child Abuse, Northwestern Greece

G62 Aneurysms and Old Lace: A Ruptured Splenic Artery Mycotic Aneurysm Masquerading as Arsenic Poisoning

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After attending this presentation, attendees will gain a better understanding of the clinical presentations of patients with abdominal mycotic aneurysm and understand the usual clinical findings associated with arsenic poisoning and its differential diagnosis.

This case study discussion will impact the forensic community and the general medical community by highlighting the clinical signs and symptoms of a patient with a fatal ruptured splenic artery mycotic aneurysm, expanding clinicians' and investigators' knowledge bases to heighten pre-mortem suspicion of such cases, thus decreasing the mortality of mycotic aneurysms and decreasing unfounded accusations of poisoning.

The term *mycotic aneurysm* is often used to describe infected aneurysms within the vascular system. These lesions are classically caused

by bacterial endocarditis when multiple downstream vessels are showered with and seeded by bacterial emboli. In recent times, these aneurysms are seldom attributed to fungal organisms, and may also be referred to as infected aneurysms.

A high level of clinical suspicion is often required, augmented by blood cultures, echocardiograms to identify endocardial vegetations, and additional imaging studies such as MRI or CT scans to identify specific emboli, aneurysms, or downstream infarcts. Treatment includes antibiotic therapy, and often surgical removal of the aneurysm. Symptoms vary, depending on the vessels or organs involved by the aneurysm. Mycotic aneurysms in the splenic or mesenteric arteries may present with nonspecific abdominal pain, or no pain at all. Due to the usual concurrent bacteremia, these patients often complain of headaches, and demonstrate confusion or drowsiness.

Similarly, victims of arsenic poisoning can have varying levels of clinical symptoms, depending on the amount of arsenic ingested. The baseline health status of the patient will also affect his or her reaction to the poison. Low levels of arsenic can cause headaches and confusion. Diarrhea, vomiting, and stomach pain are more common with higher levels of poison. Because arsenic is a frequent component of daily household cleaning products and some food items, a low level of arsenic may be detected in many individuals. Individuals who are poisoned, either through accidental exposure/ingestion or due to purposeful poisoning by another person usually exhibit higher levels of detectable arsenic. Arsenic levels are generally detected by chemical analysis of hair or urine. Hair samples may show falsely elevated levels of arsenic, due to environmental accumulation of arsenic on the hair. However, hair follicles retain arsenic for much longer periods than it can be detected in the urine. Nails and skin can also harbor arsenic for long periods of time.

An elderly gentleman lived in a nursing home and was the suspected victim of arsenic poisoning at the hands of one of his children with whom there had been a recent property dispute. The patient initially complained of nondescript but at times severe abdominal pain. Clinical specimens (hair samples) taken shortly before his death revealed no toxic levels of arsenic. Shortly thereafter, he died secondary to a ruptured splenic artery mycotic aneurysm.

At autopsy, the gentleman was found to have a hemoperitoneum and a large retroperitoneal hematoma in the area of the splenic artery, due to an apparent ruptured aneurysm. No endocardial vegetations were identified. There was evidence of pyelonephritis in the kidneys. Pre-mortem arsenic levels were measured clinically via hair analysis, and were found to be within normal limits.

Further discussion will outline the incidence and various clinical presentations of mycotic aneurysms, methods by which these aneurysms have been detected in other cases, and ensuing successful clinical interventions. For the purposes of comparison, the typical findings of arsenic poisoning and their overlap with this case will be discussed.

Aneurysm, Mycotic, Arsenic

G63 Lymphocytic Hypophysitis Associated With Sudden Unexpected Death in a Young Woman

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The goals of this presentation are to recognize clinical setting and pathological changes in lymphocytic hypophysitis, and to recognize importance of sampling the pituitary for histopathology in young women with sudden unexpected death.

Lymphocytic hypophysitis causes endocrine dysfunction that could potentially lead to sudden unexpected death. Moreover, the definitive diagnosis requires histopathological examination of the pituitary gland. Given the inconsistent practice of pituitary sampling, this presentation will impact the forensic science community by presenting how lymphocytic hypophysitis may be an underrecognized cause of sudden death.

Lymphocytic hypophysitis is an unusual inflammatory condition of the pituitary gland, classically seen in females during the peripartum periods. The clinical presentation is varied and depends on hormonal deficiencies and pathophysiological effects on the target organs. While involvement of the neurohypophysis and secondary diabetes insipidus are rare, progression to multiple organ endocrinopathies is common. Pathologically the condition is characterized by lymphocytic infiltration of the hypophysis with occasional involvement of the thyroid and adrenal glands. In this report, we present the case of a 23-year-old woman diagnosed at autopsy with lymphocytic hypophysitis, with concomitant infiltrates in the thyroid gland and adrenal medulla, who died suddenly and unexpectedly, with no other apparent cause of death. While the precise mechanism of death is unclear, this case raises the possibility of endocrine dysfunction as a contributing factor to sudden death and emphasizes the need for greater awareness of the entity and routinely sampling the pituitary gland in cases of sudden unexpected death.

Lymphocytic Hypophysitis, Pituitary, Sudden Death

G64 Medico-Legal Aspects of Posttraumatic Gastroduodenal Ulcers

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On the basis of presented data attendees will be well acquainted with the important medicolegal and clinical characteristics of posttraumatic gastroduodenal ulcers that can be very serious and even fatal complications of various types of injuries.

The presentation will impact the forensic community by the fact that in cases with development of posttraumatic stress ulcers medicolegal expertise of injuries may be very complicated, especially if fatal complications of stress ulcers occur (hemorrhage, perforation), since in such cases the causative relationship between the primary injuries and fatal outcome should be explained. On the other hand, the important influence on humanity may have data that indicate the most risky injuries concerning development of stress ulcers, as well as the importance of their adequate prevention during the treatment of injured individuals.

The posttraumatic gastroduodenal ulcers (PGDU), so called stress ulcers, represent very important, sometimes life threatening or even fatal complication of various types of injuries. Therefore, a broad autopsy study was performed in order to analyze frequency and other important forensic and clinical characteristics of PGDU.

The study was divided in a retrospective part (period 1996-2000, 5197 autopsies), and a prospective part (period 2004-2005, 2356 autopsies). In the retrospective part of the study 157 autopsy cases with posttraumatic gastroduodenal ulcers were observed (experimental group), and 730 cases without posttraumatic ulcers (control group). In the prospective part of the study 45 autopsy cases with posttraumatic ulcers were analyzed (experimental group), and 212 cases without posttraumatic ulcers (control group).

Data were obtained from autopsy protocols, anamnestic data from the deceased's family members and accessible medical records. Degree of the

injury severity was presented by ISS value. Furthermore, in the prospective part of the study histological examination of small vessels of the abdominal organs was performed in order to investigate influence of atherosclerosis on development of PGDU. The obtained results were analyzed by means of appropriate statistical methods.

In both retrospective and prospective part of the study, the percentage of occurrence of PGDU was approximately 17% among all cases with potentially risky injuries. Posttraumatic ulcers are more common in males (around 77% of all individuals with stress ulcers), as well as in older age (over 50 years). The outliving period ranged between 24 hours and 25 days, but it was often no longer than 12 days (76%). From the preventive point of view, it is important to point out that 16.5% out of all PGDU in the retrospective part, and 15.5% in the prospective part of the study, was found at autopsy in the injured individuals who outlived trauma less than 48 hours.

The manner of trauma was mostly accidental with the vast majority of traffic accidents (66%), and with the highest absolute number of pedestrians (66). The main causes of death in the experimental group were as following: damage to the vital brain centers (64%), chest injuries (13%), spinal cord injuries (6%), burns (6%) and complications of injuries. The most of injured persons with posttraumatic ulcers sustained multiple injuries, that is polytrauma. Isolated craniocerebral injury was found in 25% cases with posttraumatic ulcers. In majority of cases with mechanical injuries, the calculated ISS value was ≥ 16.

The most risky injuries for development of PGDU appeared to be isolated spinal cord injuries. Namely, among all cases with isolated spinal cord injuries, PGDU were diagnosed in 50% in the retrospective part, and in 25% in the prospective part of this study. The other types of injuries with high risk for development of PGDU were burns and scalds, isolated mechanical craniocerebral trauma, and mechanical polytrauma. This investigation shows that small vessels changes of the stomach and other abdominal organs are not very important factor in pathogenesis of posttraumatic ulcers, while the most important suppose to be functional disturbances of microcirculation caused by the primary injuries.

The stomach was the most frequent localization of PGDU, mostly with numerous lesions (so called erosive gastritis). Duodenum was the most frequent site of solitary ulcers, as well as exacerbated chronic peptic ulcers.

Complications of PGDU were found at autopsy in 40% of all cases with stress ulcers, mostly in form of hemorrhage, and rarely as perforation, and penetration. In 20% out of all 157 cases with PGDU in the retrospective part of the study, the postmortem diagnosed complications of PGDU were proclaimed to be a cause of violent death in the autopsy protocols (mostly mutually with primary injuries).

In the medicolegal expertise of cases with PGDU, three main problems usually appear: (1) estimation of severity of primary injuries, (2) establishing of causative relationship between the primary injuries and lethal outcome in cases with fatal complications of PGDU (mostly hemorrhage with resultant exsanguination), and (3) possible accusation of treating physicians for medical negligence.

Medico-Legal Aspects, Stress Ulcer, Trauma

G65 Death Caused by Cardioinhibitory Reflex: Myth or Reality?

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The goal of this presentation is to inform the medicolegal community about the different practices in using the cardioinhibitory reflex.

This presentation will impact the forensic science community by informing the medicolegal community about the mainstream opinion.

It has been known for hundreds years that pressure applied to the carotid sinus region may result in unconsciousness and convulsions. Hering and Heymans demonstrated that stimulation of the carotid sinus region results in a number of reflexes, with effects on the cardiac rhythm, vascular tonus, and respiratory function. Ever since, a number of reports dealing with cases of death after mechanical pressure (such as strangulation, short-termed neck trauma and/or other traumatic injuries) against the carotid sinus region were published in the literature. The autopsy signs were the lack of local vital signs (such as absence of congestion, cyanosis, petechiae), indicating a very short agony possibly due a reflex mechanism.

In recent times, there has been an observed increase in numbers of clinical forensic cases in which the victim have suffered neck compression. Some victims show suggestive signs (e.g., petechiae, bruises). Other victims do not show any objective signs but anamnestic subjective symptoms are consistent with neck compression. The role of the forensic expert is to evaluate if there was life endangerment subsequent to compression based on objective and subjective findings.

The question whether 'violence against the neck may cause life endangerment by cardio-inhibitory reflex' is often the subject of discussion in medicolegal practice. The answer to this question may have important consequences in penal jurisprudence, particularly in cases in clinical forensic medicine.

In order to evaluate this question we mailed six questions in the framework of a qualitative and quantitative study to the members of different organisations of legal medicine: IALM, AAFS (International listing), NAME, French Society of Legal Medicine, German Society of Legal Medicine, and the Swiss Society of Legal Medicine.

The survey was conducted by E-Questionnaire based on the opinion, experience, and collaboration of several experts from about thirty countries.

The two principle questions were: (1) can cardioinhibitory reflex subsequent to neck injury cause death (forensic pathology)? And (2) can cardioinhibitory reflex subsequent to neck injury cause life endangerment (clinical forensic medicine)?

The questions required the participants to specify how often they made this kind of diagnosis and on which criteria they based their conclusions. Criteria for forensic pathology included the following: provided information, postmortem examination (macroscopic), histological examination, complementary investigations (such as medical imaging), or by elimination.

Criteria for clinical forensic medicine included the following: provided information, subjective findings (such as spots before the eyes, loss of consciousness), objective findings on the victim, complementary investigations (such as medical imaging), or by elimination. Other variables concerning the forensic experts were the following: active - emeritus, years of experience in forensic pathology and/or clinical forensic medicine, principal discipline of activity: forensic pathology, clinical forensic medicine, genetics, and toxicology.

The preliminary analysis indicates that over two-thirds of the participants believe that neck injury can induce a cardioinhibitory reflex and therefore life endangerment is possible. About a third of the experts use the cardioinhibitory reflex in their medicolegal opinions to confirm life endangerment in clinical forensic medicine or as a cause of death. They base their diagnosis on different criteria.

Cardioinhibitory Reflex, Neck Compression, Life Endangerment

G66 Ehlers-Danlos Syndrome Type IV (Vascular): An Atypical Presentation and Unexpected Diagnosis in a Medical Examiner Setting

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After attending this presentation, attendees will have a basic knowledge of the pathophysiology of the Ehlers-Danlos Syndrome, particularly the most severe form, Ehlers-Danlos Syndrome Type IV. They will also learn some of the basics of the genetic testing performed and be made aware of resources available should this diagnosis be suspected.

Because Ehlers-Danlos Syndrome can result in premature death, which may be related to trauma or even mistakenly thought to be due to trauma, this presentation will impact the forensic science community by demonstrating how it is important for medical examiners and forensic investigators to be aware of this clinical entity and have a basic understanding of the pathophysiology.

Ehlers-Danlos Syndrome is a group of genetically inherited defects in collagen synthesis characterized by a wide array of clinical manifestations and with diverse clinical presentations. Because Ehlers-Danlos Syndrome can result in premature death, which may be related to trauma or even mistakenly thought to be due to trauma, it is important for medical examiners and forensic investigators to be aware of this clinical entity and have a basic understanding of the pathophysiology. This presentation will accomplish those goals using a recent case as an example.

There are six recognized major types of Ehlers-Danlos Syndrome, all of which vary somewhat in biosynthetic defect, mode of inheritance, and clinical presentation. The common feature among the subtypes is decreased tissue tensile strength, particularly tissues rich in collagen. Elhers-Danlos Syndrome type IV is the most severe form because the defect involves type III collagen and may result in the rupture of large blood vessels or organs. Complications include arterial and bowel rupture and, in pregnancy, rupture of the uterus at delivery.

A recent case at the Office of the Armed Forces Medical Examiner-Pacific Region demonstrated the importance of considering diseases like Ehlers-Danlos Syndrome in the differential diagnosis. An adolescent female developed right flank pain and was treated presumptively for a urinary tract infection. After a week of both outpatient and inpatient management her condition did not improve. The patient collapsed while getting out of a vehicle and sustained a large scalp laceration. She subsequently went into cardiac arrest in the Emergency Department and died in the operating room of the local medical treatment facility.

During the autopsy the medical examiner was struck by the friability of the patient's connective tissue, particularly the mesentery. Multiple vascular defects and complete avulsion of one kidney with partial avulsion of the vascular pedicle of the other kidney were noted. A connective tissue abnormality, such as Ehlers-Danlos Syndrome, was suspected based on the gross anatomic findings. A microscopic examination demonstrated organizing hemorrhage outside of the adventitia of the right renal artery, indicating that the rupture had evolved over a period of time.

The medical examiner consulted with a research laboratory that specializes in the Ehlers-Danlos Syndromes. Frozen tissue specimens were provided and spleen was used to extract DNA for analysis. The researchers identified a mutation in one allele of the COL3A1 gene that is located on chromosome two. The effect on the gene product was deletion of 18 amino acids from the protein, accounting for the clinical presentation and autopsy findings.

In retrospect the family related that their daughter had always bruised easily and sustained unusually severe lacerations for seemingly minor trauma as a child. She also had some of the characteristic facial and skin features of Ehlers-Danlos Syndrome as well as the classic finding of joint laxity. Routine laboratory studies performed years earlier to evaluate the problem of easy bruising were all within normal limits.

An accurate diagnosis was extremely important to provide closure for a family that was attempting to understand how their daughter could be diagnosed with a urinary tract infection and die one week later. Establishing a diagnosis was critical for the clinicians who took care of this patient, all of whom were initially left wondering if there was anything they could have done to change the outcome. It was also essential to recommend genetic counseling for the parents and siblings of the deceased, particularly since Ehlers-Danlos Syndrome Type IV is typically inherited in an autosomal dominant mode.

Special acknowledgement to Peter Byers, MD, Ulrike Schwartz, MD, and Melanie Pipin, MS, in the Department of Pathology, University of Washington, Seattle, Washington, for performing the genetic testing and providing technical information and support.

Collagen, Vascular, Genetic

G67 Mechanisms of Delayed Splenic Rupture: A New Hypothesis

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After attending this presentation, attendees will understand a new hypothesis which describes a potential mechanism of delayed splenic rupture.

This presentation will impact the forensic community by introducing a new mechanism of delayed splenic rupture. Also it impacts the medical and surgical communities as it guides to reduce the high mortality rate in delayed splenic rupture.

A 46-year-old man was assaulted with a club to the face and chest and sustained multiple contusions. On admission there were no signs of circulatory shock. The abdominal examination was unremarkable. During his stay in hospital he had light diets due to pain and loss of appetite. He was managed symptomatically and discharged five days after the incident.

Two hours after discharge he was admitted again with a complain of severe abdominal pain. He claimed that soon after his return to home, he ate two full plates of rice and curry, three mangos, and drank two glasses of water as he was so hunger and developed appetite for home made food. Immediately after the diet he experienced this abdominal pain.

On admission, he was pale with a pulse rate of 116 beats per minute and a blood pressure of 60/30 mmHg. There was a marked tenderness with rigidity and guarding on abdominal palpation. Bowel sounds were attenuated. Hemoglobin level had dropped to 7.2 g/ dl from a level of 10.5 g/dl within five hours. Two pints of blood were transfused. Although it was planned to do an ultrasound scan of abdomen the patient was pronounced dead thirteen hours after admission.

Autopsy revealed a generalized pallor. The abdomen was distended. A contusion of 8x3.5 cm was seen on left lower chest laterally. There were no rib fractures. A hemoperitoneum of 2300 ml was noted. The spleen was within the normal range. A hematoma of 2.5x3x1.5 cm was seen overlying a splenic laceration on the gastric area of the visceral surface. The laceration was 1.25 cm in length with a depth of 0.25 cm, involving splenic capsule and parenchyma. The body of the empty stomach was in contact with this hematoma. Histological examination confirmed the perisplenic haematoma of otherwise normal spleen.

The mechanism of this serious and possible life threatening complication is still not fully understood. There are a number of potential mechanisms for delayed splenic rupture.

Intrasplenic hematomas, pseudoaneurysms of intraparenchymal splenic artery branches, and asymptomatic splenic pseudocysts all of which develop following abdominal trauma and rupture, possibly days, months or years later are three mechanisms suggested in this context. Also bleeding from a splenic rupture could be tamponaded by surrounding organs and /or perisplenic haematoma formed at the time of injury, delaying its rupture at a later date.

The visceral surface of the spleen consists of gastric, colic and renal surfaces. The gastric surface is directly in contact with the body of the stomach. Therefore a perisplenic hematoma which plugs the splenic laceration on the gastric surface temporarily, may easily be dislodged by the mechanical forces exerted by distending stomach, causing fatal intraperitoneal hemorrrhage. Such risk is imminent during the early period of regeneration of splenic laceration where wound breaking strength is relatively low.

In this case, the laceration occurred at the time of assault was plugged temporarily by the hematoma. On day five, pressure exerted by full stomach after the heavy solid meal, dislodged the hematoma causing hemorrhage from the site of laceration.

The pressure exerted by full stomach after heavy solid meals may disturb perisplenic hematoma overlying a laceration on the gastric surface of the spleen causing delayed splenic rupture leading to sudden fatal intraperitoneal hemorrhage.

It is advisable to maintain a light liquid/ semisolid diet instead of a heavy solid meal during the period of recovery of the patients who are having perisplenic haematomas due to lacerations on the gastric surface of the site of laceration.

Delayed Rupture, Spleen, Mechanisms

G68 Death of a Vampire?: Case of Exhumation and Mutilation of a Corpse in Rural Romania

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After attending this presentation, attendees will have a better understanding on how the mis- interpretation of decompositional artifacts have contributed to beliefs, superstitions and the myth about the existence of vampires. Attendees will be shown a video clip of the actual forensic grave side examination of a reported "vampire" who was put to his final death by family members.

Even before the famous classic tale of horror "Dracula", written by Bram Stoker in 1897, the belief of vampires can be traced back as far as the fifteenth century to various parts of Europe. Of all the various countries and regions steeped in the belief of vampires and the undead, none run so deep as in the country of Romania. The belief in vampires is rooted in many cultural beliefs regarding the after life such as the acknowledgement of Satan and his monstrous minions. Another important aspect of the belief in vampires is based on the mis-understanding of the changes that occur to the body as the result of the decompositional process. Misunderstood changes include the postmortem purging of bloody fluids from mouth and nose which were thought to be evidence of recent feeding, and the appearance that the hair and nails continue to grow after death. Other examples of mis-conception include the presence of guttural sounds from the deceased as the result of expelled post mortem gases, and the postmortem pink and reddish discolorization of the skin which gave the appearance that a corpse had returned to life.

A prime example of the deep seated cultural belief in vampires in parts of rural Romania is demonstrated in a recent case which involves the exhumation, and mutilation of a corpse. In December of 2003 a seventy-six year old retired school teacher in the rural Romanian village of Marotinul de Sus died. At his death, the elderly male was placed in a simple wooden coffin, which was then buried in a shallow grave located below a make shift stone vault. Later in time various relatives of the deceased begin to fall ill and claimed to have had dreams in which the deceased had risen from the dead as a vampire to drink their blood. As a result of the unexplained illnesses, and terrifying dreams, several family members made the decision to follow the ancient cultural tradition, and destroy their now believed undead family member.

In July of 2005 six family members traveled to the cemetery under darkness, and exhumed the body of their deceased relative. Waiting to the stroke of midnight a member of the group drove a pitchfork into the chest of the corpse, and then opened the chest cavity with a large knife, and removed the heart. The corpse was then repeatedly stabbed in various locations with wooden stakes, and garlic sprinkled over the body. The group departed the cemetery with the heart impaled on the pitchfork, and proceeded to a near by crossroads. At the crossroads, the family members burned the heart, then mixed the ashes with peppermint schnapps, and drank the concoction. As a result of their actions, they no longer felt ill, and their terrible dreams of their vampire relative were no repeated.

Later in time, word of this macabre ritualistic act made its way to the daughter of the deceased, and local authorities. A second exhumation of the corpse was ordered by authorities investigating the horrific act, in which a grave side forensic examination was conducted by a forensic pathology team. The grave side examination by the forensic pathology team corroborated the story of the mutilation, including the removal of the heart. A video clip of the actual grave side examination will be presented.

As a result of the seemingly indignant and horrid act, the six family members who had participated in the mutilation of the corpse were arrested and sentenced to six months in jail. The arrest of the family members, greatly angered local villagers who indicated that this was a practice that been conducted by locals for many centuries. Many villagers praised the action carried out by the six, noting that it was a great thing to take out his heart as the people were in danger. Other villagers confessed to have taken the hearts from the dead many times before, and to have drunk a solution containing the ashes of the heart. In their own defense, the leader of the six family members pleaded innocent, having done nothing wrong. The leader informed the police that when they exhumed the corpse he had blood surrounding his mouth, and that he moaned when they stabbed him with the pitch fork. Pleading with authorities the head family member stated that if he hadn't conducted the ritual, that his son, wife, and daughter- in- law would have died.

Decomposition, Postmortem Mutilation, Ritual

G69 Sickle Cell Disease and Sudden Death

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The goal of this presentation is to educate and alert the forensic community to the common causes of death in sickle cell patients.

This presentation will impact the forensic community by demonstrating the importance of recognizing pulmonary complications at autopsy that are frequently seen in the sickle cell population and which are responsible for causing sudden death. Lastly, the possibility of sickle cell disease should be entertained in any young African-American person who dies suddenly and unexpectedly without a known history of sickle cell disease.

Sickle cell disease afflicts one of every 650 African Americans and an estimated 8% of African Americans are heterozygous for the sickle cell gene. Sickle cell anemia is attributed to profound morbidity as well as mortality to those afflicted with the disease. In the clinical setting, sickle cell anemia can present as recurrent infection especially in the younger population and as sickle cell pain crisis, stroke, and sudden death in the adult population. In 1949, the discovery that sickle hemoglobin exhibited an abnormal electrophoretic mobility has pioneered our current understanding that sickle cell disease is a molecular disease/diagnosis. With the advent of immunizations and vaccinations, antibiotic therapy and the implementation of newborn screening programs, the mortality rate of individuals with sickle cell disease has declined.

Although morbidity and mortality from sickle cell disease has declined in recent years, a subset of patients die from sudden and unexpected deaths. The most common causes of sudden death in individuals succumbing to sickle cell disease are acute and chronic pulmonary complications that encompass pulmonary edema, pulmonary thromboembolism/thrombosis, and pulmonary hypertension. Although the literature comments on the presence of pulmonary thromboembolism as a frequent autopsy finding, the literature is unclear as to whether these patients also exhibited deep venous thrombosis. Therefore, sickle cell patients may not share the same risk factors for development of pulmonary thromboembolism as the rest of the population (i.e., recent surgery, obesity, and immobilization). Instead, sickle cell patients may undergo pulmonary thrombosis as a consequence of in-situ sickling of red blood cells within blood vessels during hypoxic episodes. For forensic pathologists who perform autopsies on all cases of sudden death, the history of sickle cell disease may be absent or may never have been diagnosed, especially in athletic adolescents. Therefore, in those individuals who are of African American race, younger age, and presenting with pulmonary thromboembolism/thrombosis in the absence of known associated risk factors, the importance of a thorough autopsy examination including a detailed gross and microscopic examination of the heart and lungs, and dissection of the lower extremity veins, in conjunction with postmortem hemoglobin solubility/electrophoresis tests are underscored.

During the past year at the Cook County Medical Examiner's Office in Chicago, IL the authors have encountered two (2) cases of young African American individuals (one female at 31 years old and one male at 38 years old) who carried a diagnosis of sickle cell disease and who were found unresponsive with no known antecedent symptoms. After a complete autopsy, the cause of death in both cases was pulmonary thromboembolism/thrombosis in the absence of deep venous thrombosis. In both cases, the microscopic sections displayed acute and organizing pulmonary thrombi. In addition, both cases displayed severe pulmonary hypertensive changes characterized by thickened pulmonary arterioles and plexiform arteriopathy.

Given these findings, the decision was made to pull all cases of young African American individuals who died suddenly from pulmonary thromboembolism/thrombosis without a known history of sickle cell disease over a two year period. Three (3) additional cases were identified and consisted of two females and one male (ages 20-40s). Hemoglobin solubility tests were performed on the postmortem blood of these individuals. The hemoglobin solubility tests were negative in all three cases. Although the tests were negative, we eliminated the possibility of sickle cell disease as a contributory factor and upon further review of these cases, all these cases demonstrated deep venous thrombosis, and an identifiable risk factor was observed in one case.

Sickle cell disease is a common disease that afflicts the African American population. For forensic pathologists, the findings of pulmonary thrombosis in the absence of deep venous thrombosis and associated risk factors in the young African American population should alert the forensic pathologist to the possibility of sickle cell disease and further laboratory testing of postmortem blood for hemoglobin solubility.

Sickle Cell Disease, Sudden Death, Pulmonary Complications

G70 The Biochemical Alteration of Soil by Decomposition Products

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After attending this presentation, attendees will understand the importance of soil analysis in cases involving decomposed remains, and the correlation of soil composition changes with the decomposition period.

This presentation will impact the forensic community by serving as a potential tool for estimating the postmortem period and may have implications for both forensic and human rights investigations.

Decomposition chemistry refers to the chemical degradation processes which occur in soft tissue as decomposition proceeds. These processes involve the breakdown of the body's main constituents including proteins, carbohydrates and lipids. Lipids represent an important biomarker of decomposition as they are not easily degraded and can be retained in the soil environment for extended periods. Currently, there are few techniques which can provide an accurate estimation of the postmortem period. When a body decomposes in a soil environment the currently available techniques become even less accurate.

The aim of this study was to investigate the relationship between the release of decomposition fluids into a soil environment and their potential correlation with the decomposition period. The study was conducted in the southern region of Ontario, Canada during the summer months of July and August. Pig carcasses were used as acceptable models for human decomposition and were allowed to decompose on the surface of the soil until skeletonization occurred after approximately 100 days. Soil samples were collected from the region directly beneath the carcass at varying decomposition intervals. The total microbial biomass was determined by measuring the extractable lipid phosphate and the fatty acid content. Samples were analyzed by chromatography and spectroscopy techniques. The soils were characterized using particle size analysis and variations in total carbon, nitrogen, phosphorous, pH and moisture content were also investigated.

The study identified a significant increase in the amount of total nitrogen and soil extractable phosphorous released into the soil. However, the total available carbon did not increase significantly with time. Lipid-phosphate and fatty acid concentrations also increased with time confirming that there was a flux in the microbial biomass present in the soil. The pilot study was able to highlight the forensic potential of these techniques for estimating the postmortem period and promoted ongoing studies in this area. The results have the potential to be used in a forensic investigation involving remains which have decomposed for an extended period in a soil environment.

Decomposition, Soil, Postmortem Period

G71 A Cadaver Encased Within Concrete: A Case Report

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The goal of this presentation is to present an amazing case report on a cadaver encased within concrete.

This presentation will impact the forensic science community by showing the particularities of the crime scene and the autopsy of this deceased person.

Encasings within concrete are relatively rare forms of hiding or disposing of a body. At first, these cases are often treated as "matters involving a missing person". In this case report, the circumstances and findings are described in which a body was encased within concrete. It is of importance to note that the body may be preserved quite well in concrete, which allows not only the identification of the victim but also the determination of the cause of death, even after a prolonged postmortem interval.

A male cadaver aged 65 is discovered in reinforced concrete in a cellar. Circumstances of his death, circumstances of his burial, identification, autopsy findings, and the perpetrator's behavior are described. In March 2003, Mr P's brother goes to the Police Department and says he hasn't seen his brother for five years. The police investigations lead to his wife. She says her husband was very violent physically with herself and their son. Five years ago, during summer, her husband fell on the floor in their house. Because she was afraid of his reactions, she went away from the house, came back three weeks later and discovered her husband dead, still at the same place. She decided alone to remove the body. With the help of her son, she put her husband in her car, enveloped in several layers of tissues, and deposed him in a cellar of another house. She said she built a wall alone and placed the body under 70 centimeters of reinforced concrete.

Crime scene and autopsy findings are described. The body was found dressed like on the day of his death. His wife had put a plastic bag on his head and pins on his nose. She said it was to avoid a putrid flow. She wrapped the body into several blankets. The body was putrefied (three weeks of putrefaction) and conserved in the same state. Identification was easy, rapid, and completed odontologically. No traumatic lesions were discovered during the autopsy. Several hypotheses were proposed for the manner of the death: toxic, natural or asphyxia by plastic bag. Anthropological analysis is detailed to determine the origin of the lesions. On the body, in the blankets, *Calliphora vicinae* larvae and *Calliphora vomitaria* pupae were discovered. An entomologist expert tried to precisely determine the postmortem delay since it was crucial for the investigations to conclude the delay between the death and the encasing in the cellar. These findings are compared to police investigations. These findings are compared to literature on bodies disposed in reinforced concrete, on the behavior of this woman. The body conservation is detailed according to different methods of burial. Moreover, after denunciation, selenium intoxication was suspected. The investigation and findings on selenium are described.

This case is amazing, and has required a multidisciplinary approach to be elucidated. The authors underline, one more time, the importance of the description of the death scene associated with the autopsy findings to understand and to conclude on the cause and the manner of death.

Anthropology, Concrete, Entomology

G72 A Degloving Experiment to Suggest Postmortem Interval: Give the Anthropologist Some Hands From Freshwater

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Following the presentation, the attendee will know the results of a unique experiment to determine the minimum length of time necessary for a pair of human hands to be degloved after being submerged in freshwater at 21°C.

This presentation will impact the forensic science community by using the degloving of human hands to suggest the postmortem interval.

A unique experiment was performed during spring 2007 in response to an unusual request from a defense attorney. In late March 2007 an attorney inquired if human hands could be "degloved" after being submerged in freshwater for a period of 36 hours at a water temperature of approximately 70°F. Of particular interest was the minimum length of time necessary for human hands to be "degloved" under the specified conditions. "Degloving," or the removal of the entire epidermal skin surface of human hands has been well documented as resulting from both: (1) some types of accident, and (2) natural phenomena occurring after hands have been submerged for an extended period.

In this particular instance specific aqueous parameters needed to be addressed, such as the type of water (freshwater over that of a marine environment), complete submergence of the hands, and a water temperature of approximately 21°C (70°F). Following a preliminary literature review it was determined that most information on degloving was anecdotal (Aggrawa 2005, Anderson and Hobischak 2004, Boyle, Galloway and Mason 1997, Kovarik, Stewart and Cockerell 2005, Rodriguez, 1997). Therefore, a unique experiment was proposed, and ultimately agreed upon.

Over the next few weeks the University of California Davis Donated Body Program (UCD-DBP) in central California was contacted. Specifically, arrangements were made to acquire two freshly harvested human forearms with the intent of soaking them in freshwater, and to the best degree possible, emulating the conditions of a canal described by the attorney and documented by the relevant county's Water Quality Control Board. It seems the canal, which is used for agricultural irrigation and thus well monitored, passes through a county in which a decedent had previously been recovered. At issue was the postmortem interval and thereby a possible alibi for the attorney's client. Water temperature and speed of water flow for the central California canal were recorded throughout the period relevant to the investigation.

Thus, to determine the length of time necessary for degloving to occur a controlled degloving experiment was initiated. By May 18, 2007 arrangements had been made to pick-up two forearms on that date from the UCD-DBP. A left (UCD-07-048-UL-FL) and a right (UCD-07-048-UL-FR) forearm was acquired from an 89 year-old female who had died from cardiopulmonary arrest shortly before becoming a part of the experiment. Both forearms had been removed from the decedent during the morning of there acquisition. They had been refrigerated until approximately 1400 hours when they were then transported to the CSU, Chico Human Identification Laboratory for the experiment. By 1800 hours on May 18, both the forearms had been prepared for being submerged in a stainless steel water bath maintained at a near constant water temperature of 21°C (70° F) for the next ten days. Preparation included: initial photographs of both the arms and hands, sealing the disarticulated proximal ends with rubber seals and additionally covered with waxed polyseal, preparing the stainless water bath with a thermometer, and filling the bath with un-chlorinated, room temperature, fresh water. The proximal ends of both arms were sealed to prevent water from entering beneath the skin from the disarticulated ends. Additionally, both arms were submerged to slightly below the seals for the same reason.

The arms were then monitored every six (6) to twelve (12) hours for changes in color, odor, and general appearance, including the degree of skin-slippage. Additionally, the water temperature was carefully monitored on each occasion the forearms and hands were checked. The observational process was maintained throughout the first 42 hours of the experiment, after which the arms and hands were checked only twice a day, in the early morning and early evening (i.e., at 600 and 1800 hrs.).

During the entire experimental period the highest and lowest water bath temperature achieved was 24°C and 18°C, (75.2ºF and 64.4°F, respectively) while the average water temperature was 20.5°C (68.9°F). Periodically water was removed from the bath and replaced with fresh, unchlorinated water of an appropriate temperature to more accurately reflect the conditions described by the Water Quality Control Board for the canal's condition. Thus, every day from three to four liters, or approximately three to four quarts, of water were removed and replaced.

Both hands acquired the classic "washer women's appearance" during the first six hours and continued to worsen over the first 36 hour period. By the end of the second day (i.e., 42 to 48 hours) deep wrinkles appeared and very minor skin-slippage began to appear. Photos were taken, and neither hand was capable of being "degloved" at the end of 36 hours, nor at the end of 48 hours. By day four both hands had begun to become discolored (dark pink), as gases and odor became apparent. During the fifth day (96-120 hrs.) marbling of black and blue colors was acquired, odor increased, and marked bloat of gases was found at the proximal ends beneath the rubber seals (i.e., the ends where the disarticulation had occurred). During day six (by 141 hrs.) both hands had become increasing marbled black and blue as skin-slippage also increased. During the seventh day (between 160 and 168 hrs.) an attempt to deglove the right hand failed but resulted in tearing the skin on the dorsal surface. The left hand had developed a large blister at the anterior wrist where putrid fluid had accumulated. Gases continued to be produced at the proximal ends of both arms but to a greater extent on the right than the left. Simply, the skin on the left hand was generally more firmly attached than that of the right. Photos were taken of the tear and the blister as well as the general deteriorating condition of both hands. On day eight (182 to190 hrs.) the degree of skin-slippage increased on the dorsal and anterior surfaces but the skin of all the fingers remained moderately attached. There was a marked difference between slippage on the right versus the left hand, with the right hand proceeding more rapidly. During day nine (at 204 hrs. into the experiment) the right hand was "degloved," although the skin of some of the fingers and all the fingernails remained attached. The left hand was still not ready to be "degloved" on day ten. However, at 256 hours into the experiment, or after 10.5 days, the left hand was "degloved," although once again, the skin of some of the fingers and all the fingernails remained attached.

It was concluded that freshly acquired fleshed human hands submerged in freshwater at a temperature of 20.5°C could be "degloved" after a minimum period of nearly 200 hours. However, additionally, it was concluded that because the skin of the fingers as well as the nails never become completely detach during the experiment (as they had in the questioned case) it would very likely take much longer for such degloving to occur. Since all chemical and decomposition processes are temperature dependant the temperature of the water can be expect to play a critical role in the length of time necessary degloving to occur. Also of note, because the experimental hands were acquired from an 89-year-old decedent (i.e., one much older than the decedent prompting the experiment) a decedent's age or health status needs be considered in affecting the experimental result – the attachment and elasticity of connective tissue between the epidermis and dermas in younger versus older persons could be expected to play a role. If that were the case the length of time for degloving to occur in a young healthy male should be expected well after the 36 hour period in question.

Degloving, Postmortem Interval, Freshwater Death

G73 Parasitic Wasps: Succession, Development, and Forensic Importance as PMI Indicators

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After attending this presentation, attendees will understand the potential forensic value of parasitic wasps associated with decomposing remains in determining time since death. Aspects of parasitoid biology and behavior in regard to carcass attendance and insect development will also be discussed for use in the estimation of a postmortem interval (PMI).

This presentation will impact the forensic science community by. These results provide biological and developmental data for forensically relevant species of parasitic wasp for use in determining time since death in forensic investigations. Data gathered will improve the accuracy of PMI estimations in cases where decomposition has advanced beyond the life cycle of flies, the traditional indicators of time since death. Discussion of the relevance of the results presented here to forensic cases will establish the importance of parasitic wasps as forensic indicators of time since death and our findings provide reference data required for accurate PMI estimation.

Knowledge of the predictable pattern of insect succession onto a carcass and the relationship between temperature and larval development has proved invaluable in estimating PMI. To date forensic entomologists have focused on the use of synanthropic flies, particularly Calliphorids as forensic indicators of time since death. However, where time since death extends beyond the larval development time of these commonly used species, only a minimum PMI can be estimated. For instance, where only empty fly pupae cases are recovered from a crime scene the time lapse between the emergence of adult flies from the pupae cases and the discovery of the body is unknown. In such cases, the presence of parasitic wasp larvae within insect hosts such as fly pupae can be used to estimate an extended PMI.

The order Hymenoptera contains an extremely diverse range of insects, including numerous parasitic wasps or more accurately "parasitoids." The term "parasitoid" encompasses those arthropod species whose larvae feed exclusively on the body of an arthropod host, eventually killing it. Parasitoids use a broad spectrum of hosts including necrophagous insects found in association with decomposing remains (Archer & Elgar, 2003).

Use of parasitoids as tools in criminal investigations requires; baseline data on the temperature-dependant development of both the host and parasitoid species; knowledge of the development stage at which the female wasp parasitizes the host; and an understanding of the factors involved in host location within a decomposition habitat. Currently, there is a paucity of relevant reference data and the research that is available is either geographically specific or is focused on parasitoid species used as biological control agents of filth flies rather than in a forensic context.

In this study, the species and biology of parasitic wasps associated with decomposing remains in Western Australia and their relevant host species were investigated. A monthly survey of relevant insect fauna frequenting decomposing remains was conducted. Domestic guinea pig carcasses (*Cavea porcellus*) were used as an attractant. The stage of decomposition at which the observed parasitoid species attended carcasses, species seasonality and rates of parasitization in the field were identified. Predominant species identified included *Tachinaephagus zealandicus* Ashmead (Hymenoptera, Encyrtidae) and *Nasonia vitripennis* Walker (Hymenoptera, Pteromalidae). Base-line reference data on the temperature-dependant development of both of these parasitoid species were also established under laboratory conditions.

These results provide biological and developmental data for forensically relevant species of parasitic wasp for use in determining time since death in forensic investigations. Data gathered will improve the accuracy of PMI estimations in cases where decomposition has advanced beyond the life cycle of flies, the traditional indicators of time since death. Discussion of the relevance of the results presented here to forensic cases will establish the importance of parasitic wasps as forensic indicators of time since death and our findings provide reference data required for accurate PMI estimation.

Entomology, Parastic Wasp, Postmortem Interval

G74 Difficulties in Determining Sex From the Skull: Considering Conflicting Lines of Evidence

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The goal of this presentation is to demonstrate that forensic scientists should understand and employ all available scientific techniques when analyzing human remains, as well as to emphasize that individuals performing forensic osteological analysis must possess a firm understanding both of modern human variation and of the theoretical subtleties of the methods employed to study such variation.

This presentation will impact the forensic community by emphasizing the importance of: (1) a firm foundation in patterns of modern human biological variation, (2) an equally firm understanding of the theoretical and practical strengths and limitations of the methods employed in sex determination, (3) an education in statistics in order to realize that misclassification is not random and can usually be traced to some morphological idiosyncrasy of the remains in question, and (4) a demonstration of the value of using all available scientific methods to determine biological sex from the human skeleton.

A common misconception held by non-anthropologists is that the determination of biological sex from human skeletal remains is relatively easy and/or straightforward because there is a 50% chance of just "guessing" the correct sex assignment. While it is true that forensic anthropologists are extremely accurate at sex determination, they are also aware of the potential sources of error within their assessments, as well as the potential error associated with the external interpretation of their analyses.

Determining sex from gross skeletal morphology can be accomplished via both non-metric and metric techniques. Non-metric techniques examine sexually-dimorphic patterns of discrete skeletal trait expression to distinguish between males and females. Metric techniques rely on the quantification of size and shape differences between males and females, as measured from several diagnostic skeletal elements. The determination of sex using metric methods is most frequently accomplished via the discriminant functions calculated by the FORDISC software (Ousley and Jantz, 1996). Both non-metric and metric approaches to sex determination rely heavily on the os coxa and cranium, which are the two most reliably-diagnostic skeletal elements. Though the os coxa is the preferred element for sex assessment, unfortunately this element is not always present in the remains available to forensic anthropologists for analysis. Indeed, many forensic anthropology cases consist solely of isolated skulls or crania. Not surprisingly, accurate sex determination becomes increasingly difficult in instances of heavily fragmented or largely incomplete skeletons.

Regardless of the techniques or skeletal elements used in the analysis, the forensic anthropologist's ability to accurately assess the sex of unidentified skeletal remains may be stymied by individuals who are atypically skeletally robust or gracile, or by individuals who originate from populations which are outside the forensic anthropologist's sphere of experience. The possibility of encountering such individuals therefore places several critical demands on the forensic anthropologist, including: 1) a firm foundation in patterns of modern human biological variation, and 2) an equally firm understanding of the theoretical and practical strengths and limitations of the methods employed in sex determination. Additionally, the forensic anthropologist should be well educated in statistics in order to realize that misclassification is not random, and can usually be traced to some morphological idiosyncrasy of the remains in question. Collectively, these considerations caution against the hasty interpretation of the results of anthropological analyses, as they may not always be as clear-cut as a cursory examination of the conclusions may suggest.

This presentation will impact the forensic community by demonstrating the value of using all available scientific methods to determine biological

sex from the human skeleton. Two cases will be presented in which the only skeletal element available for analysis was the skull. In the first example the non-metric analysis was suggestive of a female and was supported by FORDISC's sex-only function; however, when ancestry was considered, the specimen was classified as a male. In the second example, both the metric and non-metric analyses suggested female. However, the individual's ancestry was questionable and the skull may have represented a male from a population of small, gracile individuals. The atypicality of both specimens alerted the forensic anthropologist to possible interpretational issues which warranted further investigation. In order to supplement the osteological analysis, samples from each individual were sent for genetic sex determination. While it is understood that there are also errors associated with genetic sex determination, this reemphasizes the forensic anthropologist's need to understand modern human variation and the available scientific methods to study variation. Each case will be discussed with an emphasis on sex determination by both osteological and genetic means, as well as a critical assessment of the interpretational error associated with each.

Sex Determination, FORDISC, DNA

G75 Molecular Genetic Testing in 323 Cases of Fatal Pulmonary Thromboembolism in the City of New York Revealed Racial Stratification

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The goal of this presentation is to investigate the frequency of these genetic risk factors in fatal PE and to understand the genotype and phenotype correlation.

This presentation will impact the forensic science community by presenting detailed characterization of the mutation spectrum in fatal PE is vital for providing accurate diagnosis of cause of death and efficient preventative treatment to the high-risk family members.

Fatal pulmonary thromboembolism (PE) is a common cause of death encountered in the forensic pathology setting and usually presents as a complication of deep venous thrombosis (DVT). The pathogenesis of venous thrombosis is multifactorial and requires interaction between both inherited and acquired risk factors. Heterozygous or homozygous Factor V Leiden (G1691A) or prothrombin (G20210A) mutations, and homozygous MTHFR (C677T) variant have been recognized as common independent genetic risk factors in DVT. In order to investigate the frequency of these genetic risk factors in fatal PE and to understand the genotype and phenotype correlation, we have validated a genetic testing method to detect the three common mutations.

Testing was conducted using multiplex PCR-SNaPshot technologies on postmortem tissue and blood samples. Between March 2005 and May 2007, we tested 323 fatal PE cases from the New York City Office of Chief Medical Examiner. The authors found that 48 of the 323 cases were positive for at least one mutation. The genetic testing results were categorized by the demographic data and acquired contributing factors. The overall frequency of three mutations in PE cases was found is highest in Whites (34.15 %), followed by Hispanics (28%), very low in Blacks (3%), and zero in Asians. In contrast, the number of fatal PE instances in our study is highest in Blacks (54.8%), followed by Whites (25.4%), and Hispanics (15.5%), and very rare in Asians (1.5%). Blacks were also associated with a high percentage of idiopathic PE with unknown acquired contributing factors. This study suggests that there are racial disparities in genetic risks contributing to fatal PE. In addition, comparing the incidences of PE in different races to the racial composition in New York City residents (44.7% Whites, 26.6% Blacks, and 9.8% of Asians), Blacks showed the highest incidences of fatal PE. Further research focused on delineating the genetic risks in black populations is warranted. Detailed characterization of the mutation spectrum in fatal PE is vital for providing accurate diagnosis of cause of death and efficient preventative treatment to the high-risk family members.

Molecular Genetic Testing, Fatal Pulmonary Thromboembolism, Racial Stratification

G76 The Pathologist's Role in Preserving Implanted Pacemakers and Cardiac Defibrillators or How Not to Get Shocked!

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After attending this presentation, attendees will understand the standardization of techniques for safe and effective explantation of implanted electric cardiac devices such as pacemakers, defibrillators, and leadwire systems.

This presentation will impact the forensic science community by demonstrating how careful adherence to recommended procedures by medical examiners will minimize damage to retrieved implanted cardiac devices (pacemaker, ICD, CRT-D and leads), and will facilitate postmortem device analysis and cause of death determination. In addition, appropriate pre-extraction planning of methods for removing implanted defibrillator leads will reduce risk of electrical shock for personnel.

Permanent implantable electrical cardiac devices such as Pacemakers, Implanted Cardiac Defibrillators (ICDs), and Cardiac Resynchronization Therapy-Defibrillators (CRT-D) are common therapies. On occasion, the function or malfunction of such devices has been suspected in patient deaths, especially in view of recent large recalls. It is possible to determine what role, if any, an implanted cardiac device could have played in a patient's death from postmortem examination of a retrieved device, interrogation of stored memory, and additional testing even several years after death. It is very important that implanted electrical devices and associated leads be considered for retrieval as a system. The goals for removal of pacemakers/ICDs/CRT-Ds are: (1) keep as much of the total system together and intact as possible, (2) identify the components for the device and how it was implanted before retrieval, (3) document throughout the retrieval process, and (4) keep explanting personnel safe.

Before attempting removal of any implanted electrical device system, it is advisable to familiarize yourself with how it is implanted, and possible risks. Whenever possible, review any x-ray or imaging that shows the device and lead(s). Pacemakers, ICDs and CRT-Ds are surgically implanted in a similar manner, in a prominent palpable subcutaneous pocket located usually on the left chest or abdomen. Electrical leadwires (leads) are attached to a pacemaker, ICD, CRT-D by screws in a "header." Leads are usually tunneled together upwards through the left chest and into the medial left subclavian vein and then to the appropriate areas of the atrium and ventricles.

The lead carries electric current to the electrode attached to the patient's heart and carries sensed electrical information to the pacemaker/ICD/CRT-D. These signals are processed by an on-board computer and software for interpretation and delivered therapy. The treating physician has prescribed desired device performance by programming the device. An electrical lead is made of an outer layer of plastic insulation, an often intricate inner metal wire core for carrying current, a terminal electrode attached to the heart's surface, and an attachment to the device's header. Lead failures are known to account for approximately 50% or more of implanted electrical system failures. Therefore, it is vital that we attempt to optimize lead retrieval during postmortem examinations. Also of note, additional unattached leads may be found because when leads are replaced in patients often times original leads are simply abandoned—and often it is the abandoned leads that are of interest. Therefore, whenever possible both the pacemaker/ICD/CRT-D and

the attached lead should be extracted as a single device system, along with careful extraction of any abandoned leads.

The pacemaker/ICD/CRT-D subcutaneous pouch should be documented by sketches or photographs looking for pre-mortem burns or charring of the walls, type and amount of fluid present, or evidence of fluid ingress into the plastic header or metal pacemaker/ICD/CRT-D case. All findings and clinical impressions about explanted lead(s) and attachment to pacemaker/ICD/CRT-D header should be documented for the record and photographed.

ICDs and CRT-Ds are about the same size as pacemakers and are implanted in a similar manner, but because defibrillators use high energy, they represent a significant safety issue. ICD/CRT-D leads have a special terminal electrode attachment for defibrillation. For retrieval of ICD or CRT-Ds which remain switched on, personnel must be aware to avoid inadvertent contact with the lead's terminal defibrillation electrode. The ICD/CRT-D terminal electrodes resemble springs or coils and are attached to the end of the lead attached to the heart, and must be assumed to be "hot" even after a patient's death. Retrieval procedures can induce electrical signals in to the ICD/CRT-D that, while artifact, may set the device up to deliver a shock. If an ICD/CRT-D is known to be implanted in a patient, prior to starting an autopsy or retrieval, identification of the make and model of the device and consultation with a cardiologist can help ensure the unit is switched to "off" to reduce the risk of shock. A patient's chart can also be examined to determine if the unit was switched to "off" prior to death. However, it is always best to handle a retrieved terminal electrode from a defibrillator as if it is still "hot" and capable of delivering an electrical shock.

Brief background information on pacemakers and ICDs with appropriate references will be presented, along with a detailed suggested extraction protocol.

Implantable Cardioverter Defibrillator, Cardiac Resynchronization Therapy Defibrillator, Pacemaker

G77 Postmortem Angiography in Support of Radiologic Assisted Autopsy

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Upon completion of this presentation, participants will be able to recognize the usefulness of digital radiography and computed tomography in the assesment of vascular injury. Postmortem studies may be preformed with antegrade or retrograde injection of contrast medium into the vessels under investigation, in conjunction with the standard forensic autopsy.

This presentation will impact the forensic science community by demonstrating the value of Radiologic Assisted Autopsy.

Radiologic Assisted Autopsy (RAA) performed with digital radiographs (DR) and multidetector computed tomography (MDCT) is limited in its ability to assess vascular integrity. Postmortem angiography has been proposed as a technique to overcome this limitation, a variety of contrast agents and techniques are being evaluated. This report outlines a method for performing postmortem peripheral vascular assessment in conjunction with the standard forensic autopsy.

During autopsy the vessel of interest was isolated at its source or a convenient location distal to the area of interest. Lower extremity arteries were cannulated with embalming trocars where they exited the open abdominal cavity. Vertebral arteries were isolated in the posterior fossa after brain removal and cannulated with a 5F angiocatheter. Hand injection of contrast was performed during MDCT imaging of the area of interest. Satisfactory visualization of peripheral arteries was achieved with a mixture of embalming fluid and radiographic contrast [Omnipaque 320]; undiluted contrast was injected retrograde into the vertebral arteries. Arteries can be injected postmortem in either antegrade or retrograde direction.

Successful demonstration of a lacerated femoral artery (2 cases), lacerated iliac artery and vein (1 case), intact vertebral artery (2 cases) and a lacerated vertebral artery (1 case) were accomplished. When performed in conjunction with RAA postmortem angiography has the potential to: (1) allow the investigator to avoid unwanted dissections, and (2) optimization of autopsy resources.

Angiography, Radiologic Assisted Autopsy, MDCT Virtual Autopsy

G78 CSI Halifax in Miami: The Importance of Practical Courses in the Forensic Sciences

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Upon completion of this workshop, participants will gain insight into the importance of providing practical experiential learning opportunities for students in the forensic sciences and gain a better understanding of the collaborative effort involved with forensic investigations.

This presentation will impact the forensic science community by illustrating the need to develop hands-on courses as students, who want to pursue careers in forensic science, need to understand the realities of the training required and the job tasks as well as illustrating the desire for students to experience practical hands-on courses in the forensic sciences and therefore the importance for educators and practitioners to create such courses. In addition, this presentation will illustrate the importance and need for international collaboration in the forensic sciences – students were unable to gain this experience in Nova Scotia but were able to experience it in Miami-Dade County.

Student interest in forensic science has grown tremendously over the past few years; however, a practical approach to the topic is very rare. Within North America and Europe, forensic cases are highly guarded and treated as 'top secret' by police departments and coroner's offices; only a select few individuals receive security clearance to examine and analyse human remains, therefore making it almost impossible for a novice to gain this very necessary 'realistic' forensic experience.

However, in May 2007, a unique and groundbreaking practical hands-on internship was created by the collaboration of Saint Mary's University and the Miami-Dade County Medical Examiner's Office. During this course, students gained a rare and comprehensive knowledge of applied forensics; they were exposed to the multidisciplinary nature of forensic investigation and mentored by experts in the field of forensic science.

Education, Experiential Learning, International Collaboration

G79 Can Renal Acute Tubular Necrosis Be Differentiated From Autolysis at Autopsy?

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After attending this presentation, attendees will have an understanding of the morphological characteristics used to define acute tubular necrosis (ATN) and how certain characteristics may be used to differentiate between ischemic ATN and autolysis in postmortem samples.

This presentation will impact on the forensic community by providing morphological characteristics to be used in the microscopic examination of postmortem renal tissue to determine and/or confirm analyses of ATN as contributing to cause of death. The use of diagnostic criteria will augment the identification of ischemic ATN as distinct from the process of autolysis.

Acute tubular necrosis is the most common cause of acute renal failure and accounts for 50% of all cases of acute renal failure in hospitalised patients and greater than 75% of critical care/intensive care unit cases. Acute renal

failure affects about 5% of hospitalized patients and has a high mortality rate of 50%. It is a commonly held view amongst autopsy pathologists that it is generally not possible to diagnose ATN at autopsy because of the presence of autolysis, and that the only way the condition can be diagnosed is by identifying mitotic figures in the tubular epithelium. This belief may lead to the under-reporting of the condition as a finding upon microscopic analysis of renal tissue.

The Department of Forensic Medicine, Glebe, Sydney autopsy database was queried for cases where an antemortem diagnosis of ATN was made. Antemortem hospital medical charts for each case were searched for a diagnosis of ATN based on clinical and biochemical parameters. A total of 57 cases over a 5 year period were found. These cases were compared to a similar number of age and sex matched controls, who died suddenly as a result of self-inflicted hanging but were otherwise healthy.

A total of 114 deidentified and randomized kidney sections were examined. Serial tissue sections from each case were stained with H&E, Martius Scarlet Blue (MSB), Masson's Trichrome and anti-human Ki-67 immunoperoxidase. Morphological characteristics compared were proliferating epithelial cells (as visualized by Ki-67 positivity); fibrin thrombi in glomeruli; tubular epithelial whorls; mitoses in tubular epithelium; presence of tubular casts; degree of autolysis; tubulorrhexis; tubular epithelial flattening; interstitial inflammation, and interstitial edema.

All results were expressed as mean ± standard deviation. Differences between groups were determined by two sample t-test. A p *value* < 0.05 was considered to be statistically significant.

Statistically significant differences were between the cases exhibiting ATN and the controls in the following morphological characteristics: number of tubular epithelial whorls, proliferating cells, tubulorrhexis, and interstitial edema. The mean number of tubular epithelial whorls in ATN cases was 1.93 ± 5.15; no whorls were found in any control cases ($p < 0.001$). The mean number of proliferating cells in ATN cases was 19.5 ± 29 and in control cases was 5 ± 9.2 ($p = 0.0001$). The mean number of tubules exhibiting tubulorrhexis in ATN cases was 0.0309 ± 0.0826 and in control cases was 0.007 ± 0.0258 ($p = 0.041$). The mean degree of interstitial edema (as determined by proportion of fields exhibiting the condition) in ATN cases was 0.533 ± 0.412 and in control cases was 0.195 ± 0.312 ($p < 0.001$).

The remaining morphological characteristics (fibrin thrombi, tubular casts, degree of autolysis, mitotic figures, tubular epithelial flattening and interstitial inflammation) were analysed and showed no statistically significant differences between the two groups.

Acute tubular necrosis can be reliably differentiated from autolysis at autopsy. The presence of characteristic tubular epithelial whorls is highly diagnostic of ATN. When taken together with tubulorrhexis, interstitial edema and epithelial proliferation, a diagnosis of ATN can be reliably made at autopsy.

Autopsy, Acute Tubular Necrosis, Renal Pathology

G80 The Effects of a New Level 1 Trauma Center on the Local Medical Examiner Office

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The goal of this presentation is to describe the changes in the medical examiner non-natural case load in relation to the establishment of a level 1 trauma center.

This presentation will impact the forensic community and humanity by providing insight into the effects of a level 1 trauma center on regional medical examiner, which in turn affects law enforcement, families, funeral homes and regional funding.

The goal of this study is to look at the change, if any, to the medical examiner case load and distribution following the opening of a new level 1 trauma center. Factors evaluated included the increase or decrease in the total number of medical examiner cases per year, the medical examiner districts from which these cases are originating and what types of cases the trauma center is bringing into the district.

On October 1, 2004, the University of Florida & Shands Hospital in Gainesville, Florida became a Level 1 Trauma Center. For a patient to be given trauma alert status, they must meet very specific criteria, such as two or more long bone fractures, ventilation beyond passive oxygen administration, or 15% or more of body involved in second or third degree burns.

This new trauma center covers nine whole counties and seven partial counties. The counties with partial coverage are relatively equidistant between two level 1 trauma centers, such that patients in these counties may go to one of two trauma centers for treatment. Of these sixteen counties covered by the new trauma center, only seven are within the District 8 Medical Examiner's jurisdiction. Even though the injury(s) may have occurred outside the jurisdiction of District 8 Medical Examiner Office, when a trauma patient dies at the trauma center, the time and place of death is in Alachua County. Because medical examiner jurisdiction in Florida is defined by place of death, not place of injury, such cases fall under the auspices of the District 8 Medical Examiner Office.

The District 8 Medical Examiner Office case files were retrospectively reviewed from January 1, 2002 to June 30, 2007. Only non-natural deaths were included in the study population as natural deaths would not be affected by the presence or absence of a level 1 trauma center. The trauma center began operating at level 1 status October 1, 2004, and this is the date used to demarcate "before" and "after" data sets. During this time, 3156 total cases were investigated by the MEO and 2388 were autopsied. The annual case load has been steadily increasing, with the largest increase in 2005 (a 10% increase in total cases and a 22% increase in autopsies). Since October 1, 2004, 312 cases have been investigated that came through the trauma center as a trauma alert, with 275 investigated by the District 8 MEO. Roughly 58% of the deaths coming through the trauma center were a result of motor vehicle crashes, by far the largest mechanism, followed by falls of all types (20%). Only 33% of the trauma center deaths had their corresponding injuries within the District 8 medical examiner jurisdiction. Before the trauma center opened, approximately 15% of all non-natural investigations were outside of the District 8 MEO, whereas afterwards, 26% were outside the jurisdiction.

This study has found that a much larger percent of the District 8 Medical Examiners case load is now coming from outside of the current jurisdiction since the opening of the trauma center, which is associated with an increase in the over all number of cases each year and an increase in the complexity of the cases. Patients from the trauma center tend to have more complex injuries resulting in longer autopsies and more time spent determining causes of death. Additionally, a large percentage of the trauma cases are coming from surrounding districts, cases that originally would have gone to that outside district or a different one with a level 1 trauma center, such that trauma deaths are being redistributed throughout the region. The larger implication being that the opening of a Level 1 Trauma Center not only affects the medical examiner district in which it resides, but also the surrounding medical examiner offices by reducing their case load.

Medical Examiner, Trauma, Non-Natural Death

G81 Mapping the Literature in Forensic Pathology and Legal Medicine: A Bibliometric Study of North-American Journals From 1980 to 2005

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The goal of this presentation is to describe the evolution of the literature in forensic pathology and legal medicine for North-American journals over more than twenty-five years. More precisely, it will draw a picture of our literature and describe developments and trends regarding numbers of author(s) per article, represented countries and international collaborations, types of articles and use of the scientific method.

This presentation will impact the forensic community by providing new insight in the forensic pathology literature. A better knowledge of this body of literature could help us assess our strengths and weaknesses, and better position ourselves on literature ethical issues.

Bibliometric studies have increasingly being used over the last years. Those studies are useful to understand the evolution of literature or trends in particular fields or within a geographical area. However, in forensic sciences, bibliometry has barely been used yet and the few studies that have been performed mainly focused on most highly cited articles, most prolific authors and impact factors. Thus, the present study specifically aims at mapping the literature in the field of forensic pathology and legal medicine.

The two North-American leading journals in forensic sciences were selected: the Journal of Forensic Sciences and the American Journal of Forensic Medicine and Pathology. All articles in the field of forensic pathology and legal medicine published in those journals in 1980, 1985, 1990, 1995, 2000, and 2005 were retrospectively analysed, excluding editorials, guest editorials, tributes, and book reviews. For each article, the following features were compiled: number of author(s), author's country and international collaboration and type of article. Furthermore, it was assessed if the article was using or not the scientific method, with testing of hypotheses by statistical analysis. A total of 522 articles were examined from 1980 to 2005 at a 5-year interval: 215 articles from the Journal of Forensic Sciences and 307 articles from the American Journal of Forensic Medicine and Pathology. The SPSS 15.0 software was used to perform statistical analyses at a threshold of significance of 5%. Mean values were compared using analysis of variance, while proportions were compared through Chi-square tests.

Overall, the number of articles per year has passed from 55 articles in 1980 to 89 in 2005. Meanwhile, the average number of author(s) per article has significantly increased ($p=0.000$, $p<0.05$), passing from 1.8 to 3.5. The relative contribution of other countries in comparison to the United States has significantly increased from 9.3% to 57.3% ($p=0.000$, $p<0.05$). Articles from international collaboration were absent in 1980, passing to 5.62% of articles in 2005. As for the types of articles, the review article was the only type of article significantly decreasing ($p<0.05$). No significant differences was revealed for the remaining types of articles, although letters to the editor showed a tendency to decrease ($p=0.069$), while original studies showed a tendency to increase ($p=0.088$). Finally, the number of studies using the scientific method did not significantly progressed from 1980 to 2005 ($p=0.416$, $p>0.05$), passing from 10.9% to 15.7%.

The literature in forensic pathology and legal medicine in North-American journals has expanded in number of articles per year from 1980 to 2005. However, the relative proportion of pathology and legal medicine in the forensic literature as a whole has stayed about the same. The significant increase in the average number of author(s) per article follows a similar trend in the forensic literature. Finally, it is surprising to see that while the use of the scientific method has significantly progressed in the forensic literature over the last twenty-five years, pathology and legal medicine literature has stayed behind on this aspect. This observation is a warning sign that researchers and authors in our field should notice.

Forensic Pathology, Literature, Bibliometric

G82 Purtscher Retinopathy Detected by Postmortem Monocular Indirect Ophthalmoscopy

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The goals of this presentation are to: (1) describe the retinal features of the Purtscher retinopathy, (2) list conditions and disorders associated with Purtscher retinopathy, and (3) describe the histological features of Purtscher-flecken.

After attending this presentation, attendees will gain insight into the value of postmortem monocular indirect ophthalmoscopy (PMIO) in detecting Purtscher retinopathy and subsequent histopathological description of the observed retinal lesions. This presentation will impact the forensic community by providing an introduction to non-hemorrhagic retinopathies detectable by PMIO and consequent histopathological characterization.

In 1910, Dr. Otmar Purtscher described a patient with severe head trauma who had a hemorrhagic and vaso-occlusive retinopathy characterized by multiple variably sized cotton-wool spots (Purtscher-flecken) plus retinal hemorrhages around the optic nerve head. Two years later he designated the condition angiopathia retinae traumatica. Since then the term Purtscher retinopathy has been used to describe a clinical picture of angiopathia retinae traumatica even in the absence of known head trauma. Purtscher-like retinopathy has been observed in a variety of conditions including compressive chest injuries, long bone fractures, retrobulbar anesthesia, connective tissue and vasculitic diseases, orthopedic surgery, acute pancreatitis, strenuous childbirth, and battered child syndrome. The exact pathophysiologic mechanism causing Purtscher or Purtscher-like retinopathy remains controversial and published supportive histological descriptions are rare. Two cases are described of Purtscher retinopathy detected by postmortem monocular indirect ophthalmoscopy plus the histological features and immunohistochemical staining for β-amyloid precursor protein of observed Purtscher-flecken.

Case 1: A 36-year-old man sustained a traumatic brain injury with immediate loss of consciousness following an assault in a parking lot. Cranial computed tomography revealed subdural and subarachnoid hemorrhages. He remained comatose and died thirteen days after the injury. Neuropathological examination revealed traumatic axonal injury, a cerebral contre-coup contusion plus organizing subdural and subarachnoid hemorrhages. Prior to autopsy PMIO identified retinal hemorrhages and multiple posterior, peripapillary, polygonal foci of retinal whitening (Purtscher-flecken) distributed between retinal arterioles and veins. Histologically, these areas were collections of swollen, contracted axons (cytoid bodies) in the nerve fiber layer highlighted by immunohistochemical staining for β-amyloid precursor protein.

Case 2: A 27-year-old man had experienced nausea and vomiting for a number of days. While at his girlfriend's residence he collapsed following an episode of vomiting. Resuscitative efforts were unsuccessful and he was pronounced dead in the emergency department. Hepatosplenomegaly was present at autopsy and his hypercellular bone marrow contained > 20% myeloid blasts with Auer rods. The leukemic cells stained positively for CD68 and myeloperoxidase. Prior to autopsy PMIO revealed multiple bilateral retinal hemorrhages, many white-centered, plus posterior foci of small Purtscher-flecken. Histologically, these foci were cytoid bodies in the nerve fiber layer that stained positively for β-amyloid precursor protein.

No published reports of Purtscher retinopathy detected initially at autopsy are in the medical and scientific literature. Previous articles on the histopathology of Purtscher retinopathy have been two case reports from patients with acute pancreatitis who died 6 and 23 days after the onset of their illness. Both had focal areas of retinal edema and loss of architecture

in the inner retinal layers with abrupt transition to normal retina. In the author's reported cases the detected Purtscher-flecken were cytoid bodies that stained positively for β-amyloid precursor protein. These inner retinal collections of swollen, contracted axons are relatively nonspecific and histopathologically similar to retinal cotton-wool spots and foci of axonal injury observed throughout the nervous system commonly associated with a variety of traumatic and non-traumatic conditions.

Purtscher Retinopathy, Traumatic Brain Injury, ß-Amyloid Precursor Protein

G83 Sudden Death Due to a Cardiac Sarcoidosis: Histopathological Helping Evidences

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The goal of this presentation is to present an uncommon case of sudden cardiac death in a 34-year-old. A complete methodological forensic approach by means of autopsy, histological, and immunohistochemical examinations led us to conclusion of a systemic sarcoidosis with massive cardiac involvement.

This presentation will impact the forensic science community by demonstrating how the rarity of cardiac sarcoidosis makes the case peculiar; in addition to clinical and lab tests, a complete forensic methodological approach by means of autopsy, histopathological examination and immunohistochemical stain led us to confirm the diagnosis of cardiac sarcoidosis as the cause of death.

Sarcoidosis is a multisystem disorder of unknown aetiology, characterized by noncaseating epithelioid cell granulomas. The aetiology and pathogenesis are unclear, although many infectious, environmental and genetic factors have been implicated. Prognosis and clinical manifestations are dependent on the location and extend of granulomatous infiltrates. The cardiac involvement is uncommon (at autopsy, cardiac involvement has been reported in 20-30% of patients with sarcoidosis, although most studies indicate that <5% of patients with sarcoidosis have symptoms related to cardiac involvement) and has a wide range of clinical manifestations (conduction disorder, ventricular arrhythmias, atrial arrhythmias, pericarditis, valvular dysfunction, congestive heart failure). It is unusual for sarcoidosis to present with isolated cardiac involvement. In autopsy study, cardiac nvolvement proved to be the cause of death in 37% of the patients with sarcoidosis. Cardiac involvement associated with poorer prognosis and the mortality rate may exceed 40% at 5 years and 55% within 10 years. The presence of pulmonary involvement was associated with better survival. Sudden death due ventricular tachyarrhythmia or conduction block accounts for 25 to 65% of the deaths due to cardiac sarcoidosis.

A 34-year-old woman was found lifeless at home from by her parents. Death scene investigation was unremarkable. The extended family hadn't a history of sudden death. In her history a visit to the Emergency Room three months before death was recorded. She complained chest pain, non – sustained ventricular tachycardia and loss of consciousness. Body temperature was normal. Subsequent cardiological evaluation with ECG showed sinusal rhythm with ventricular premature beat and intraventricular conduction abnormalities. Echocardiography showed normal chamber dimensions, no wall motion abnormalities. The research for viruses was negative. The laboratory findings were normal. During hospitalization she presented some episodes of supraventricular paroxysmal tachycardia (160 bpm) and non – sustained ventricular tachycardia. No others symptoms or apparatus failure were present. Family history was reportedly negative for cardiac disease. An anti – arrhythmic treatment was prescribed.

A complete postmortem examination was performed two days after death. External examination was unremarkable. The internal examination revealed only a polivisceral congestion and pulmonary edema. All internal organs were macroscopically normal. The heart had a normal shape and was normal in size and weight. The left and right coronary arteries arose normally. No significant stenosis or thrombotic occlusion of the coronary segment were detected. The atrio – ventricular and semilunar valves were normal. The myocardium showed an extensive fibrotic scarring, particularly in the supero – anterior wall of the LV and the posteroseptal wall. The histological examination of the heart, performed with routine haematoxylin-eosin revealed diffuse and extensive fibrosis with non-caseating granulomas composed mainly of an aggregate of epithelioid cells and multinucleated giant cells in the centre surrounded by lymphocytes, plasmacells and mastcells. The lungs and kidneys also showed the same non caseating granulomas. An immunohistochemical examination of heart samples was performed to confirm diagnosis. Mycobacterium tuberculosis and fungal infections were excluded on special stains. The remainder of the histological examination was unremarkable. The diagnosis of sarcoidosis with massive and extensive cardiac involvement was established as cause of death.

Cardiac Sarcoidosis, Sudden Death, Ventricular Arrhythmias

G84 A Diagnosis of Chagas Disease at Autopsy

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The goal of this presentation is to become familiar with Chagas disease and to consider it as a diagnosis in the setting of chronic myocarditis and sudden death

The forensic community will be presented with an interesting case of chronic myocarditis related to Chagas disease, raising awareness of the presence of this disease in the United States, and its relation to sudden death.

Chagas disease is caused by the parasite *Trypanosoma cruzi*, which is a blood-dwelling and tissue-dwelling protozoan. The disease occurs in the Americas, primarily in Central and South America. It is transmitted to humans through the bite of the reduviid bug. The disease is commonly seen in children younger than five years who develop a skin lesion known as a chagoma at the site of infection where the organisms proliferate in the skin. The trypomastigotes (flagellate forms) may then spread via hematogenous or lymphatic routes and cause an acute illness characterized by lymphadenopathy, fever, anorexia, and fatigue. After the acute phase, recovery may occur, or the disease may progress into a chronic phase, which is usually seen in adults and older children. Chronic carriers of *Trypanosoma cruzi* may develop chronic myocarditis and a cardiomyopathy or dilatation of the digestive tract, characterized by dysphagia and megacolon.

Chagas disease is diagnosed at autopsy in a 66-year-old Hispanic male originally from El Salvador who died in Houston while at work in the construction of a residential apartment complex. He was found dead by his employer who had arrived at the job site to supervise him. He was found on the floor inside of an apartment that was being renovated, and it appeared he had collapsed as he was preparing to perform some caulking. Per his family, he had no known medical or social history but had been complaining of dizziness and palpitations over the past two weeks. At autopsy, he had an enlarged, 515-gram heart with left ventricular hypertrophy and focal thinning of the left ventricular wall toward the apex. A 1.5-centimeter mural thrombus was in the apex of the left ventricle, and the surrounding myocardium had diffuse scarring. Extensive myocardial fibrosis extended into the lateral and posterior left ventricle towards the base of the heart. The coronary arteries showed mild atherosclerosis with 10% to 20% stenosis in the left anterior descending and right coronary arteries. He also had remote embolic infarcts in the kidneys and brain with 9-centimeter and 3-centimeter cortical scars in the kidneys and a 2-centimeter area of cortical encephalomalacia in the left occipital lobe. Microscopically, sections of the heart showed chronic interstitial inflammation with lymphocytes and eosinophils associated with patches of mycoardial fibrosis. Toxicology was negative for drugs and alcohol. Chagas disease was considered in the differential diagnosis of

chronic myocarditis in an adult male from Central America; therefore, serologic testing was requested through the Centers for Disease Control. An indirect fluorescent assay showed an IgG antibody titer of 1:512, which was positive for Chagas disease.

There are many different causes of myocarditis including infections, immune reactions, drug hypersensitivity, poststreptococcal, giant cell myocarditis, and sarcoidosis. Common infectious causes are typically viral such as coxsackieviruses, echoviruses, influenza, and adenovirus. Additionally, other protozoa such as toxoplasma and helminths can also affect the heart and cause myocarditis. Although typically prevalent in South and Central America, Chagas disease should be considered in individuals in the United States who present with cardiac arrhythmias, congestive heart failure, and sudden death, especially in Texas, California, and throughout the South given the large immigrant population in these states. *Trypanosoma cruzi* can also be transmitted through blood transfusions, organ transplantation, transplacentally, and through breast milk. In 2006, the FDA approved a screening test for Chagas disease in the blood donation population, which is currently being used for screening the donated blood in the Gulf Coast region of Texas.

Chagas Disease, Chronic Myocarditis, Autopsy

G85 Dysplasia of the Atrioventricular Nodal Artery: A Case Report and Review of the Literature

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After reviewing this presentation, attendees will understand the pathophysiology and epidemiology of conduction system arterial dysplasia, a rarely reported condition. Autopsy findings and the correlation between histopathologic abnormalities and sudden death will be emphasized via a case presentation and a review of the literature on this topic.

It is important that the forensic community be aware of this process, its characterisitc histopathology, the distribution and clinical consequences of similar lesions throughout the body, and its implicatons as a cause of sudden death. Pathologic processes involving the conduction system are often considered in the investigation of otherwise healthy persons, and this presentation will impact the forensic science community by presenting evidence for the systematic examination of conduction system histology.

A case of the investigation of the sudden death of a previously healthy 15-year-old male will be presented. The patient had a history of being overweight (BMI 28.4), mild well-controlled asthma, and Attention Deficit and Hyperactivity Disorder treated in the past with stimulants. Examination revealed an essentially negative autopsy, a negative skeletal survey by radiography, and normal histopathology of the usual microscopic sections taken at autopsy. Postmortem toxicology was significant for the presence of a moderate amount of caffeine. Viral and bacterial cultures grew a likely postmortem contaminant only, and vitreous chemistries were normal. Further examination of the conduction system revealed significant dysplasia of the atrioventricular nodal artery, characterized by irregular fibrointimal thickening of the vessel wall with marked disruption of the elastic lamina, highlighted by special stains.

Dysplasia of the atrioventricular nodal artery is a rare entity, described only in small case reports and series. The morphologic changes are the same as those found with fibromuscular dysplasia, which is most commonly seen in the renal and internal carotid arteries but has been reported in numerous arterial beds and may even be a generalized condition. Fibromuscular dysplasia is a nonatherosclerotic, noninflam-matory disease of the arterial wall, the exact cause of which is unknown. The lesions may predominantly alter the intima, media, or the adventitia, and the sequelae are dependent upon the degree of vascular wall thickening or destruction and the location of the affected vessels.

Within the forensic literature, there are scattered case reports of dysplasia within the vasculature supplying the conduction system, but the majority of the literature linking fibromuscular dysplasia to a cause of death focuses on the disease process within the small coronary arteries. In fact, some controversy exists as to the presence of apparent dysplasia within the nodal arteries in control subjects dying of other causes and whether the use of special stains can highlight specific alterations of the vessel wall that may lead to an increased association with sudden death.

An example of atrioventricular nodal dysplasia is the cause of sudden death in a relatively healthy adolescent. It is important that the forensic community be aware of this process, its characteristic histopathology, the distribution and clinical consequences of similar lesions throughout the body, and its implications as a cause of sudden death. Pathologic processes involving the conduction system are often considered in the investigation of otherwise healthy persons, and this presentation will present evidence for the systematic examination of conduction system histology.

Atrioventricular Node, Dysplasia, Sudden Death

G86 Subaortic Aneurysm of the Left Ventricle Complicating Staphylococcal Endocarditis

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After attending this presentation, the audience will learn about an unusual complication of endocarditis, which could lead to sudden death of young people.

This presentation will impact the forensic science community by demonstrating how subaortic aneurysms can complicate staphylococcal aortic valve endocarditis and cause sudden unexpected deaths in young people.

Subaortic aortic aneurysms are rare. Initially thought to be of congenital origin, they may occur as a complication of aortic valve endocarditis. This report describes a subaortic aneurysm in a 21-year-old patient who had a recent history of staphylococcal endocarditis.

A 20-year-old Vietnamese male who worked as a machinist presented to the Emergency Room of a local hospital with a 4-6 days history of fever, chills, and headache. A cardiology evaluation was requested due to a systolic murmur on examination. A transesophageal echocardiography revealed abnormal vegetation of the aortic valve and mild aortic, tricuspid and mitral regurgitation. Blood cultures drawn at the time of the admission grew *Staphylococcus aureus*. *Staphylococcus aureus* endocarditis was diagnosed. The patient was treated with Gentamycin for 14 days, and Nafcillin for seven weeks. The patient was followed by a cardiologist for eight months. The patient refused aortic valve replacement surgery. Ten months after the onset of the first episode the patient was found down at home with shortness of breath and an altered level of consciousness. He was transported to the hospital, but suffered cardiac arrest and was pronounced in the Emergency Room. At autopsy, the patient weighed 149 pounds and measured 67 inches. The external examination showed evidence of therapeutic intervention and no external trauma was noted. The pericardial cavity was filled with 200 mL of clotted blood. The heart weighed 430 grams. There was aneurysmal enlargement at the base of the left ventricle, between the aorta and the left atrium, measuring 3.0 cm in diameter. A ruptured snout measuring 1 cm was located on the superior aspect of the aneurysm. The aortic valve was bicuspid. The aneurysm communicated with the left ventricle just below the right commissure of the two cusps by a triangular opening measuring 1.5 x

1.0 cm. Death was attributed to cardiac tamponade from spontaneous rupture of a subaortic aneurysm.

Subaortic aneurysms can be congenital, infective or traumatic. Congenital weakness of the fibrous annuli could predispose to the development of such aneurysms. A bicuspid aortic valve is another contributing condition. The role of aortic regurgitation as a consequence of infective endocarditis in the aneurysmal formation needs to be considered in our case. It is probable that rupture of the aneurysm resulted from weakness and increased tension of the aneurysmal wall.

Forensic Pathology, Sudden Death, Subaortic Aneurysm

G87 A Rare Case of Cardiac Failure Due to Hypertensive Crisis in Pheocromocytoma: A Methodological Approach for Diagnosis

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The goal of this presentation is to present a rare case of cardiac failure due to hypertensive crisis in pheocromocitoma in an asymptomatic 25-year-old young man is presented. The rarity of pheocromocytoma makes the case peculiar and the complete pathologic investigation adopted (autopsy performing, immunoistochemical staining, and biochemical screening) is strongly recommended to pathologists to confirm diagnosis.

This presentation will impact the forensic science community by demonstrating how the rarity of pheocromocytoma makes the case peculiar. It is strongly suggest, in these cases, the relevance for pathologists of a complete methodological approach, integrating clinical data by means of autopsy findings, immunoistochemical staining and biochemical screening to confirm diagnosis.

Pheocromocytomas are rare but clinically important tumours of chromaffin cells that produce, store, release and metabolize catecholamines. Pheocromocytomas usually manifest clinically as hypertension which can be sustained or paroxysmal. The diagnosis of pheocromocytoma is based on measuring excessive amounts of catecholamines and their metabolites on blood and urine; more than 90% of patients with pheocromocytoma have elevated levels of catecholamines, metanephrine, and vanillyl-mandelic acid. Sensitivity and specificity of these measurements are 91%. Failure to diagnose the tumours can result in sudden, unexpected and potentially lethal complications; cause of death in these cases is generally a consequence of paroxysmal hypertension as well as cerebral vascular accidents, abrupt haemorrhage into the tumour or acute left ventricular failure.

A 25-year-old man, with a past medical history significant for recurrent episodes of cephalalgia, was transported to the local Hospital at 11:44 p.m. complaining of vomiting and headache. A prescription for symptomatic treatment was issued unsuccessfully. He had high blood pressure (180/80) and tachycardia (110 bpm). Neurological examination was unremarkable, abdomen showed no rigidity, peristaltic sounds were normal. Initial laboratory findings showed hyperglycaemia (177 mg/dl) and high level of amylase (125 U/L); further findings showed high levels of myoglobin (153 ng/ml). A 12 lead electrocardiogram on admission was performed showing sinus tachycardia, with right bundle branch block and ventricular bigeminy extra systoles; non specific repolarization change were also described. Few hours later, 8:15 a.m. the patient appeared pale and sweating; blood pressure was unappreciable and hypocontractility of left ventricle with low ejection fraction was observed on echocardiography (EF 25-30%). A state of haemodynamic shock was declared (FC 170, blood pressure was unappreciable). Pulmonary edema was observed on chest Rx examination and oro-tracheal intubation was performed substaining ventilation in intensive care unit. At 9:15 a.m. ECG monitor showed cardiac arrest; resuscitation manoeuvres were attempted unsuccessfully.

A complete postmortem examination was performed two days after death. External examination was unremarkable except for food residuals in the mouth. Internal examination showed cerebral oedema; food residuals were recorded at oesophagus exploration; heavy lungs presenting white foam on the main bronchi was also detected. Heart was fixed in formalin, cardiac size was normal, with conical shape. Macroscopic study (cut in cross-section 3 mm intervals) of coronary arteries was unremarkable. A well circumscribed encapsulated lobulated reddish and brownish suspected lump measuring 3.5x3x3 was attached to the medial aspect of the left kidney; it was soft on section and presented aspect of necrosis and haemorrhage. Adrenal tissue was attenuated over the upper part of the mass; aspect of minimal haemorrhage was observed on pancreas examination.

Histological examination revealed polyvisceral stasis, mild cerebral edema: massive pulmonary edema was recorded. Cardiac myofibers varied considerably in size with many large fibers and aspect of fibrosis suggesting for hypertension; the pathological myocardial picture included fragmentation of the whole myocyte (pancellular lesion) which ranged from early break-down in pathological band (intense hyperosinophilia of the hypercontracted myocardial cells with rexis of the myofibrillar apparatus into cross-fiber, anomalous and irregular) to a total granular disruption (myofibrillar degeneration). Histological examination of the suspected lump addressed diagnosis for a benign pheocromocitoma with the presence of well-defined nests (Zellballen) bound by a delicate fibrovascular stroma, which contain amyloid. The cells varied considerably in size and shape and had purely granular basophilic cytoplasm; the nuclei were round with prominent nucleoli.

An immunoistochemical study was performed and it showed a positive reaction for chromogranin and synaptophysin.

Dosage of catecholamines and their metabolites on a blood and urine samples was performed showing high levels of catecholamines, metanephrine and vanillyl-mandelic acid.

Clinical data, autopsy findings, data collected from immunoisto-chemical staining and biochemical analysis led us to conclude that cardiac failure due to hypertensive crisis in adrenal pheocromocytoma was the cause of death.

In conclusion, the rarity of pheocromocitoma makes the case peculiar. The authors strongly suggest, in these cases, the relevance for pathologists of a complete methodological approach, integrating clinical data by means of autopsy findings, immunoistochemical staining and biochemical screening to confirm diagnosis.

Pheocromocitoma, Cardiac Failure, Hypertensive Crisis

G88 Arrhythmogenic Right Ventricular Dysplasia (ARVD): A Not So Rare Cause of Sudden Death in Young Adults

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The goal of this presentation is to make the forensic community aware of this entity (ARVD) as a sudden cause of death in the young adult population.

This presentation will impact the forensic science community by demonstrating how routine full autopsies may not detect the subtle pathologic changes that cause Arrhythmogenic Right Ventricular Dysplasia.

Ten (10) cases of ARVD/Arrhythmogenic Right Ventricular Cardiomyopathy (ARVC) autopsied at Danbury Hospital, CT, from June 2002 until June 2007 were reviewed. This number represents 3.75% of the total adult full autopsies performed in our institution during the same period.

Age, sex, and ethnic background were noted. Associated cardiac and non cardiac related diseases were reviewed.

Medications, social and family history (sudden death of a sibling) as well as body habitus (obesity) were tabulated.

Prior symptoms (syncopal episodes, palpitations) and pre-terminal circumstances (place of death, physical activity) were examined. Autopsy findings (both cardiovascular and systemic) were correlated.

The ten patients' ages ranged from 34 to 65. Sex ratio was 1:1. 8/10 were obese, 5/10 used alcohol frequently, 10/10 were at rest at time of pre-final event, 1/10 had family history of sibling (brother) sudden death, 10/10 had some degree of Coronary Artery Disease (CAD), 7/10 had cardiomegaly (450g to 650g), 1/10 had coexisting myocarditis, 10/10 were Caucasian (only 1 with an Italian background), 4/10 had suffered a significant traumatic injury and 3/10 used medications for depression or anxiety. In patients with ARVD, the most common findings were obesity, CAD. The authors also concluded that Caucasian ethnicity is prevalent, the pre-terminal episode happens at rest, the age group is between 4th and 7th decades, and M:F ratio is ~ 1.

This report helps to increase awareness regarding this congenital cardiac disease. It is relevant to the forensic community, because of its high incidence in children, and young adults, and it is a frequent cause of (sudden death) in the North East (New England).

Arrhythmogenic right ventricular dysplasia (ARVD, also known as arrhythmogenic right ventricular cardiomyopathy or ARVC) is a type of non-ischemic cardiomyopathy that involves primarily the right ventricle of the heart. It is characterized by hypokinetic areas involving the free wall of the right ventricle, with fibrofatty replacement of the right ventricular myocardium, with associated arrhythmias originating in the right ventricle.

ARVD is an important cause of ventricular arrhythmias in children and young adults. It is seen predominantly in males, and 30-50% of cases have a familial distribution. It is usually inherited in an autosomal dominant pattern, with variable expression. The penetrance is 20-35% in general, but significantly higher in Italy. Seven gene loci have been implicated in ARVD. The incidence of ARVD is about 1/10,000 in the general American population, although some studies have suggested that it may be as common as 1/1,000. It accounts for up to 17% of all sudden cardiac deaths in the young. In Italy, the incidence is 40/10,000, making it the most common cause of sudden cardiac death in the young.

Up to 80% of individuals with ARVD present with syncope or sudden cardiac death. The remainder frequently present with palpitations or other symptoms due to right ventricular outflow tract (RVOT) tachycardia.

Apoptosis (programmed cell death) appears to play a large role in the pathogenesis. It is unclear why the right ventricle is predominantly involved. The disease process starts in the subepicardial region and works its way towards the endocardial surface, leading to transmural involvement. The left ventricle is involved in 50-67% of individuals. If the left ventricle is involved, it is usually late in the course of disease, and confers a poor prognosis.

90% of individuals with ARVD have some EKG abnormality. The most common one seen in ARVD is T wave inversion in leads V1 to V3.

Transvenous biopsy of the right ventricle can be highly specific for ARVD, but it has low sensitivity. A biopsy sample that is consistent with ARVD is found to have > 3% fat, >40% fibrous tissue, and <45% myocytes.

A postmortem histological demonstration of full thickness substitution of the RV myocardium by fatty or fibro-fatty tissue is consistent with ARVD.

There is no pathognomonic feature of ARVD. The diagnosis is based on a combination of major and minor criteria. The diagnosis is based on a combination of major and minor criteria, and requires either 2 major criteria or 1 major plus 2 minor, or 4 minor criteria.

Many of these patients have symptoms associated with ventricular tachycardia, such as palpitations, light-headedness, or syncope. Others may have symptoms and signs related to right ventricular failure, such as lower extremity edema, or liver congestion with elevated hepatic enzymes. Unfortunately, sudden death may be the first and sole manifestation of disease.

The goal of management of ARVD is to decrease the incidence of sudden cardiac death. This raises a clinical dilemma: How to prophylactically treat the asymptomatic patient who was diagnosed during family screening.

Sotalol, a beta blocker and also a class III antiarrhythmic agent, is the most effective antiarrhythmic agent in ARVD. Other antiarrhythmic agents used include Amiodarone and conventional beta blockers (i.e., Metoprolol). If antiarrhythmic agents are used, their efficacy should be guided by series ambulatory Holter monitoring, to show a reduction in arrhythmic events.

Individuals with decreased RV ejection fraction and dyskinetic portions of the right ventricle, may also benefit from long term anticoagulation with warfarin to prevent thrombus formation and subsequent pulmonary embolism.

Implantable cardioverter-defibrillator devices (ICD's) are the most effective prevention against sudden cardiac death.

Cardiac transplant surgery is only rarely performed in ARVD. It may be indicated if the arrhythmias associated with the disease are uncontrollable or if there is severe bi-ventricular heart failure that is not manageable with routine pharmacological therapy.

All first degree family members of the affected individual should be screened for ARVD. This is used to establish the pattern of inheritance. Screening should begin during the teenage years unless otherwise indicated. Screening tests include: Echocardiogram, EKG, holter monitoring, cardiac MRI, and exercise stress test.

ARVD, Sudden Death, Pre and Postmortem Diagnosis

G89 Cardiac Death in Anabolic Steroid Abuse: A Pathological and Toxicological Study

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After this presentation, participants will understand the proposed methodological approach in analysis of cases of doping-related death. The presentation will cover reports in the scientific literature of doping-related deaths due exclusively to the use of anabolic androgenic steroids (AAS).

This presentation will impact the forensic science community by highlighting the importance of a correct methodological approach in such cases, and the possible cause-effect relation between AAS intake and cardiac death.

The true extent of doping is underestimated. The absence of chemico-toxicological findings in biological samples is a limitation in epidemiological studies, conducted as surveys on the living or case histories of the dead. Literature reports of doping-related deaths due exclusively to AAS confirm that the phenomenon is underestimated and that epidemiological data from postmortem and intra vitam studies are contradictory.

The present work describes two cases of the death of young athletes who had taken AAS; cardiopathological evidence is discussed in relation to studies in the relative literature.

The methodological approach is based on the following steps: (1) assessment of circumstances, (2) analysis of medical documentation, (3) external examination and autopsy, (4) microbiological analysis, (5) chemico-toxicological analysis, and (6) interpretation of results.

Case 1 - A body-builder aged 32 was found dead in his home. Medical history: Subject had taken AAS for years. He had recently stopped taking them, due to unidentified side-effects. Postmortem findings: External examination, excessive muscular development. Cadaveric section: cardiomegaly, with concentric hypertrophy of the left ventricle (LV). Histology: focal lymphocytic myocarditis and adipose distrophy in disarray at the apex of the right ventricle. Microbiological analysis: Molecular study by Polymerase Chain Reaction (PCR): negative for cardiotropic viruses. Toxicological analysis: Screening and confirmatory chromatographic techniques to search for xenobiotics were negative.

Case 2 - A body-builder aged 31, accustomed to practicing martial arts, unexpectedly lost consciousness during training. Hospitalized in intensive care, he died 72 hours later of cardiac failure and acute hepato-renal failure.

The medical history included astenia, dyspnea, and perimalleolar edema. The clinical picture had worsened ten days before death. Also was reported long-term intake of AAS (boldenone, dromostanolone, enanthate methenolone, stanozolol, trenbolone). Postmortem external examination: Excessive muscular development. Cadaveric section, dilatative

cardiomyopathy, with endocardial thrombosis. Histology: Marked dysmetria of hypertrophic myocytes, with diameter up to 30 µ; dyschromic and dysmetric nuclei, evident interstitial fibrosis, and rare inflammatory infiltrates. The subendocardial trabeculae, especially of the right ventricle (RV), showed extensive areas of colliquative myocytolysis in repair phase. Microbiological analysis: Molecular study by PCR positive for Epstein-Barr Virus (EBV). Toxicological analysis: Screening (GC-MS) and chromatographic (GC-MS/MS) confirmatory techniques to reveal xenobiotics in hair were positive for AAS (stanozolol).

A cause-effect relation between AAS and cardiac death can only be demonstrated by applying rigorous methods of investigation. Further clinical and experimental studies are needed for further in-depth knowledge of the pathogenetic and physiopathological role played by AAS in causing cardiac death. In particular, clarification is needed on the possible effects of AAS on sympathetic control of the cardiac function, related to myocardial contractility and vascularization.

Anabolic Androgenic Steroids, Cardiac Death, Doping

G90 A "Café Coronary" in a 2-Year-Old: Case Report

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After attending this presentation, attendees will understand the history of the term "café coronary" and the mechanisms, genetics, presenting signs and symptoms, and pathologic findings of abnormal cholesterol metabolism involved in familial hypercholesterolemia.

This presentation will impact the forensic community by reviewing the role genetic diseases play in fatal, premature pediatric coronary artery disease. During café coronary events, myocardial ischemia should be considered as a cause of death, even in the pediatric population, and especially if there is a family history of premature coronary artery disease or familial dyslipidemia.

"Café coronary" is a term used to describe a sudden attack resulting in death that occurs during or shortly after eating, often in the elderly, and is secondary to choking; however, the death is erroneously attributed to coronary artery disease. In children and adolescents, the opposite scenario, death in a suspected choking victim having a final diagnosis of myocardial ischemia secondary to coronary artery disease, is extremely rare.

Childhood is a critical period in which dietary and lifestyle patterns have long-term implications for coronary heart disease risk in adult life. Smoking, high intake of dietary total fat and saturated fat, low exercise level, and excessive alcohol consumption are correlated with elevated serum cholesterol, obesity, and hypertension in children, as well as a predisposition to premature death from coronary heart disease.

Children and adolescents can be at an even higher risk of cardiovascular disease if there is a family history of premature coronary artery disease or familial dyslipidemia. Of the primary hyperlipidemias, familial hypercholesterolemia (FH) is the most common and the most documented to have important cardiovascular consequences beginning in childhood. FH is an inherited dominant condition due to a defect in the LDL receptor gene and is usually discovered when there are increases in plasma total and LDL cholesterol in the child and in at least one of the parents. More than 600 different LDL-receptor mutations have been described. Mutations of the LDL-receptor cause significantly elevated LDL levels. This inability for cholesterol uptake leads to premature atherosclerosis and a very high risk of early cardiovascular disease and myocardial infarction. Patients with homozygous FH manifest cardiovascular disease within the first two decades of life, and may present within the first decade of life with physical findings related to cholesterol deposition, such as tendon xanthomata, cutaneous xanthelasma, or corneal arcus. FH heterozygotes usually present with problems in early to mid-adulthood.

A 2-year-old Hispanic male appeared to be suffering from a "café coronary" while eating, but was actually suffering from acute myocardial ischemia secondary to >90% stenosis of multiple coronary arteries. Initial responders and emergency department personnel proceeded with resuscitative procedures/protocols in response to a presumed choking/asphyxia event. Autopsy revealed extensive cholesterol deposition in the coronary arteries with additional deposits found throughout the aorta and within the skin (xanthomas). The decedent's family history was significant for a father and 12-year-old sister with hypercholesterolemia. A recent visit to the pediatrician revealed fasting plasma total cholesterol >400 mg/dl. It is recommended that medicolegal death investigators become familiar with the possibility of an acute cardiac death in young children with a family history of abnormal cholesterol metabolism.

Café Coronary, Children, Familial Hypercholesterolemia

G91 Identification of Twenty Charred Victims of a Helicopter Accident, Africa

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This presentation offers a paradigm for the identification of multiple charred bodies in situations where there is no existing medicolegal infrastructure.

This presentation will impact the forensic science community by-demonstrating how a rush to immediate autopsy is not always the best first step. A first triage including sex, size, and personal effects allowed quick matching with antemortem data.

Since each mass disaster presents unique challenges, the medicolegal response must be tailored to the circumstances at hand. Scientific standards for identification vary from country to country, often in proportion to the urgency of identification and the country's scientific capabilities.

On June 11 2007, a helicopter transporting twenty supporters of a soccer squad, among them two French nationals, ignited a couple of feet off the ground at an airport in Africa; investigation revealed that the private helicopter company was not certified to fly. The bodies, unnumbered, had been simply repatriated to local morgue. No forensic investigation were performed locally. The French embassy asked the french government to send a team to Africa in order to identify the french bodies and to help local government to identify their bodies. As the bodies were charred, the identification procedure might include all the victims.

A seven member team of French forensic experts, including two pathologists and an odontologist, were dispatched to the scene, accompanied by half a ton of equipment; a one week mission was planned.

The first step was to petition the local judiciary to confer official status on the mission. Next, a unit of the team worked with families to organize intake of antemortem data (medical and dental history, descriptions of personal effects) and exemplars for possible DNA comparison.

A second unit worked on analyzing the bodies. A decision was made to do an intake exam to assign the bodies case numbers, determine the sex and size, then describe any personal effects. This preliminary triage facilitated more exacting processing with regards to comparison with available antemortem data (scars, prostheses, dental irregularities). With that goal, an autopsy (minimal autopsy following the Interpol procedure) with odontologic evaluation was conducted on each body, and a segment of femur retained for possible DNA testing.

On-site identification was possible for fourteen of the twenty bodies as follows: dental charting – eight bodies; radiographic comparison – two bodies; confirmation of a hip prosthesis - one body; anthropological identification of an old fracture – one body; identification by highly specific ritual scars – two bodies; fingerprints – one body. Some bodies were identified by multiple modalities. Finally, for six bodies, genetic testing was the only possible option, and was accomplished through mitochondrial DNA extracted from bone specimens sent to France packed in dry ice. Location work took one week, with DNA identification of the final six bodies completed in three weeks.

All site work was done by the specially french trained team, equipped to perform postmortem examinations without relying on local infrastructure (with the exception of access to water). This team includes police officers, crime scene investigators, forensic odontologists, and forensic pathologists, all trained in identification methods and technics.

The authors experience demonstrates that a rush to immediate autopsy is not always the best first step. In this case, preliminary triage on the basis of sex, size and personal effects allowed quick matching. Time for identification was reduced, and the bodies were rapidly released to families as identifications progressed, easing the political pressure.

Forensic, Mass Disaster, Identification

G92 Risk Factors for Pedestrian Deaths

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After attending this presentation, attendees will understand some of the pertinent risk factors associated with pedestrian deaths.

This presentation will impact the forensic community and public health agencies by documenting and highlighting factors which can help focus injury prevention strategies.

All pedestrian deaths investigated by the Central Virginia District Office of the Chief Medical Examiner in the years 2002 through 2006 were reviewed using police reports, death certificates, and medical examiner investigation and autopsy reports. The decedent information and circumstances of the death were extracted to analyze factors such as age, sex, race, manner of death, intoxication, time of day, season, location of death, activity of decedent, and vehicles involved.

Approximately 70% of all deaths were adults (21 to 65 years old) and 70% of all deaths were males. The rate of pedestrian deaths (per million) was 21 for males compared with 8.7 for females. Rates were highest for Hispanics (24.2) followed by African Americans (19.3) then non-Hispanic Caucasians (12.1).

Considering individual risk factors in adult pedestrian deaths, the leading factor was darkness with approximately 76% of deaths occurring at night. The second most prominent factor was alcohol intoxication (Blood Alcohol >= 0.08 % by weight by volume) present in 44% of pedestrian deaths. The next most common factors were crossing a road (41%) or walking along or in a road (25%). Almost 8% of the pedestrian deaths were associated with a domestic dispute and 88% of the victims were male. Nearly 7% of the pedestrian deaths occurred in victims of or responders to a previous motor vehicle accident.

Most of the pedestrian deaths were certified as accidents (94%). Only 4% of the pedestrian deaths were certified as suicides but in an additional 6% of the deaths there were circumstances which were suspicious for but not diagnostic of suicide.

Education and enforcement focusing of risks of darkness, alcohol use and pedestrians crossing or walking on roads are focus areas for prevention. Pedestrians and responders on roads after motor vehicle collisions are at great risk. Domestic disputes are associated with a surprising number of pedestrian deaths. Pedestrian deaths require careful investigation to correctly establish manner of death.

Pedestrian, Motor Vehicle, Death

G93 Cervical Spine Injuries in Fatal Traffic Crash Victims: Microscopy and Diagnostic Imaging Findings

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The objective of this presentation is to familiarize the attendees with the presence of discrete lesions in the cervical spine facet joints in fatal traffic crash victims based on a large case-control forensic autopsy study utilizing advanced diagnostic imaging procedures and histological methods.

This presentation should encourage forensic specialists and researchers to include detailed examination of the posterior elements of the spinal column in the evaluation of trauma victims. Furthermore, clinical sciences should consider these findings as potentially relevant in cases of cervical spine symptomatology after severe road traffic crashes despite negative diagnostic imaging evaluation.

Occult lesions have previously been identified in the cervical spine in case studies on autopsy material using diagnostic imaging procedures and microscopy; very few case-control studies have, however, been performed.

The lower cervical spine facet joints from 42 subjects (20 fatalities from passenger car traffic crashes (cases) and 22 decedents due to non-traumatic causes (controls)) were removed *en bloc* during autopsy. The specimens were examined with: (1) advanced diagnostic imaging procedures (conventional x-rays, computed tomography and magnetic resonance imaging), (2) stereomicroscopy of 3-mm thick anatomical slices, and (3) microscopy of 10µm thick stained histological sections. Each facet joint was examined and described systematically with each of the three methods. The diagnostic imaging examination included evaluation of fractures and bleeding, the stereomicroscopy included evaluation of fractures, bleeding and damage to the synovial folds, and the microscopy included evaluation of fractures, bleeding in and disruption of the folds and haemarthrosis. Furthermore, age-related changes were evaluated microscopically with regard to cartilage fibrillation and fissures, vascular invasion of the tidemark and semi-quantitative histomorphometric measurements of the cartilage thickness, subchondral bone thickness, cartilage length, and percentage overlap of the anterior and posterior folds. Results from the diagnostic imaging procedures and the stereomicroscopy were compared to the microscopical findings.

Lesions in the lower cervical spine facet joints were common, particularly in the soft tissues, including bleeding in the joints spaces and the synovial folds. Among the diagnostic imaging procedures, computed tomography was the most sensitive towards identifying facet fractures, whereas soft tissue lesions could not be identified reliably in any of the diagnostic imaging procedures. None of the stereomicroscopical findings correlated significantly with the microscopical findings. Microscopical examination was the most sensitive method and identified all facet fractures, haemarthrosis, and bleeding in the folds. The microscopical findings correlated well with the exposure to trauma. None of the osseous or soft tissue lesions in the cervical spine facet joints were identified during the autopsy. Furthermore, histomorphometric data were collected for the normal anatomy of the lower cervical spine facet joints.

Discrete injuries in the lower cervical spine facet joints are common after fatal road traffic crashes. Osseous lesions of the facet joints can be reliably identified on computed tomography whereas soft tissue lesions can not. Stereomicroscopical examination does not reliably identify lesions in the facet joints in comparison to microscopical examination which identifies both osseous and soft tissue lesions in great detail.

This presentation should encourage forensic specialists and researchers to include detailed examination of the posterior elements of the spinal column in the evaluation of trauma victims. Furthermore, clinical sciences should consider these findings as potentially relevant in cases of cervical spine

symptomatology after severe road traffic crashes despite negative diagnostic imaging evaluation.

Fatal Traffic Crash, Cervical Spine Injury, Investigation

G94 Reconstruction of a Fatal Dragster Crash

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After attending this presentation, attendees will understand the basic principles in crash reconstruction, vehicle crash dynamics, measures of impact severity, occupant kinematics, seatbelt overloading, and biomechanics of injury in the context of an unique type of motor vehicle collision.

This presentation will impact the forensic science community by presenting concepts in crash reconstruction vehicle crashworthiness, occupant protection and human tolerance to impact by an in-depth analysis of an uncommon type of high-severty collision, this presentation will be of interest to all motor vehicle collision investigators.

This presentation examines a number of different concepts in crash reconstruction, vehicle crashworthiness, occupant protection and human tolerance to impact through the in-depth analysis of an uncommon type of high-severity collision. This illustrative case will be of interest to anyone investigating motor vehicle collisions and consequent injury patterns.

A 17-year-old female driver lost control of her rail-type dragster at the finish line during a routine performance run. The vehicle struck a rigid left concrete barrier running parallel to the track. The driver's seatbelt failed during the crash, and she was ejected and fatally injured. The cause of the seatbelt failure and its role in the death of the young woman were major considerations during the in-depth investigation of the crash.

The light stiff dragster rail was propelled by a jet engine mounted behind the seat and was traveling at a speed of 305 mph when it suddenly veered to the left at the finish line. The driver shut off the jet engine just past the finish line, and the vehicle began to decelerate rapidly due to large aerodynamic forces that also put the vehicle into a hard counterclockwise rotation. The "jet car" was traveling at approximately 280 mph and slipping sideways when it struck the barrier with its front end just 80 yards past the finish line. At impact, the approach angle of the vehicle's center of mass was 9.3 degrees to the barrier as indicated by a single tire mark. The component of the vehicle's velocity directed perpendicular to the barrier was 45 mph. Impact speed is often a poor measure of crash severity, and the velocity change (delta-V) and time duration (delta-t) of the impact must be considered. The delta-V in this case would be similar in magnitude to the component of the impact velocity that was directed perpendicular to the barrier. A delta-V of 45 mph is indicative of a severe crash. By comparison, full-frontal passenger vehicle crash tests into fixed rigid barriers are conducted at test speeds of 30 mph by regulatory agencies in North America. While the delta-V sustained by the dragster was very high and well beyond the compliance limits of passenger vehicles, there are additional considerations when evaluating impact severity. Due to the low mass and very stiff construction of the vehicle it sustained minor front-end crush. As a result of the short ride-down distance, the delta-t would be much less than a similar severity crash by a passenger vehicle. Consequently, the resulting decelerations sustained by the dragster were very large, and the impact extremely severe.

The occupant compartment remained intact, but the driver's five-point restraint harness failed during the crash. The left lap belt, right lap belt latch plate and central crotch strap separated due to occupant loading. The failure of the left lap belt occurred at the adjuster mechanism and appeared similar to the restraint failure observed after Dale Earnhardt's fatal NASCAR crash. The dragster driver was ejected and slipped out of her helmet, which remained tethered to the vehicle. Both driver and vehicle traveled approximately 275 yards from the point of impact before coming to rest near the barrier. The driver sustained severe injuries to the head, neck, torso and abdomen. Some of the injuries that contributed to her death resulted from excessive lap belt loading.

This case is an example of high severity crash occurring in a unique vehicle. The severity of the collision is due not only to the high delta-V of the crash but also its short time duration. Irrespective of the restraint system integrity, a fatal outcome was predictable.

Dragster, Crash, Reconstruction

G95 Death Due to Aquatic Erotic Asphyxia - Accident or Homicide?

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The objective of this presentation is to alert medical examiners, medicolegal investigators and other forensic experts to unusual and potentially deadly forms of erotic asphyxial behavior in an aquatic environment. Our concern is that such behavior can be misconstrued as autoerotic and classified "accident" in the event of a death.

This presentation will impact the forensic science community by illustrating that aquatic erotic asphyxia is a potentially deadly activity that can be a venue for more sinister activities such as aquatic sexual sadism and child abuse. Since aquatic erotic asphyxia requires the participation of two or more individuals, it should not be confused with autoerotic asphyxia. In the event of a death, a thorough investigation is needed to assign manner of death.

Accidental autoerotic deaths generally occur during solitary sexual activity involving the use of props or other stimulatory devices, when the victim miscalculates or when a safety mechanism or breathing apparatus fails. Some of the mechanisms used to produce cerebral hypoxia include ligatures, plastic bags, body wrapping and submersion in water. Aquatic erotic asphyxia (AEA) a potentially dangerous but less known form of erotic asphyxial behavior, may involve more than one participant, whereby the manner of death is at issue in the event of a death. Illustrative cases and a brief review of the literature will be presented.

AEA and its many subcategories as advertised on the internet with particular attention to the more pernicious forms of the practice such as aquatic sexual sadism and the forceful immersion of children are described. Surprisingly, references to aquatic pedophilia can be found on some of the websites catering to "aquaphiles". AEA can involve more than one participant in various gender combinations, with one dominant figure dunking or drowning a submissive figure, or with two individuals wrestling under water for dominance. AEA enthusiasts are careful to avoid injury and even post detailed medical questionnaires on their websites. AEA activity sometimes involves the use of actors wearing underwater makeup and props to ensure a safe and controlled environment. Aquatic sadists on the other hand derive pleasure from the dunking-related torture and/or actual drowning of another person, and promote more "realistic" scenarios.

Given that the AEA community is becoming increasingly organized, with personal ad websites, commercially available videos, DVD's and photographs, and even conventions and hosted parties, the authors strongly recommend that the practice be taken into consideration when investigating a death in water. Investigators should search for unusual items such as cinderblocks, cut lengths of rope, large clear plastic tarps, diver weight belts, unusually set-up scuba regulators, large empty fish tanks, and other apparel not usually worn in hot tubs or pools. Evidence suggesting the participation of more than one individual should also be carefully looked for, since the death scene may have been altered or sanitized. The concern is that when aquatic erotic asphyxial activity results in the death of a participant, we may be dealing with homicidal violence and sexual sadism and not accidental

autoerotic activity. The fact that death can potentially occur after the person exits the water further underscores the need for a thorough and thoughtful death investigation whenever a drowning is suspected.

Aquatic Erotic Asphyxia, Aquatic Sexual Sadism, Autoerotic Asphyxia

G96 Bear Facts Alaska: The Good, The Bad, and the Ugly

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After attending this presentation participants will understand characteristic trauma patterns found in fatal bear maulings , how these patterns relate to bear etiology in the wild and the latest research about and how to avoid bear attacks. The presentation will include autopsy results from highly publisized attacks, as well as those that are less well known looking at data from all species of bears.

This presentation will impact the forensic community/humanity by providing the latest information on bear fatality trauma and pathology with data accumulated by wildlife biologists in a synthesized fashion. It will provide the forensic community with a model of the injury patterns that are found in fatal bear attacks and hopefully help in the prevention of future attacks.

There has not been much forensic research conducted in the realm of bear fatal bear maulings and attacks. Because human development continues to encroach on natural habitats the numbers of bear- human encounters appear to be on the increase. A review of the literature consists mainly of brief case studies or papers that have been written in past decades in the context of emergency medicine or wildlife biology. Although being fatally mauled by a bear may be at the fringes of popular forensic science, these deaths usually enter the realm of forensic pathologists either because the death is unattended, suspicious or gets attention from the media. Because of these reasons, pathologists should have an understanding of injury patterns and a general understanding of why they occur. Biologists have contributed a great deal of data to aid pathologists in explaining why particular injuries occur. It is hoped that when fatal bear injuries are carefully documented and analyzed, pathologists can reciprocate and help biologists better understand bear species behavior with the goal of preventing further deaths.

Numerous case studies of bear mauling injury patterns found at autopsy are presented as well as the most recent scientific data from biologists that examine the specific nature of bear-human interactions and the best way to avoid them.

Bear Fatality, Trauma Patterns, Etiology

G97 Concussive Head Injury and Alcohol

Jane Willman Turner, PhD, MD, St. Louis University School of Medicine, 1402 South Grand Boulevard, St. Louis, MO 63104*

Upon completion of this presentation, attendees will gain an appreciation of the combined effects of ethanol and concussive head injury in causing sudden death. A detailed review of autopsies of individuals whose cause of death was concussive head injury with alcohol will be presented along with outlines of the scene investigations and examination of the toxicology results.

This study is of use to the forensic community in supporting the theory that sudden death occurs from concussive injry of the brain in the presence of alcohol. Consideration of this entity can unquestionably impact the medicolegal investigation of some deaths.

The spectrum of diffuse brain injury ranges from mild concussive injury to diffuse axonal injury resulting in death. The cases of diffuse axonal injury are often apparent to the forensic pathologist at the time of autopsy as the associated markers of injury are often present. That is to say, in cases of sudden death from severe head injury, significant intracranial injuries are often present. However, there exist rare cases of head injury in which only soft tissue injury is found and there are no epidural, subdural or subarachnoid hemorrhages, or gross injuries to the brain, and yet sudden death has occurred. In these specific rare cases the blood ethanol levels are elevated. The proposed mechanism of death is that the combined effect of concussive brain injury and elevated blood alcohol produces postinjury apnea, leading to sudden death. Normally, concussive brain injury rarely causes postinjury apnea. However, the presence of elevated blood ethanol, a respiratory depressant, appears to potentiate fatal apnea in even mild concussive injury.

A computer search was used to identify all cases in the City of St. Louis and four of the adjacent counties in the past ten years. Eight such cases were found. The ages ranged from 23 to 64 years. Each of the individuals suffered blunt trauma about the head and/or face and had blood ethanol levels ranging from 0.18 to 0.40 g/dl. Two of the cases involved women who had been sexually assaulted and in which the manner of death was homicide. In each of these cases the thorough scene investigations and the circumstances surrounding their deaths exclude other possible causes of death.

Milovanovic and DiMaio published a series of cases of death due to concussion and alcohol in 1999. This review of autopsies in the St. Louis metropolitan area corroborates the findings of these authors and their description of the pathophysiologic processes that take place in such deaths and provides additional cases for review.

This study is of use to the forensic community in supporting the theory that sudden death occurs from concussive injury of the brain in the presence of alcohol. This diagnosis must be seriously considered in any death in which there is injury to the head without visible injury of the intracranial structures and the blood ethanol levels are elevated. Overlooking this cause of death may result in erroneous classifications of manner of death as natural or accidental, for example, when the manner may indeed be homicide. As such, consideration of this entity can unquestionably impact the medicolegal investigation of some deaths.

Blunt Head Trauma, Concussion, Alcohol

G98 Preliminary Study and Potential Role of CT Imaging Autopsy in the Investigation of Death Due to Accidental Blunt Trauma

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The goals of this presentation are: (1) to understand the investigational technique of 2 dimensional and 3 dimensional CT imaging autopsy in the medical examiners investigation of death, (2) to review a U.S. medical examiners office early experience and results of CT imaging autopsy compared with conventional autopsy for fatal accidental blunt trauma, and (3) to describe circumstances where CT imaging autopsy may evolve into a triage tool for the medical examiners investigation of sudden death.

This presentation will impact the forensic community and humanity by addressing the potential role of non-invasive CT imaging autopsy to replace conventional autopsy or enable performance of limited, focused autopsy in the U.S. medical examiners investigation of fatal accidental blunt trauma. CT imaging autopsy has potential for rapid and cost effective investigation in such circumstances, including mass casualty investigations. It may also provide options in the setting of religious and cultural objections to conventional autopsy.

Recent publications have suggested a potential role for high-resolution CT imaging using 2D and 3D techniques in the forensic investigation of

death. This pilot study evaluated the sensitivity of CT imaging autopsy for major injuries and accuracy for the cause of death. The study also evaluated the potential role of CT imaging autopsy as a replacement for or adjunct to conventional autopsy in the investigation of traumatic accidental death within a U.S. state medical examiner system.

Of 40 decedents prospectively investigated with whole body 40-detector row 2D and 3D CT within 24 hours of death, 27 were identified as victims of suspected accidental blunt trauma. Each CT study acquired approximately 3,000 images in 10 minutes scanning time and required 30 minutes interpretation time. As this was a new technique, CT was interpreted with consensus reading by 2 radiologists and compared with medical examiners autopsy results for major findings and cause of death in all cases.

CT imaging autopsy correctly identified 217 major traumatic findings (average 8/decedent, sensitivity 93.4%). It correctly identified a specific injury or combination of blunt trauma injuries as the cause of death in 25 cases and excluded traumatic death in 2 others. Fourteen major false-negative CT findings included non-displaced atlanto-occipital subluxation (n=4); fractures of the ribs or sternum (n=3); lacerations of the aorta (n=3), bronchus (n=1), and liver (n=1); cardiac contusion (n=1); avulsion of the renal pedicle (n=1). CT identified 8 major findings not detected at conventional autopsy: fractures of sacrum (n=2), mandible (n=2), skull base (n=2), cervical spine (n=1); lung lacerations (n=1). Suspected significant air embolism associated with major skull base or thoracic trauma (n=6) and tension pneumothorax (n=1) were noted on CT but not found at autopsy, likely related to the technique used.

This early experience suggests that CT imaging autopsy has promise as a sensitive tool for the detection of major injuries and accurately determines the cause of death after accidental blunt trauma. It may be insensitive for some major findings including non-displaced fracture or subluxation and the exact site of vascular injury in the setting of obvious major hemorrhage. Air embolism appears to be more easily detected by CT than conventional autopsy and may play a greater role in death due to blunt trauma than previously recognized.

CT Imaging, Autopsy, Accidental Blunt Trauma

G99 Stairway Related Deaths: An Analysis of Autopsy Findings of Individuals Found Dead at the Bottom of a Stairway

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After attending this presentation, the attendee can expect to learn the characteristics of autopsy findings of individuals found dead at the bottom of a stairway.

This presentation will impact the forensic science community by showing that it is not possible to predict which individuals found dead at the bottom of a stairway died from injuries and which died from non-traumatic causes based on age, cutaneous injuries, or a past medical history of a disease that could cause sudden death.

Cases from the Sparrow Health System Forensic Pathology Department (Lansing, Michigan) database were searched for deaths of individuals found dead at the bottom of a stairway. Twenty-seven such cases were identified; all of the deaths had full autopsies and twenty-six had blood drug screens.

The cases were divided into two groups: those whose deaths were caused by injuries consistent with a fall and those in which no significant injuries were identified. The age range, natural diseases, toxicology findings, and external injuries were compared between the groups. For the group of individuals who died due to a fall, the types of lethal injuries were characterized.

Twenty-seven deaths investigated since January 1, 2000 were of individuals who were found dead at the bottom of a set of stairs. Nineteen of the twenty-seven died from injuries associated with a fall and eight of twenty-seven were free of significant injuries.

Of the eight individuals who were found dead at the bottom of a stairway, but had no significant injuries, six were men and two were women. The age range was 48-87 years with an average age of 63 years. Six of the eight decedents had cutaneous head injuries. Six of the eight individuals had cutaneous injuries of the torso and/or the extremities. None of the individuals were free of cutaneous injuries. Seven of the eight deaths in this group resulted from atherosclerotic cardiovascular disease and/or hypertensive cardiovascular disease. One death resulted from a mixed drug intoxication with citalopram and ethanol. Cocaine intoxication was a contributing factor in one of the deaths due to cardiovascular disease. The drug screens in the remaining six were negative for significant findings. Four of the eight individuals in this subset had a reported significant chronic medical condition, known before the autopsy, that might explain a sudden death.

Of the nineteen individuals who died from injuries related to a fall, 15 were men and 4 were women. The age range of this subset was 30-93 with an average age of 63 years. Eighteen of the nineteen deaths in this category were caused by craniocerebral injuries. The one death in this group not caused by head injuries was a 93-year-old woman whose death resulted from a left femur fracture and multiple left rib fractures. Thirteen of the eighteen had cutaneous head injuries, and three of these thirteen had cutaneous head injuries and blood draining from the external auditory canal(s). Fifteen of the nineteen individuals had cutaneous injuries of the torso and/or the extremities. There were no cases of individuals without any cutaneous injuries.

Of the nineteen individuals who died from injuries due to a fall, the blood drug screens in seven were negative for significant findings. Ethanol was present in the blood of eleven of the twelve with positive findings and ranged from 0.04 – 0.30% (in six of these eleven, the level was greater than 0.20%). THC was present in the twelfth case with significant toxicology findings.

Of the eighteen individuals with lethal craniocerebral injuries, most had skull fractures, however, none of the individuals with lethal injuries had depressed skull fractures.

Ten of the nineteen individuals in this subset of individuals who died from injuries had a reported significant chronic medical condition, known before the autopsy that might explain a sudden death.

Conclusions: The majority of individuals found dead at the bottom of a stairway have sustained lethal injuries. The factors that were evaluated (age of decedent, past medical history, presence of cutaneous injuries) are not predictive of lethal internal injuries identified at autopsy. A very high percentage of individuals found dead at the bottom of a set of stairs have positive postmortem drug screens, primarily alcohol.

Stairway, Autopsy, Fall

G100 Discrimination of Falls and Blows in Blunt Head Trauma: Assessment of Predictability Through Combined Criteria

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The goal of this presentation is to propose a criteria tool for the distinction of falls from blows in blunt head trauma.

This presentation will impact the forensic community by providing new insight into the evaluation of blunt head injuries.

The discrimination of falls from homicidal blows in blunt head injuries is a common but difficult problem in forensic pathology. One of the most often used criteria to evaluate this issue is the hat brim line rule. According to this rule, an injury located above the hat brim line (HBL) is more likely the result of a blow, while a fall would generally produce a wound at the level of HBL. The objective of this study was to evaluate the validity of this

criterion, as long as of two other possible criteria: side lateralization of skull fractures and number of lacerations. Furthermore, a combined criteria tool will be developed.

Over a 6-year period (2000-2005), all autopsy cases from the Montreal *Laboratoire de sciences judiciaires et de médecine légale* were analyzed. Cases selected consisted of falls downstairs, falls from one's own height, and head trauma by a blunt weapon. Upon review of photographs and autopsy reports, all cranial fractures and lacerations were positioned on figures representing the head and the skull in different anatomical views. For the present study, HBL was defined as 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). For each case, the following elements were compiled: location of fractures in relation to HBL, side lateralization of skull fractures and number of lacerations.

A total of 114 cases were selected: 21 cases of downstairs falls, 29 cases of falls from one's own height, and 64 cases of head trauma by a blunt weapon. The location of a cranial fracture inside HBL was of little interest in the distinction of falls from blows. On the other hand, fractures located above HBL were associated to blows in 75.9% and to falls in only 24.1%. Hence, a fracture positioned above HBL was in favour of a blow (α=0.02, contingency coefficient=0.25). Side lateralization of fractures was also of interest in the distinction of falls from blows: right skull fractures were more likely to result from falls whereas left skull fractures were more often associated with blows (α=0.007, contingency coefficient=0.36). Even more interesting was the number of lacerations: cases presenting 3 or less lacerations were mostly falls cases (60,5%), whereas all cases (100%) with more than 3 lacerations were cases of blows (α =0.000, contingency coefficient=0.48).

By combining those criteria, a better predicting rate was achieved. Indeed, the presence of at least two criteria in favor of a fall was successfully predicting cases in 65.9%, whereas the presence of at least two criteria in favor of a blow revealed a perfect score of 100% of successful prediction. Furthermore, by combining the three criteria altogether, the predictability of the criteria tool was even better: the presence of a combination of three criteria in favour of blows still demonstrated a success rate of 100%, while the success rate for falls reached 83.3% (α=0.001, contingency coefficient=0.62).

Considering the previous results, the presence of a fracture above HBL, of a left side lateralization of skull fractures and the presence of more than three lacerations are criteria in favor of a blow. On the contrary, a typical fall case is more likely to present with a fracture inside HBL, a right side lateralization of skull fractures and 3 lacerations or less. A criteria tool based on combination of those criteria can achieve a predictability rate of 100% for cases of blows and 83.3% in falls cases.

Blunt Head Trauma, Hat Brim Line, Skull Fracture

G101 Unusual Death of a Transsexual (Identification of Damaging Means and Death Time)

Alessandro DellErba, Sandra Cornetta, MD, Fiorenza Zotti, PhD, and Annalisa Addante, MD, PHD, Section of Legal Medicine, Place G. Cesare, BARI, 70124, ITALY*

After attending this presentation, the attendees will understand how scanning electron microscopy and immunohistochemistry can assist the forensic investigator and pathologist in correlating the scene, autopsy findings, and cause of death.

This presentation will impact the forensic science community by illustrating the importance of ancillary studies in the forensic autopsy.

February 2007 in Puglia, a transsexual homicide victim was discovered on a suburban road. The body was adjacent to the victim's automobile.

The autopsy confirmed that the cause of death was a serious encephalic concussion. There were doubts about the means of trauma, and for such a reason further analysis was conducted with the scanning electron microscope. Material that was deposited on the epidermic borders of the scalp was compared with the varnish rests of the automobile. It was suspected that the collision/impact of the victim's head was to the lower clapper of the right front door.

The time of death was evaluated by immunohistochemical surveys executed on samples of cerebral parenchyma using the anti-betaAPP antibody.

Transsexual Homicide, Damaging Means, Immunohistochemical Investigation

H1 A Small Plane Crash With (Unforeseen) Large Legal Consequences

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Viewers of this presentation will be better able to utilize forensic anthropology in sorting potentially commingled remains, and recognize the importance of radiology, both as an analytic tool and a permanent record.

This presentation will impact the forensic community by emphasizing the value of radiology of remains as a means of analysis and interpretation, as well as permanent documentation in case unforeseen questions should arise.

A small plane crash resulted in the death of three individuals: the owner (who was a licensed pilot), his son, and the pilot employed by the plane's owner.

The remains of one individual, who was later identified as the professional pilot, were fairly intact and collected in one body bag.

The mangled and fragmented remains of the other two men, later identified as the owner and his son, were put into two separate body bags.

Each set of remains was quickly and positively identified by comparison of antemortem and postmortem dental radiographs and returned to the two families.

The authors' anthropological services were not used, inasmuch as the identifications appeared to be straightforward and provided rapid closure for the families.

Unfortunately, some time later, as aircraft and other insurance claims were being processed, a dispute arose between multiple opposing law firms as to whether or not the non-pilot son of the owner might have been flying the aircraft at the time of the accident, rather than one of the two licensed pilots aboard.

The authors were called in at that belated point and were asked to answer the following questions: (1) was there commingling of remains within the body bags? and (2) could they help determine who was flying the plane (who was at the controls at the time that the plane crashed? Fortunately, the Coroner's Office involved had a policy of always taking full body radiographs - in this case full body bag radiographs.

The forensic anthropology procedures used to answer these seemingly simple questions are discussed in this presentation. They include determination of relative ages of the commingled body fragments, and identification of trauma to the extremities - using the available body bag radiographs.

The remains of the hired pilot could be excluded from consideration, because his remains were found relatively intact and at some distance from the other two "sets" of remains. The radiographs of the single body bag containing the remains of the pilot showed no signs of commingling. This was a helpful starting point, because he was approximately 20 years old at death - about the same age as the non-pilot son.

Age differences provided the main basis for determining that the fragmentary remains of the father and the son were indeed commingled within the two other body bags, inasmuch as the father was approximately 45-years-old at death and the son was approximately 20-years-old at death.

These findings were based primarily on radiographic evaluation of joint surface configuration and the presence or absence of persistent lines of density suggesting recent epiphyseal union (sometimes called "growth plate scars" and not to be confused with the "Harris lines" associated with growth arrests followed by growth augmentation).

The disarticulated and severely fractured feet were those of the older individual (the father, who was a licensed pilot), although they were located within the body bag containing other remains identified dentally as being those of the son. The damage present was consistent with that found in individuals "working" control pedals in both automobile and airplane crash situations. The foot of the younger individual (the son) showed minimal damage.

Aircrash, Anthropology, Radiology

H2 An Assessment of Biological Ancestry in an Unmarked Cemetery From Nevada: An Integrated Approach

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After attending this presentation, the audience will understand the value of a multidisciplinary approach in the assessment of biological ancestry, and the inherent limitations between methods. Using a small historic cemetery sample, biological ancestry is assessed through the study of craniometric variation, non-metric cranial traits, and ancient DNA.

This presentation will impact the forensic community in general by increasing the understanding of different methods used to evaluate biological ancestry and their value in constructing biological profiles of unknown individuals.

This study presents an analysis of nine individuals recovered in 2000 from an unmarked cemetery in Palisade, Nevada, a ghost town officially abandoned in 1961. The cemetery was discovered during a mining operation, which required that the burials be removed. The remains and associated grave items were excavated by local law enforcement, and were submitted to the Human Identification Laboratory at California State University, Chico for osteological analysis. An analysis of the coffin material and associated grave items suggests that these individuals were interred between 1880 and 1910. Because these individuals were buried in separate location in close proximity to the town's main cemetery, it is hypothesized that the burial site may represent a segregated cemetery.

Sex, age, and stature were estimated using standard osteological methods. The nine individuals consist of four males and five females, and range from 25 to 59 years of age. Stature was estimated using regression formulas from the 19th century Terry collection. Female stature ranged from 4'10" to 5' and male stature ranged from 5'3" to 5'6".

Ancestry was assessed through craniometrics, non-metric traits, and ancient DNA. Cranial measurements were taken following guidelines outlined in the Forensic Databank. Each skull was measured twice by different authors to limit intra-observer error. Many of the skulls were fragmentary and/or showed evidence of deformation, which reduced the number of valid measurements that could be taken. Of the nine skulls, only individuals 4, 5, and 8 had crania intact enough for all measurements. The skull of individual 9 is incomplete and is excluded from the analysis. Also, burial 3 lacked a skull upon initial recovery. However, a skull discovered in 2001 at the site is thought to be associated with this burial. Ongoing DNA testing will be used to resolve this issue.

Burial	Sex	Age	Stature	Ancestry	FORDISC 3.0	
1	Female	40-49	4'10" +/-3.1"	Black	Post: 0.816	Typ: 0.307
2	Male	40-49	5'6" +/-3.1"	Japanese	Post: 0.871	Typ: 0.004
3	Male	25-34	5'4" +/-3.1"	Black	Post: 0.333	Typ: 0.071
4	Female	30-39	4'11" +/-3.1"	Black	Post: 0.756	Typ: 0.589
5	Female	40-49	5'0" +/-3.1"	American Indian	Post: 0.538	Typ: 0.993
6	Female	50-59	4'11" +/-3.1"	American Indian	Post: 0.676	Typ: 0.355
7	Female	35-45	4'11" +/-3.1"	Black	Post: 0.882	Typ: 0.344
8	Male	30-35	5'3" +/-3.1"	Guatemalan	Post: 0.670	Typ: 0.127
9	Male	35-39	5'4" +/-3.1"	N/A	N/A	N/A

FORDISC 3.0 was used to compare cranial measurement data from our sample against the modern Forensic Databank sample. In addition, 17 non-metric traits were recorded for the dentition as well as the malar, nasal, and alveolar region following by Gill and Rhine (1990).

Biological profiles and statistical results for FORDISC 3.0 (posterior probability and typicality probability) are provided in the table. FORDISC 3.0 classified each individual into one of five groups: Black, Japanese, American Indian, and Guatemalan. However, the low typicality values for individuals 2 and 3 suggest that these crania are highly atypical of the classified groups. The non-metric assessment yielded similar results as the metric assessment, in that it also indicated that these individuals are of Asian, Native American, and/or African ancestry. However, none of the individuals showed non-metric cranial traits consistent with a single ancestral group. This may suggest that at least some of the individuals are of mixed ancestry.

To help reconstruct the maternal genetic ancestry of this population, mitochondrial DNA was also extracted from a minimum of two samples from each individual. Haplotypes based on HVS I sequences were analyzed, and where applicable, haplogroups based on restriction fragment length polymorphisms were determined. Ongoing DNA testing will provide an additional line of evidence for evaluating the ancestry of these individuals.

Although the metric and nonmetric assessment of ancestry suggests a biologically diverse sample, none of the individuals were classified as European ancestry. In conjunction with the grave items and other contextual information, our analysis suggests that these individuals may have been buried in a segregated location due to their biological (non-European) heritage. This study shows that osteological assessment of ancestry is just one key piece of the puzzle. When used in conjunction with other forms of evidence such as ancient DNA, and archaeological evidence, a more complete picture of biological heritage is achieved.

Ancestry, Craniometrics, DNA

H3 Separately Discovered Skeletal Remains and the Path to Reassociation: A Case Review

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After attending this presentation, attendees will have an understanding of the potential for missing minute, yet essential, pieces of artifactual evidence when recovering skeletal remains from the crime scene. Attendees will also have gained an understanding of the importance of interdisciplinary cooperation when reassociating skeletal elements and identifying an unknown deceased individual.

This presentation will impact the forensic community by educating forensic practitioners and investigators about reassociating separated human skeletal remains, as well as emphasizing the importance of anthropological and odontological techniques for recovering minute and easily missed, yet vitally important, pieces of evidence.

In late 2006 and early 2007, Forensic Anthropologists at Simon Fraser University and Forensic Odontologists at the BOLD Laboratory of The University of British Columbia received from the BC Coroners Service two separate cases involving the skeletonized remains of unknown individuals. The two scenes were located several kilometers distant from each other, and the discoveries were made several months apart. Distinct morphological characteristics and similar injury patterns suggested the remains actually represented one individual, which was later supported by DNA analysis.

The cranium was discovered submerged in a semi-urban recreational lake, and exhibited evidence of a mostly healed Le Fort II fracture of the left maxilla. Additionally, there was a healed surgical trephination of approximately 1 cm in diameter on the left parietal, with an associated notch in the posterior-inferior margin. The root of a single tooth remained *in situ*; all other teeth had been lost antemortem or during the postmortem interval.

Approximately six months later, the postcranial remains of an individual were found in a brushy, semi-urban setting approximately 3 km from the lake. This individual exhibited multiple severe healed fractures of the ribs, consistent with a major crushing chest injury. Screening of the associated soil matrix produced several artifacts of internal soft tissue microsurgery. A maxillary fixed dental bridge was recovered along with a mandible, although no cranium was found at this location.

The similarities in injury patterns, degree of injury healing, and morphology of articulation points between the cranial and postcranial remains suggested a single unidentified person. Odontological examination revealed consistency between the dental bridge and missing maxillary dentition; the color, contour and surface condition of the cranium and postcranial remains; and the mandibular and maxillary alveolar contours. A goodness-of-fit examination supported a match of the temporomandibular joints and condylar heads; the shape and sizes of the dental arches; and articulation of the dental bridge with the lower anterior teeth. Forensic anthropological examination produced biological profiles of both cases which were of the same sex and age range. Both cases had injury patterns consistent with a severe trauma, and exhibited the same degree of healing, suggestive of a single event. A goodness-of-fit examination of the articulation of the occipital condyles and the unique morphology of the first cervical vertebra supported a single individual. The results of DNA analysis were consistent with the two sets of remains representing a single person.

This unusual case presented a rare opportunity for the reassociation of disassociated remains, and highlights the importance of investigating improbable relations between distinct and apparently separate sets of remains. The discovery of the microsurgical hardware emphasizes the importance of a detail driven recovery and examination of unknown remains.

Reassociation of Skeletal Elements, Forensic Anthropology, Forensic Odontology

H4 Surgical Sutures as a Means of Identifying Human Remains

Katy L. Shepherd, BS, 10101 Villagio Palms Way, Unit 201, Estero, FL 33928; Heather A. Walsh-Haney, PhD, Florida Gulf Coast University, Division of Justice Studies, 10501 FGCU Boulevard South, AB3, Fort Myers, FL 33965-6565; and Marta U. Coburn, MD, District 20 Medical Examiner, 3838 Domestic Avenue, Naples, FL 34104*

After attending this presentation, the audience will understand how surgical sutures found in human remains may be used to help establish a positive identification.

This presentation will impact the forensic community by providing anthropologists, medical examiners, coroners, and law enforcement another tool to aid in identifying decedents. This presentation also demonstrates the investigative process used to pinpoint suture manufacturers, and in turn the identification of the victim, by presenting a case where surgical sutures were a distinctive characteristic.

In 2006, a set of skeletonized remains was discovered in a dense, wooded area adjacent to a residential gated community in Naples, Florida. The human remains consisted of a nearly complete skeleton and associated physical evidence that included a .357 magnum (found beside the remains), one spent bullet and shell casing, several unfired bullets contained within a box of ammunition, and a bicycle. Upon initial examination by the medical examiner and law enforcement personnel, the cranium was found to be fragmented, and the mandible had a midline fracture. Based on the scene evidence, the preliminary cause and manner of death appeared to be consistent with a single suicidal gunshot wound to the head. No identification was found with the remains nor was fingerprint evidence an option. A tentative identity was established by tracing the serial number on the gun.

The forensic anthropologist conducted an osteological analysis of identity, trauma, and time since death. As such, the metric analysis of sex, ancestry, and stature using Fordisc 3.0 determined that these remains were a White (e.g., European American) male approximately 5'10" in living stature. Nonmetric analysis of the skull and pelvic morphology supported the metric sex and ancestry findings. Radiographic and gross examination of the skeletal remains, both before and after reconstruction, evidenced one cranial gunshot wound that entered on the right and exited on the left. Skeletal age was determined through visual examination of all joint surfaces, including the pubic symphysis, auricular surfaces of the ossa coxae, and sternal end of the right 4th rib and subsequent comparison with known age exemplars for White 20th century males. The most accurate age estimation was determined to be between 50 and 60 years of age. Time since death was determined to be from weeks to months and no more than one year as evidenced by the extent of skeletonization, lack of the odor of decomposition, relative completeness of the remains, and the mechanical integrity of the bones.

Two green surgical sutures were discovered imbedded in the right acromial process of the scapula, which suggested that the decedent had undergone rotator cuff surgery—either as rotator cuff tendon repair, acromioplasty, or subacromial decompression. The dearth of published casework and research concerning the use of surgical sutures in human identification and the establishment of time since death required a consultation with a local suture and orthopedic implant manufacturer. To wit, several suture manufacturers were considered and the tentative identity was further bolstered by the biological profile and previous rotator cuff surgery.

There are several types of non-absorbable sutures, including, silk, nylon, polyester, polypropylene, and surgical steel. Non-absorbable and steel sutures are more likely to be found in forensic cases than absorbable sutures, so the concentration for this presentation will be on the former. Each manufacturer produces non-absorbable sutures of various colors and diameters that are determined by the suture material and the designed medical use. Non-absorbable sutures may be further classified based on whether they are constructed as a monofilament or multifilament (e.g., twisted together, spun together, or braided).

In addition to color, diameter, and construction materials, a non-absorbable suture's degradation may also help provide information concerning when surgery may have occurred and perhaps help narrow the time since death. While most non-absorbable sutures do not degrade completely, some materials, such as silk and nylon, do progressively lose their tensile strength. As such, suture manufacturing companies are able to assist in estimating timelines—whether determining when the surgery may have taken place or estimating time since death—based on degradation of the sutures as assessed by changes in the suture's mechanical properties. There are several surgical suture manufacturers, each with readily available information on their products and these include: DemeTECH®, Arthrex®, United States Surgical™, Syneture™, Ethicon©, and CP Medical®. Many manufacturing companies have employees who are able to identify their products simply by visual recognition and can reference in-house research reports that address suture use, properties, and degradation. Therefore, when medical examiner's and coroner's offices, law enforcement agencies, and forensic anthropologists find surgical sutures with human remains, a useful investigative tool exists to narrow down the suture manufacturer, and may aid in determining the decedent's identification and time interval since death.

Surgical Sutures, Identification, Human Remains

H5 Fractured Frontier: An Analysis of Fracture Patterns in a Historic Nevada Cemetery

Carrie A. Brown, BA, Nikki A. Willits, BA, Brenna K. Blanchard, BA, and Kristin L. Chelotti, BA, California State University, Department of Anthropology, 400 West First Street, Butte Hall 311, Chico, CA 95929*

This presentation will demonstrate the value of antemortem fracture analysis in the interpretation of life characteristics in unidentified skeletal remains. This poster presents evidence of antemortem fracture healing in a small historic burial sample.

This presentation will impact the forensic community by furthering the understanding of fracture patterns and bone remodeling processes as they relate to the construction of biological profiles.

In February 2000, an unmarked cemetery containing nine individuals was discovered in Palisade, Nevada, a deserted frontier railroad town. The remains were excavated by local law enforcement and transferred to the Human Identification Laboratory at California State University, Chico for analysis. Contextual information and grave items indicate that the individuals were interred in the late 19th to early 20th century. Of interest was the fact that these individuals were buried in a separate location from the marked town cemetery. The group consists of four males and five females, ranging in age from 25 to 59 years of age. Craniometric and non-metric analyses suggest that at least eight of the individuals were of Asian or African ancestry.

Of particular note is the high prevalence of traumatic injury present among seven of the nine individuals. These injuries consisted primarily of healed fractures, with no evidence of perimortem trauma. Several of the individuals also exhibit evidence of degenerative disease, especially of the spine and the lower limb. Individuals 2 and 7 have healed boxer's fractures on the right fifth metacarpal. Individual 5 has a similar healed fracture on the right second metacarpal, and also exhibits an unreduced healed fracture of the distal right ulna. In addition, the left nasal bone shows probable evidence of an unhealed fracture. Individual 3 has an unreduced fracture of the left tibia and fibula with major bone remodeling and severe lateral displacement of the distal end. These fractures resulted in a height loss of approximately 2 cm for both the tibia and the fibula when compared to the contralateral side. Individual 6 has an unreduced healed fracture of the right distal ulna and a possible partial fracture of the right distal radius. A pseudoarthrosis is present at the radio-ulnar joint, as well as an increased porosity of the carpals, which is likely related to the trauma sustained from the fracture of the lower arm. Individual 8 has a separated neural arch of the fifth lumbar vertebra, consistent with spondylolysis, a stress-fatigue fracture. This individual also has a bony spur on the lateral surface of the right femur, which may be associated with trauma to adjacent muscle tissue. Individual 9 has several healed fractures of the ribs: left ribs V and IX and right rib XII. This individual also exhibits an unhealed depressed fracture of the right tibial plateau.

Overall, boxer's fractures are the most prevalent in the sample, although several other fractures are remarkable in their severity. The evidence of severe, unreduced fractures in individuals 3, 5, and 6 provide evidence for a lack of medical treatment. Although the sample size is small, there is some evidence for a different patterning of injury between the sexes. While males exhibit a higher prevalence of lower limb trauma, there is a trend toward upper limb injuries among females with fractures. The differential fracture patterning observed in males and females indicates a likely difference in activity type between the sexes.

The high prevalence of fractures and marked degenerative conditions observed in several of the skeletons, in conjunction with other contextual evidence from the burial site, suggest that these individuals were of low socio-economic status. Furthermore, the severity of many of these injuries and the unreduced nature of some of the fractures suggest that these individuals may have had limited access to medical care and likely led lives of strenuous and possibly dangerous activity.

Fractures, Antemortem Trauma, Biological Profile

H6 Homicide by Lapidation in Neolitic Age: Results of Two Cases

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The goal of this presentation is to identify the process of recovery and describe physical findings from skeletonized remains performed by a team of forensic anthropologists and archeologists.

This presentation will impact the forensic community by identifying the process of recovering skeletal remains and presenting the methodologies and results used to reconstruct the biological profiles, race, sex, age, and stature of skeletal remains, date of death and probably manner of death.

Introduction: While preparing a grave for oilduct in the little country of Marsicovetere in the South of Italy, workers discovered the remains of two skeletonized unknown individuals placed 2 mt of depth close to the other not in genu-pectoral or classic deposition. At the beginning it was performed a scanning of the archeological area to obtain digital 3D excavation map. Archeological recovery testifies Neolithic installation about the epoch of 4,000 years Before Christ. Records were taken and kept in the Ridola Museum in Potenza. Remains consisted of two full human skeletonized bodies highly fragmented. They were presumed to belong to prehistoric period in virtue of their extreme lightness and porosity; they were very fragile and then moved from grave, digging around skeletal remains and taking out together with ground. No clothing or other articles were found with remains, but just a stone with a pyramidal shape and dimension 4x4x5 cm.

Forensic Anthropological and Odontological Examination: The general identity of the skeletal remains was determined by estimation of age and stature and the determination of the sex using anthropological methods for old remains. The estimation of age was based on pubic symphyseal phases and cranial suture closure. These criteria determined that the deceased was closer to 20 years than 40 years. The determination of sex was basically performed using morphological features of skull and pelvic bones and metric analysis of long bones fragments. The sex was clearly that of a female for both. The stature was estimated using the lengths of long bones, not fractured, which were measured using an osteometric board; the bones were used individually and in combination using tables available to determine the average stature, which was found to be respectively 161 $\pm$ 1 cm and 152 $\pm$ 2 cm.

Odontological analysis showed that high maxillary was wide, characterized by a round palate with an intermolar distance of 6.5 cm. There were all the dental elements except for the second left molar (antemortem lack) and completions not damaged by decay. This aspect is coherent with the alimentary habits of Neolithic period that were lacking in sugars, even though carbohydrates, associated with game were introduced in feeding. The deep usury with dentinal exposure of incisive and molars is due to not refined feeding and the impurities of cereals. Typical of the period is also the wide diastem (6mm) between the middle incisives that is noticeable between the central and the lateral incisive and this last one and the left canine (3mm) too. The characteristics of the high maxillary can be refered to the jaw, where it can be observed the absence of decay and the deep usury of the canines and posterior sectors, characterized moreover by the disappearance of the cuspids particularly on the second premolars and molars.

Radiocarbon Dating: Radiocarbon dating can provide useful information to elucidate the date of death of skeletonized human remains; interpretation was enhanced with analysis of different bone fragments within each skeletons by high resolution mass spectrometry. Radiocarbon analysis was conducted in this study on cortical and trabecular bone samples in dating and diagnostic laboratory of the University of Lecce. The radiocarbon analysis clearly assigned the bones to 4000 years BC.

Instrumental Analysis: The skull showed an antemortem fracture pattern on the right temporal bone; this fracture was depressed, had a negative pyramidal shape 4x4x5 cm, and was not related with all the other skull postmortem fracture. Multislice-computed tomography (MSCT) and magnetic resonance imaging (MRI) are increasingly used for forensic purposes. To elucidate the skull fractures and pattern of injuries it has been used 3D computerized imaging; three-dimensional volume-rendered (VR) CT images can be helpful to understand the temporal bone. Matching between shape of injuries in temporal bone and shape of stone, found close to the skull, allowed to support the hypothesis of lapidation. At the moment remains are stored in the Ridola Museum in Potenza (Italy).

Personal Identification, Neolithic Recovery, Radiocarbon Dating

H7 Identification by the Numbers: A Case Study in Skeletal Trauma Examination and Surgical Implant Tracking

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The goal of this presentation is to illustrate how thorough skeletal analysis teamed with surgical implant investigation/tracking lead to the positive identification of unknown skeletal remains. Further, this presentation will illustrate the need for multi-agency/disciplinary cooperation in successful case resolution.

This presentation will impact the forensic community by demonstrating how unknown skeletal remains can be positively identified through surgical implant tracking teamed with anthropological analysis.

This case study demonstrates how uniquely numbered medical implants/devices can be used to search medical records for unknown individuals. A multidisciplinary/multi-agency approach provided different lines of evidence that brought this case to successful resolution.

In March 2007, relatively complete skeletonized human remains were discovered lying on the ground surface near a major interstate in Franklin County, Missouri. The area of discovery was near an interstate exit and overpass that is known to attract transient individuals. Clothing and possible

bedding materials were associated with the remains. No identification media were readily apparent for the deceased. Investigators from the Franklin County Sheriff's Office, in conjunction with the Franklin County Medical Examiner's Office, performed a detailed recovery of the remains and all associated evidence. The remains and associated clothing were removed *in situ* and transported to the Medical Examiner's Office in St. Louis County, Missouri for examination by a forensic anthropologist.

The skeletal remains were in a good state of preservation which facilitated a relatively complete biological assessment. Extensive antemortem and perimortem trauma was observed and documented. The majority of the observed antemortem trauma was present on the left side of the body. Of particular interest for possible identification were areas of antemortem trauma that had been fixed with surgical implants/devices which appeared consistent in age based on the observed level of bone remodeling. This suggested that they were produced from the same traumatic event. The cranium exhibited extensive surgical repair of left maxilla fractures with mini-plates and screws (n=3), surgical repair of left orbit fractures with orbital floor implants, and a healing fracture located on the superiomedial aspect of the left orbit. An antemortem fracture of the left proximal ulnar diaphysis had been stabilized with a plate and screws. Finally, the left tibia had been fixed with an intramedullary rod and screws. A subsequent oblique fracture event of the distal tibia had displaced one of the screws. The secondary fracture had not been medically treated and the bone was extremely reactive in this area. A healing oblique fracture of the left distal fibula was also observed. This fracture appeared to have occurred at the same time as the secondary fracture of the left tibia and also showed no evidence of medical treatment. Observed perimortem trauma included blunt craniocerebral trauma in addition to blunt and sharp trauma of the chest and neck consistent with homicidal violence.

An identical service/trademark and unique numbering were observed on the surface of the intramedullary rod and the ulnar surgical fixation plate. A search on the service/trademark through the Missouri Intelligence Access Center (MIAC) linked the design with the company Synthes, Inc., a global provider of trauma implant devices. Synthes, Inc. was able to provide investigators with a list of hospitals nationwide that had received devices with the same numbering schemes. Although ulnar fixation plates are quite common, the unique combination of implants in this case provided investigators with a truncated list of possible individuals for comparison. The developed biological profile served to further shorten the list. From this abbreviated list, the Franklin County Medical Examiner's Office requested and received medical records from a hospital in Tulsa, Oklahoma for an individual who had received both implants after being struck by a vehicle in 2002. Comparison of ante- and postmortem radiographs led to the positive identification of this victim. Identification was made within 90 days of body recovery.

This case study demonstrates how mulit-agency/multidisciplinary cooperation is imperative for timely case resolution. Although the numbering present on the surgical devices was not unique, investigators were able to compile a shortened list of possible individuals which was further reduced by the developed biological profile.

Identification Techniques, Trauma Analysis, Skeletal Remains

H8 Practical Consideration of the *Daubert* Guidelines on Methods of Identification in the Medical Examiner Setting

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The educational objective of this presentation is to consider the methodological dichotomy between satisfaction of the federal law regarding forensic testimony and the practical constraints of daily operation of a medical examiner's office.

This presentation will impact the forensic community by highlighting the dichotomy between the *Daubert* rules and practical constraints associated with identification in the medical examiner's setting.

Scientific identification is of primary importance in forensic death investigations. Medical examiner personnel, including anthropologists, are obligated to pursue positive scientific identification under certain circumstances including homicides, disfigurement, commingling and decomposition. The definition of positive identification varies based on the circumstances of death, and the distinction between what is required under different circumstances is significant in the application of current techniques of identification and the development of future ones. A quantified estimate of identity is often required in cases pending prosecution, whereas presumptive identification is acceptable in non-prosecutory cases. The *Daubert* ruling of 1993 is the most influential of the federal laws that pertain to this issue (Steadman et al. 2006). This particular court case has resulted in an increase in the scientific and statistical rigor required of methods of identification of the deceased. Medical examiner personnel must reconcile the practical constraints of the medical examiner context with the requirements of the law. The end results are concomitant conflicting interests in: (1) establishing a quantified estimate of identity, and (2) expediting the process of identification in the face of limited antemortem records and resources as well as familial demands.

This presentation details a case in which the antemortem records available for positive identification were limited to MRI imagery of the head and other standard sources of antemortem data including fingerprints, dental records, and skeletal x-rays were not available. The decedent was found dead in his apartment following an altercation with other individuals. The decedent's brother was on the scene at the time of the incident and survived. The parents of the decedent viewed a photo of the decedent and were able to visually identify him. Given the traumatic nature of the event and the interests of the family, identification by a method more expeditious than DNA comparison was essential.

Positive identification of the decedent was achieved by consideration of several qualitative features visible on the MRI images rather than the application of a quantified method of antemortem and postmortem radiograph comparison. Visible on the MRI imagery was the decedent's frontal sinus outline, his dentition, and a soft-tissue defect visible at autopsy. The frontal sinus morphology, as seen on the MRI imagery, was very complex and strongly resembled postmortem images in number of cells, bilateral dimension, bilateral asymmetry, superiority of side, distribution of partial bony septations, number of partial bony septations, distribution of complete bony cells, and number of complete bony cells (Reichs and Dorion 1992). The incomplete development of the third molars in both the postmortem and antemortem images indicated that the decedent was in the appropriate age category relative to the antemortem records. In addition, a sebaceous cyst noted at autopsy was clearly visible and located in the same position on the antemortem imagery. Taken together, these two characteristics were deemed appropriate for scientific identification following a conference between the anthropologists and the medical examiner presiding over the case.

This case represents a situation in which limited antemortem records and familial demands required utilizing a method to expedite identification in lieu of a quantified method. Although the method applied was not quantified, subjectivity was minimized through accumulative findings. Active research in the development of identification methods that meet the demands of the *Daubert* ruling and the constraints of the medical examiner's setting is ongoing by the Anthropology Division at the Harris County Medical Examiner's Office.

Forensic Identification, Medical Examiner, Daubert vs. Merrill-Dow

H9 Archival Matters: The William R. Maples Collection at Florida Gulf Coast University

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After attending this presentation, attendees will know how to identify special collections within the medical examiner/coroner's offices and law enforcement agencies and the steps necessary to curate the documents.

This poster presentation will help the forensic community by providing the techniques involved in archiving materials related to the life's work of senior forensic scientists which will facilitate access to past research and data that will inevitability help to close current and future forensic cases and answer forthcoming research questions.

All too often, the unpublished notes, slides, data, and live-action footage relative to the forensic research, casework, and experiences of retired or deceased forensic scientists have been stored in locations that were not easily located or accessible (e.g., familial closets, garages, and attics). As such, information that had the potential to flesh-out current research endeavors or solve existing or future forensic cases was lost. The special collections warehoused in universities, libraries, or digital archives, such as the National Clearinghouse for Science Technology and the Law (NCSTL), have become conduits for accessing this critical information. As a case in point, the William R. Maples Special Collection serves to highlight those data that would have been otherwise unavailable to the forensic science community and how the materials within were subsequently archived.

In summer 2006, the William R. Maples Special Collection was donated to Florida Gulf Coast University (FGCU) in Fort Myers, Florida by his widow, Margaret Maples-Gilliland. Thankfully, Ms. Maples-Gilliland recognized the importance of ensuring that her late husband's work was accessible to myriad interested forensic practitioners, rather than restricting access to family members as has been the case for the works of countless scientists over the years. The William R. Maples collection contained records that documented the various forensic cases and historic research Dr. Maples had conducted during his 28 year career as a forensic anthropologist and 35 years as a physical anthropologist. It comprised nearly 40 cardboard boxes—must of which contained, in meticulous detail, the date, location, and relevance of each document, photo, cast, bone, and videotape. Before the formal donation was completed, the collection had to be inventoried and appraised.

The inventory required 120 volunteer hours and was beyond the capabilities of the Maples-Gilliland family. Importantly, volunteers were recruited from FGCU upper division undergraduate students who were criminal forensics majors and well-versed in Maples' work. The process began with a rough sort and inventory which pinpointed the (1) quantity of items, (2) material integrity (e.g., could the object be fumigated and digitized?), and (3) subject matter of the collection. Once the collection was considered to be of sufficient size, stable and of forensic importance, it was fumigated. Then, all of the materials were organized by subject matter. For example, subject categories included titles such as "Czar Nicholas Romanov Investigation," "Elephant Man Joseph Merrick," "Francisco Pizarro Expedition," "Medgar Evers Disinterment," "Panama Human Rights Work," "President Zachary Taylor Disinterment," and so on. Surprisingly, the collection also contained Maples' life history documents, including high school report cards, prom photos, West Point transcripts, copies of his children's birth certificates, and other personal correspondences between Maples and his family, friends, and peers. These latter non-scientific materials were included in order for future researchers to understand the implicit, unavoidable, and often subconscious biases that may have shaped Maples' data interpretations.

Once the materials were organized by subject, each document, photo, cast, 8mm film, videotape and artifact was assigned a unique identification number (UIN). Quite simply, the numerical system began with number 1 and ended with entry 3500. Each item was labeled with its UIN. An excel spreadsheet was used to catalog each UIN with a corresponding description of the item. The accuracy of the UIN assignments and corresponding item description and location was tested by checking 85 entries selected by a random number generator.

All paper documents, slides, and live-action footage was digitized by using a flatbed scanner, slide scanner, and converted to DVD, respectively. Each artifact, cast, and skeleton was digitally photographed and added to the database. Then, the original materials and specimens were transferred to acid free containers and stored within the temperature and humidity controlled special collections room within the Florida Gulf Coast University Special Collections room. Additionally, all of the digitized data will be transferred to the National Clearinghouse for Science Technology and the Law for immediate web based access.

William R. Maples, Special Collections, Skeletal Remains

H10 A Summary of Trauma Specimens at the Armed Forces Institute of Pathology, National Museum of Health and Medicine

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The objective of this poster is to heighten awareness of this valuable resource for qualified researchers in the forensic sciences. In particular the collections contain approximately 2359 trauma specimens of interest to forensic anthropologists.

The extensive collections of trauma and pathology housed at the museum cover a large historic period (antebellum to present) and can provide abundant data for research in wound ballistics, sharp force injuries, and blunt force trauma that can be used to expand knowledge in the forensic sciences, particularly in forensic anthropology.

The Anatomy Department of the Armed Forces Institute of Pathology (AFIP) National Museum of Health and Medicine (NMHM) in Washington, DC houses a large number of specimens of interest to the forensic research community. The objective of this poster is to heighten awareness of this valuable resource for qualified researchers in the forensic sciences. In particular the collections contain approximately 2359 trauma specimens of interest to forensic anthropologists.

The NMNH began as the Army Medical Museum (AMM) with the collection of thousands of surgical and autopsy specimens of Civil War gunshot wounds (GSW) collected at field hospitals and on the battlefield. Over time the AMM evolved into the world class pathology consultation organization that is known today as the Armed Forces Institute of Pathology (AFIP) with the NMHM as one of its many divisions. To this day, the museum continues to collect specimens relevant to forensic and medical investigations. Cataloged collections at the museum contain approximately 12,000 specimens of forensic, medical, surgical and historic significance, 19% of which documents the terminal effects of GSW and low velocity trauma. Specimens are often accompanied by medical records, narrative accounts and descriptions such as bullet caliber, make / model of weapon, blade type or other relevant information. Among these specimens there is also ample evidence of the body's responses to bone trauma (i.e., healing and infection.)

Of the museum specimens, high velocity GSW comprise the greater part (95%) of the trauma collections (n = 2249), with low velocity blunt force trauma (BFT) and sharp force trauma (SFT) comprising the remainder of the collection. Examples of gunshot injuries from a variety of civil and military weapons are present that document the effects of contemporary and historic firearms and the effects of cannon fire and shrapnel. High velocity trauma specimens found in the collection represent a span of time from antebellum into modern day medical examiner contexts.

There are 42 examples of blunt force trauma represented in the collection consisting mostly of depressed fractures from diverse implements and contexts such as bricks, stones, falls, aircraft accidents, hammers, firearm butts, and other sources; dates of death from this portion of the collection range from 1863 to 1987.

Examples of sharp force trauma consist of a total of 66 specimens. Implements include swords, hatchets, knives, ice-picks, unidentified sharp

instruments and surgical saws, historic and modern. Sharp force trauma from historic battles can be found ranging from a variety of edged weapons particularly those identified as sabers.

The high number of GSW in the collection is directly related to the museum's history of accessioning specimens recovered from military conflicts making this one of the largest repositories of GSW specimens in the world. Select counts for individual collections are as follows: Milton Helpern New York City Medical Examiner collection (n = 162), Louis LaGarde cadaver study (n = 60), Bruce Ragsdale Antique and Modern Firearms Study (n = 8), U.S. Army Frontier Soldiers (n = 77), Civil War Soldiers (n = 1746), General Collection (n = 89).

This presentation details some of the biological resources available at the NMHM to the research communities of the forensic and medical sciences. The extensive collections of trauma and pathology housed at the museum cover a large historic period (antebellum to present) and can provide abundant data for research in wound ballistics, sharp force injuries and blunt force trauma that can be used to expand knowledge in the forensic sciences, particularly in forensic anthropology. Research visits are coordinated by appointment only through the museum's collections manager (BFS) following standard administrative procedures. Interested researchers and donors can reach the collections manager by following the links to the anatomical collections at http://nmhm.washingtondc.museum.

Forensic Anthropology Research, Trauma, National Museum of Health and Medicine

H11 Taphonomy and Dentition: Understanding Postmortem Crack Propagation in Teeth

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Attendees will understand the taphonomic nature of crack propagation in teeth and the effects of it on the macro-and microstructure of the tooth. Also to be able to discern perimortem and postmortem cracking in teeth at the microscopic and biomechanical level.

This is a pilot study will impact the forensic community by demonstrating a clear difference in the way a crack propagates in fresh teeth and decomposed or decomposing teeth. The ability of differentiating perimortem and postmortem tooth cracking at the microscopic level is shown in this study.

The goal of this poster presentation is to introduce the preliminary results of a pilot study that examines the role of taphonomy, specifically temperature on the dehydration and subsequent alteration in the macro- and microstructure of human teeth. After attending this poster, attendees will be able to understand how to differentiate between enamel and dentin crack propagation in teeth in the perimortem versus postmortem setting using basic microscopic examination techniques. In addition, they will acquire knowledge on the use of *Sus scrofa* teeth as an appropriate analogue for human teeth.

Background: Taphonomy and it effects on the human body is a pervasive factor in the forensic analysis of skeletal remains. There has been much work on decompositional and taphonomic processes, including the effects of duration, exposure to the elements, and temperature on the appearance and quality of the human skeleton. However, there is a limited amount of research focusing on teeth, one of the most durable elements of the human body. In forensic cases, it is common to have teeth that exhibit vertical cracking, usually visible on the labial portion of the anterior teeth. It is thought that these cracks result from the dehydration process of the organic components of a tooth. Therefore, both temperature and the duration of exposure to a given temperature will influence the occurrence of vertical cracking in teeth.

The majority of the work on vertical cracking in teeth comes from the Journal of Dental Research (Rasmussen et al 1976, Brown et al. 1972, Jacobs et al. 1973, Lloyd et al. 1978). Although studies pertaining to enamel or dentin cracking are present since the 1960s, these articles are of little use to the forensic anthropologist as the primary focus of these studies is simulating *in vivo* cracking in teeth, usually as a result of compressive or tensile forces. Due to the lack of research on *taphonomic* effects on vertical cracking in teeth, the current research works to understand the effect of temperature and exposure duration on tooth structure during the process of decomposition.

Methodology: This pilot study uses a sample of 35 *Sus scrofa* mandibular incisors and premolars. The teeth were removed from the mandibles and divided into three groups, each being exposed to a temperature range of 105-120°F for up to fifteen days. Macroscopic observations were made while the tooth's overall was still intact, while the microscopic observations were made from prepared 300mm thick sections at various portions of each tooth.

Analyses: The macroscopic analysis includes biomechanical influence of tooth shape on the susceptibility to cracking, the variation in types of cracks present on the outer enamel, and the variation of the prevalence of cracks and the amount of time it takes for crack formation in each type of tooth. The microscopic analysis includes an examination of crack propagation from the external to internal tooth structures on the dehydrated *Sus scrofa* dentition, and compares this to the previously studied crack propagation in *in vivo,* or perimortem dentition. Finally, the usefulness of *Sus scrofa* dentition as an analogue for research on human dentition with the macrostructure and microstructure differences and similarities are discussed.

Results: From this pilot study, it is clear that tooth morphology, duration of exposure, and temperature all influence crack propagation in dentition. Additionally, with minimal variation in structural differences but a general difference in tooth morphology, *Sus scrofa* anterior dentition serves well as an analogue to human dentition when examining microscopic crack propagation, but has no predicative ability for human dentition when studying macroscopic tooth morphology as a factor on crack propagation. Finally, the unique microscopic characteristics of the crack propagation path in postmortem, dehydrated dentition can be used as a way to determine trauma to the teeth as postmortem or perimortem.

Tooth, Crack Propagation, Heat

H12 Quantitative and Spatial Comparison of the Microscopic Bone Structures Of Deer (*Odocoileus Virginianus*), Dog (*Canis Familiaris*), and Pig (*Sus Scrofa Domesticus*)

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After leaving this presentation, attendees will understand the importance of including spatial evaluations of microscopic bone cross-sections for the inter-species histological comparisons and intra-species histological analysis. The research has forensic implications, suggesting additional means to differentiate fragmentary remains.

The implications for this study will impact the forensic science community by suggesting future avenues of research for histologically differentiating species for both forensic and archaeological settings. Second, incorporating spatial analysis of microscopic structures in multiple elements from the same species could prove beneficial in differentiating variation of those structures within a particular species.

Species-specific variables exist that change the structure and morphology of cellular bone tissue. Identifying and quantifying these differences is necessary in the evaluation of fragmentary bones in order to assign specific species identification. In order to under the influence of species of origin on microscopic bone tissue, the influence of development and biomechanic forces specific to a skeletal element must also be assessed.

This presentation explores the preliminary study of the histological bone structures in terms of the their area, density and spatial location. In order to achieve this research goal, the cross-section of three major skeletal structures of three common, quadrupeds ubiquitous across North American and commonly found in association with human remains were compared. The specimens used for this research were taken from the comparative collection of the Louisiana State University's Forensic Anthropology and Computer Enhancement Services (FACES) Laboratory. The study analyzed the mid-shaft cross-section of six femora, five humeri, and six mid-thoracic ribs of the white-tailed deer (*Odocoileus virginianus*); six femora, six humeri, and six mid-thoracic ribs of the domestic dog *(Canis familiaris*); and five femora, four humeri, and six mid-thoracic ribs of the domestic pig (*Sus scrofa domesticus*). Each skeletal element was divided into eight sections along known body planes. All histomorphometric measurements and observations were taken within these sections to explore the spatial organization of the microscopic structures.

Plexiform bone observations suggest not only species-specific presence and absence of this bone structure but a relation to the skeletal element. There was an almost complete absence of this bone type in the mid-thoracic rib and reduced presence in the humerus versus the femur of all three species.

Secondary osteon area isolated pig in all three skeletal elements from the other two species, suggesting a species-specific difference in osteon development. On the other hand, though similar in area, deer and dog showed interspecies, parallel patterns between like elements (humerus and humerus, femur and femur). Secondary osteon density followed an expected trend of increasing density associated with older animals.

The implications for this study suggest future avenues of research for histologically differentiating species for both forensic and archaeological settings. Second, incorporating spatial analysis of microscopic structures in multiple elements from the same species could prove beneficial in differentiating variation of those structures within a particular species.

Histology, Faunal Analysis, Osteon

H13 Controlled Research Utilizing Geophysical Technologies in the Search for Buried Firearms and Miscellaneous Weapons

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The goals of this research project are to familiarize the audience with the utility of geophysical technologies at a suspected weapon burial or dump site. Participants will gain an understanding of which geophysical tool, or combination of tools, is appropriate for a specific firearm search at a crime scene or suspected weapon burial site.

This presentation will impact the forensic community by providing guidelines to forensic investigators regarding which geophysical tool, or combination of tools, is appropriate for a search for metallic weapons at a crime scene or suspected weapon burial site.

The goals of this research project are to familiarize the audience with the utility of geophysical technologies at a suspected weapon burial or dump site. Participants will gain an understanding of which geophysical tool, or combination of tools, is appropriate for a specific firearm search at a crime scene or suspected weapon burial site.

Locating metallic weapons such as firearms that have been discarded or buried by criminals often involves the use of a variety of search methods and technologies. Depending upon the size and composition of the suspected weapon, forensic scene professionals may incorporate advanced methods such as geophysical technologies into their investigation. The application of geophysical technologies in forensic investigations is a growing practice, creating a need for research in the area. One way to determine the applicability of geophysical search methods in a forensic investigation is through controlled research. This type of research provides opportunities to test the applicability of various geophysical technologies and also to improve standard geophysical detection methods, which can then be applied to real-life searches.

This research was designed to demonstrate the utility of geophysical technologies at a crime scene or a suspected weapon burial site through controlled testing of buried weapons. Utilizing two types of metal detectors and a magnetic locator, the following objectives were addressed: (1) to test the ease with which these geophysical technologies may be used to detect buried weapons with little operator training, (2) to determine what effects the metallic composition of the weapons have on their detection, and (3) to determine which instrument is better at detecting specific weapons.

The geophysical tools used in this research were chosen due to their accessibility and efficiency at detecting metal objects. Most law enforcement agencies will find these tools easy to purchase, relatively inexpensive, and perhaps most importantly, easy to use. Included in this research project are: (1) a Fisher M-97 basic all-metal detector, (2) a Schonstedt GA-72Cd® magnetic locator, which detects buried ferromagnetic objects such as iron and steel, but ignores non-ferric items such as aluminum and copper, (3) and a Minelab Explorer II advanced metal detector, which allows for metal discrimination by providing "signature" ferric and conductivity readings.

The 30 metal objects included in this research are fourteen decommissioned street-level firearms (including a rifle, a shotgun, revolvers, and pistols), ten blunt or bladed weapons, and six pieces of assorted scrap metals. The scrap metals and miscellaneous weapons have been included to test the discrimination function of the advanced metal detector and to allow for a wider variety of metals to be tested on all three of the geophysical tools. The weapons were tested both on the surface as discarded weapons, and at a number of depths.

Initial results have shown that using factory presets and medium levels on the geophysical technologies allows for detection and readings at multiple depths. The all-metal detector was able to detect each item on the ground surface; however, items made of aluminum and copper and some of the smaller miscellaneous weapons were not detected, even at the shallowest tested depth. As expected, and for both pre-burial and buried objects, the magnetic locator was able to detect ferric objects made of iron and steel and not those of copper or aluminum composition. Overall, the advanced metal detector was successful at detecting many of the weapons, including the firearms, while eliminating the trash metals of iron composition. Through the discrimination function of the advanced metal detector, valuable search time and resources are saved by not digging up false targets (trash metals) that the all-metal detector would detect. The magnetic locator would be an appropriate tool when searching for ferric items.

Geophysical Technologies, Forensic Archaeology, Metal Detectors

H14 Accuracy Testing of Computerized Facial Approximations by Comparison With Antemortem Photographs

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After attending this presentation, the audience will have an overall understanding of a cost-effective, automated method of facial approximation, an opportunity to visually compare computer generated images with corresponding antemortem photographs, and an overview of a unique application of facial recognition software for the identification of unknown human remains.

This presentation will impact the forensic community by introducing and illustrating an automated, objective, inexpensive, and rapid method of completing facial approximations for use in the identification of skeletal and decomposing remains of victims of homicide, mass disasters, and war crimes.

Traditional methods of facial approximation of unknown human remains combine forensic anthropology biological profiles, tissue depth charts, and artistic talent. Three primary issues with traditional methods are time, expense, and subjectivity. Often described as a blending of art and science, these methods require a skilled artist and are labor intensive and therefore expensive. Traditional methods do not effectively address decomposing remains or situations with a large number of remains, such as mass disasters and genocides.

This research tested the ability of humans to match computer generated facial approximation images with antemortem photographs. Facial approximations produced by a computer prototype were without head or facial hair, and had closed eyes and a smooth skin surface. Previous studies by other researchers have compared traditional facial approximations with antemortem photographs, or compared computer-generated images with other computer-generated images. However, this is the first known research to test whether human volunteers could match computer generated facial approximations of test subjects (without hair and with closed eyes) with actual antemortem photographs of those test subjects. A second test was conducted to determine if facial recognition software could be used to match computer generated facial approximations with antemortem photographs. A comparison of human versus computer accuracy rates will be presented.

Human Recognition of Computerized Facial Approximations: Ten human skulls of European ancestry (six females and four males) were selected for a photographic validation by face pool and resemblance rating validation tests. These ten test subjects were from the William M. Bass Donated and Forensic Skeletal Collections at the University of Tennessee at Knoxville. Facial approximations completed using a prototype software were visually compared with antemortem photographs by four participant groups (N = 103). Participants were asked to choose the face pool photograph that most closely resembled the facial approximation. In a second test, the same volunteers were asked to rate (on a scale of 1 to 5) how closely facial approximations of target subjects resembled an antemortem photographs. Results of the face pool and resemblance rating testing will be presented.

Computer Recognition of Computerized Facial Approximations: Facial recognition software was used to test whether a computer would be more accurate in the matching of computerized facial approximations than human recognition. As a subset of a larger research project, the same ten human skulls used in the human recognition testing were entered into a facial recognition software program. Antemortem photographs of the ten test subjects were added to the photographic database of the system. Results of the facial recognition testing and a comparison of human versus computer recognition will be presented.

All facial approximations in this research were prepared using a cutting edge prototype, ReFace (*Reality Enhancement Facial Approximation by Computational Estimation*). This computerized facial approximation system is currently undergoing validation at the Counterterrorism and Forensic Science Research Unit (CFSRU) of the FBI Laboratory Division in Quantico, Virginia. The prototype extrapolates an "approximation" of a face from a computed tomography (CT) scan of an articulated skull using a database of CT scans of living individuals. Preliminary research on the prototype indicated that under optimal conditions, facial approximations of test subjects bore a striking resemblance to antemortem photographs (Moyers *et al* 2006). Additionally, the prototype has the ability to use CT data to extract a skull model from decomposing human remains without removing and defleshing the skull. As the process is fully automated, subjectivity has been eliminated. Time and expense are also minimized, as the system does not require artistic talent to produce a facial approximation.

An objective, rapid, and low cost method of facial approximation is urgently needed to address the current backlog of more than 40,000 unidentified sets of human remains in the United States (Ritter 2007), as well as high numbers of unidentified skeletal and decomposing remains from mass disasters and war crimes. In addition to the benefit of identification to victims and their families, such a system could provide assistance to national and international investigative and law enforcement agencies in the identification and prosecution of those responsible.

References:

1 Ritter, N. 2007. Missing Persons and Unidentified Remains: The nation's Silent Mass Disaster. National Institute of Justice Journal 256:2-7.

2 Moyers, D. K. 2007. Validation Study of ReFace (Reality Enhanced Facial Approximation by Computational Estimation). Unpublished Thesis, University of Tennessee at Knoxville.

3 Moyers, D K, H L Peters, M R Mahfouz, M A Taister. Validation of Computerized Facial Approximation Using Re/Face. Presented at the 12th Scientific Meeting of the International Association for Craniofacial Identification Conference, November 1-4, 2006, Istanbul, Turkey.

Facial Approximation, Facial Recognition, Computer Prototypes

H15 Dual Energy X-ray Absorptiometry (DEXA) Scans for Skeletal Remains Identification of Anorexia Nervosa

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After attending this presentation, the audience will understand the importance of DEXA scans for analyzing individuals with osteoporosis and using them for possible identification of unknown skeletal remains. This study presents new criteria for skeletal remains identification when dental remains are unavailable, and demonstrates the long-term impact of anorexia nervosa on postmortem signs as evidenced by forensic radiological examination.

This presentation will impact forensic community by providing new criteria for skeletal remains identification and understanding of the long term impact of anorexia nervosa on postmortem findings as evidenced by forensic radiological examination. The attendees will understand the importance of DEXA scans for analyzing individuals with osteoporosis and using them for possible identification of unknown skeletal remains.

Anorexia is a well-known social problem that is constantly changing the face of eating disorders. The immediate, physical and emotional harm caused by anorexia seems to be understood. Many young women with a history of anorexia tend to develop osteoporosis and reduced bone density, which leads to fractures. The severity of these fractures ranges from minor hairline fracture to femoral head collapse, which is seen in extreme cases of anorexia nervosa. However, the long-term collective effects are more difficult to interpret. Few postmortem forensic and anthropological studies have addressed this issue.

This study examined the validity and problems associated with the use of radiological examination of skeletal remains as an identification tool when there is a concomitant history of anorexia. For instance, if long bone remains are found from an unidentified individual, and concluded to be from a young female with osteoporosis, they can be compared against missing person reports and medical histories to find the probable missing Jane Doe(s) providing that it is recognized to possibly originate from a young anorexic person rather than an older person with osteoporosis.

DEXA scans of ten anorexic patients; nine non-anorexic (older) patients with osteoporosis, and one normal control were obtained from Sharp Outpatient Imaging Center, San Diego, CA. Bone mineral density (BMD) and T score, were also obtained and used to analyze the radiographs. T score defines the amount of bone a person has compared to an individual of the same gender with normal bone mass. Questionnaires were also sent to 75 doctors/physicians/specialists across the country in order to get their opinions regarding the DEXA scan data and its application to forensic science as shown in this study.

Subjects were further divided into groups based on their T scores and diagnosis. Group 1(N=6) was anorexic only, Group 2 (N=5) was anorexic with osteoporosis, and Group 3 (N=9) was non-anorexic with osteoporosis. The DEXA scan data of these groups was compared using Student's t test

(p-value < .05) and Pearson product moment correlation coefficient *(r)* was used to compare the BMD and T scores between hip and lumbar spine.

When the DEXA scan data of the groups were compared BMD total hip in Group 2 vs. Group 3 only marginally significant (p-value = .084). BMD lumbar spine in Group 1 vs. Group 2 and Group 2 vs. Group 3 was not significantly different (p-values .184 and .242, respectively). T score lumbar spine in Group 1 vs. Group 2 and Group 2 vs. Group 3 was also a non-significantly different (p-values .136 and .603, respectively). BMD and T score total hip and lumbar spine were also shown to have a positive correlation with one another (r = .881 and .890).

This radiological data analysis would support the assumption that skeletal remains of a young anorexic individual may be mistaken for an older individual with osteoporosis, even if it is not in the hip region. Additionally, a significant portion of the questionnaire data, and specifically the question asking whether it is possible to confuse young anorexic bones and older osteoporotic bones, were in agreement with that assumption.

This study showed a high possibility for incorrect differentiation between young anorexics with osteoporosis and older non-anorexics with osteoporosis, when skeletal remains alone are examined, especially in the lumbar region. While DEXA scans are very useful for current physical information, they are also imperative for studying long term anorexia. The scans track all patients' measurements from the day they are diagnosed through every follow-up measurement until they either die or stop receiving treatment. These radiological records can be very informative for postmortem identification (i.e., mass disasters for example). Bone density scans also aid in the differentiation between malnourished remains and other bone pathologies, which by themselves are useful for identification of human remains.

DEXA Scans, Anorexia Nervosa, Osteoporosis

H16 Placement of the Human Eyeball and Canthi in Craniofacial Identification

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This paper will review the methods used for predicting/assessing eyeball and canthi position in craniofacial identification and it will quantify the anatomical relationships experimentally.

The results of this investigation will improve eyeball and canthi positioning in superimposition and facial approximation methods. These data will, therefore, have immediate applicability and will be useful to forensic anthropologists worldwide.

An accurate understanding of the spatial relationships of the deep and superficial anatomical structures of the head is essential for methods where faces must be assessed in relation to skulls (superimposition) or predicted from them (facial approximation). However, differences of opinion exist concerning: i) the position of the eyeball in planes other than the anteroposterior plane; and ii) the canthi positions relative to the bony orbital margins. Currently, little empirical evidence exists to support many of the proposed guidelines and, therefore, uncertainty accompanies almost all. This study elucidates and quantifies the spatial relationships of the globe and the canthi to the bony orbit by dissection in 14 adult human cadavers. While complete results will be released at the presentation of this paper, a pilot analysis using four cadavers indicates that the eyeballs were not centrally positioned within the orbits as commonly reported in the literature. Rather, the eyeballs were positioned closer to the orbital roof and lateral orbital wall by 1-2mm in each case, indicating that interpupillary distance is underestimated by 3mm using current methods. These results appear to have ramifications for current craniofacial identification techniques, especially in facial approximation where recognition is widely known to heavily depend upon the delicacies of the orbital region.

Forensic Science, Facial Reconstruction, Video Superimposition

H17 Analysis of the Auricular Surface on Multi-Slice Computed Tomography Reconstructions for Assessment of Aging: A Preliminary Study

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The goal of this presentation is to evaluate the possibilities of aging on two (2-D) and three dimensional (3-D) multi-slice computed tomography (MSCT) reconstructions of the auricular surface using criteria previously developed by Lovejoy, Buckberry, and Chamberlain, and original and specific MSCT criteria.

This presentation will impact the forensic community by providing an example of anthropological application of the computed multi-slice computed tomography in forensic sciences.

Background: Multi-slice computed tomography (MSCT) is uncommonly used in forensic pathology and anthropology. MSCT allows two (2D) and three-dimensional (3D) reconstructions, which can be helpful for osteoscopic analyses and consequently for age estimation.

Technique: 46 coxal dry bones of the anthropological laboratory of Toulouse and Angers (France) were examined with a sixteen-detector row MSCT (Sensation 16, Siemens). For each bone, two acquisitions were performed. The first one concerned the entire coxal bone; two filters were used, one hard and one smooth filter. In this case the thickness of reconstruction was 0.8 millimetre and the collimation 0.4 millimetre. The second one was specifically focused on the auricular surface, with a thickness of reconstruction of 0.6 millimetre and the collimation 0.3 millimetre. Two (with the MPR mode (Multi Planar Reconstructions)) and three–dimensional post-processing (with the VRT mode (Volume Rendering Technique)) were made in all cases. MPR reconstructions were performed in two planes: one parallel to the anterior branch (vertical axis) of the auricular surface and one parallel to the posterior branch (horizontal axis).

For each subject numerous of criteria were studied. On 3D reconstructions and on photos, transverse organisation, pattern, macroporosity, apical and retro apical activities were quantified (absent, moderate, important) and analysed. On 2D reconstructions, macroporosity, auriculo-acetabular line (central line and juxta-linear cells), and bone gradient under and above this line were quantified (absent, moderate, important) and analysed. All these criteria were assessed by two different observers. One observer was an anthropology student and one was a forensic pathologist with anthropological qualifications.

A first statistical analysis was performed to evaluate intra and inter-observers variabilities on MSCT reconstructions and on photos by calculating the coefficient Kappa. A second statistical analysis was performed in order to compare estimations performed on MSCT reconstructions (2D and 3D) and on photos for each observer (inter-method evaluation with a Kruskal-Wallis test). A third statistical analysis was performed for each criteria used to determinate the age of death using box- and whiskers-plots.

Results: The sample studied consisted of 46 Caucasoid subjects with 32 males and 14 females.

The intra-observer variabilities for each MSCT criteria were excellent with the coefficient of Kappa ranging from 0.75 to 0.93.

The inter-observers variabilities for each MSCT criteria were excellent with the coefficient of Kappa ranging from 0.77 to 0.93.

The inter-method evaluation between photos and 2D and 3D MSCT reconstructions had a coefficient of Kappa ranged from 0.59 to 0.90.

Concerning the Kruskal-Wallis test performed for each criterion, all the P values were significant.

Discussion: Values of the inter-observers and intra-observer variabilities objective the good reproducibility of the quantification and analyse of the selected criteria.

The inter-method error varied according to the criteria. The concordance varied from medium to excellent. For example, concerning the macroporosity criteria, the concordance was medium between photos and 2D reconstructions (coefficient of Kappa= 0.59), and excellent between photos and 3D reconstructions (coefficient of Kappa= 0.90).

For the criteria used for the age of death, the box- and whiskers-plots illustrate the pertinence of the staging performed thanks to some items (present, moderate, absent) and their slight overlapping.

For *transposed dry bones criteria*:

- Moderate or absent transverse organisation or macroporosity isolate younger cases (younger than 40 years old).
- Apical and retro apical activities had been considered by Lovejoy as secondary criteria. However, their absence is a good factor to differentiate people younger than 45 years old.
- The dominant pattern (regular or irregular) separate accurately people older or younger than 40 years old.

For *specific MSCT criteria*:

- The loss of the continuity and the clear-cut aspect of the auriculo-acetabular line associated to the absence of juxta-linear cells isolate individuals older than 50 years old.
- The difference of bone density under and above the auriculo-acetabular line, namely a bone gradient, is able to differentiate people older than 50 years old.

Conclusion: Using MSCT reconstructions of the auricular surface in order to estimate the age of a person using transposed dry bones criteria and specific MSCT criteria is possible and seems to be efficient. This study is a preliminary study and analysis on a larger population is necessary to evaluate real possibilities of age estimation on MSCT images.

Aging, Forensic Anthropology, Tomography

H18 Design Perspectives for Obtaining Facial Soft Tissue Depths From Cadavers Using a New Approach

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After attending this presentation, participants will have an understanding of potential causes of measurement error in the design and techniques of earlier methods in obtaining facial soft tissue depths, and gain an appreciation into the design proposed here to rectify these issues.

This presentation will impact the forensic and medical communities by providing more accurate anatomical data for forensic facial approximation and surgical reconstructions. The newly designed apparatus could potentially help to obtain more accurate and precise measurements for future studies of facial soft tissue depths from different cadaveric populations, as well as provide a method to produce a gold standard in which this method could be used to compare other types of methods such as magnetic resonance imaging (MRI), computer tomography (CT), ultrasound, and X-ray in order to provide validation.

Historically, past studies concerning facial soft tissue depth on cadavers have been made using the needle puncture technique, which involves inserting a needle into the flesh with a free hand until the needle strikes bone. The needle is either covered in soot or it contains a piece of moveable rubber. The needle is then removed and a measurement is taken. Sources of measurement error of this traditional method may include compression of the skin, variation in the angle at which the needle penetrates the skin, penetration of the bone due to the tip of the needle, and variation in reading a measurement after the needle is removed from the skin.

In order to rectify these problems, the authors have designed a tissue depth apparatus (TDA) which could eliminate these concerns. The TDA is comprised of a micrometer head encased in acrylic glass with an attached blank drill bit. This structure is then situated in an open-faced acrylic glass box and the micrometer head can move in all planes. The micrometer head allows the measurement of a soft tissue depth to be taken directly as soon as the drill bit contacts bone with a consistent amount of pressure. Furthermore, compression problems can be avoided as the micrometer head can be zeroed as the tip of the drill bit first touches the skin surface. Since the micrometer head can be moved in all planes, the drill bit can be inserted into the skin at a consistent angle, perpendicular to the skin.

The needle choice itself is an important part of the design of the TDA. A number of different types and dimensions of needles were tested for their applicability. A blank drill bit enclosed by a hypodermic needle was best suited for this purpose. The drill bit itself is flat bottomed, ensuring that its tip will not penetrate the bone surface when a consistent light pressure is applied, while the hypodermic needle decreases compression forces required to pierce the dermis, enabling one to retest a specific area.

The accuracy and precision of the TDA design were tested initially using two phantom models followed by cadaveric tissue. The results of measurement error based on this method are compared with past results of traditional methods. With modifications, this design could be used on living subjects, to obtain soft tissue depths by ultrasound.

Accuracy, Precision, Phantom Models

H19 VICTIMS Identification Project: The Nation's Unidentified...Who Are They? And What Can We Do?

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The goal of this presentation is to introduce and promote the utilization and application of forensic anthropology within the Victims Information Catalog, Tracking, and IMage System (VICTIMS) Identification Project. The VICTIM System is a group of research projects and development efforts sponsored by various federal agencies and supported by the FBI Laboratory. The system will, for the first time, bring technology to the forefront of the national effort to identify the thousands of unidentified human remains that lay nameless in medical examiners and coroners' offices.

This presentation will impact the forensic community by demonstrating the critical need for the deployment of useful tools and resources to the law enforcement communities and medical examiners and coroners' offices. Currently the estimated number of unidentified decedents ranges from an approximate 14,000, on record at about 2,000 medical examiners and coroners' offices, to a projected 40,000. VICTIMS is the first national attempt to apply a comprehensive approach to the problem.

Forensic anthropology plays a crucial role in the capability, quality, and success of the VICTIM System. Unlike many of the current unidentified persons data entry files, there will be specific data entry options tailored explicitly towards a forensic anthropologist's skeletal assessment of the remains. The system will accommodate forensic anthropology reports as well as highlight postmortem information that may critically coincide with antemortem information and aid in identification.

The VICTIM System is a multifaceted and comprehensive project that for the first time would merge data from a range of sources and leverage the value of the information through the application of state of the art forensic technologies. The project has three primary components and significant implications for the field of forensic anthropology.

One component is a set of Internet based applications (VICTIMS) for the data gathering and call-in effort being developed by the FBI Laboratory under an external contract to bring the data from local, state, and federal

sources together in a single comprehensive file system and allow the presentation of the information over the Internet to interested parties. The system will be capable of handling a variety of data formats including, but not limited to, case information, autopsy information/physical descriptors, Computed Tomography (CT) scans, photographic images, dental and medical radiographs, and DNA data. In addition to providing collection, storage, and search capabilities, this system will also provide access to data from other automated systems within the law enforcement community via the Internet.

A second element is an Evidence Preservation and Processing (EPP) facility for the sole purpose of examination and preservation of physical remains of unidentified decedents. The facility will provide CT scanning capabilities for gathering skeletal information on remains submitted for examination by the custodial agency. The CT scans will not only facilitate insight into the unidentified skeletal remains, but will provide a method to preserve the remains digitally. In addition, the facility will provide anthropological examinations of the submitted remains in an effort to determine a biological profile (containing age, sex, ancestry, and living stature), trauma analysis, and individualizing physical characteristics that would assist in the identification process. After the examination, the submitted remains will be returned to the originated agency of the remains, along with an anthropological report, if one was requested.

A third component, and an extension of the VICTIMS website, is a referral service for law enforcement and medical examiners and coroners' offices. This service would provide information about local or nearby forensic resources including anthropologists, entomologists, odontologists, artists, and facilities offering radiological and other imaging services. The referral service will enable the creation of a list for each discipline with qualified forensic scientists, their location, and their contact information in an effort to enhance the quality of the data about an unidentified person and increase the likelihood of identification.

Unidentified Decedents, VICTIMS Identification Project, Forensic Anthropology

H20 Virtual Skull Anatomy: Three-Dimensional Computer Modeling and Measurement of Human Cranial Anatomy

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This presentation will demonstrate the value of computed virtual models of anatomical structures and three-dimensional (3D) rapid prototyping as an accurate tool in the study of human cranial anatomy. This presentation will compare three-dimensional data sets and computer modeling to traditional caliper methodologies, as well as to current morphometric software packages.

This presentation will impact the forensic community by serving to increase scientific knowledge of new technologies and methods available to the forensic community that may ultimately increase the accuracy of human identification. Three-dimensional data sets from CT and MR images, regularly used in the medical community, are becoming of increasing value to other fields such as biological anthropology and the forensic sciences because of their ability to expand the accessibility of anatomical material beyond physical contact.

Using three-dimensional (3D) imaging technology, researchers are able to create virtual computed models of anatomical structures for a wide range of educational and research activities. The goal of this study was to compare the accuracy of measurements made using computed 3-D imaging technology to data obtained by traditional caliper measurement methodologies and current morphometric software packages, such as *morphologika* 2 © (O'Higgins and Jones, 2006).

This pilot study began by utilizing randomly selected specimens such as intact human cadaver heads and dry human skulls for use in CT and MR scans, virtual reconstruction, and prototyping.

Virtual skull models were computed from the volumetric CT and MR image data using Mimics © version 10 (Materialise). Twenty five anthropometric measurements were selected from Buikstra and Ubelaker's[1] index of standard cranial landmarks based on their effectiveness in establishing a biological profile in skeletal analysis. Measurements of the virtual computed skull models were made using *3ds Max* © (Autodesk, version 9).

A 3D rapid prototype was then generated, using a Zcorp 3D ZPrinter© 310 Plus. In the 3-D printing, layer upon layer of fine ZP 102 Powder was pressed until it formed a prototype of the cadaver skull. After printing, Z-Bond TM 101 Medium Strength Cyanoacrylate Binder glue was used to fix the specimen for handling. The prototype was then measured using the same indices as the virtual skull. The printed model contains all external and internal anatomy of the actual skull including the frontal sinuses. After 3D modeling and prototyping the specimen, the cadaver head was processed and the skull recovered and cleaned. Measurements were then taken from the actual skull. Comparisons were subsequently made with the models from the CT images and the prototype.

In the study, the actual measurements of the virtual skulls were consistent with those taken from the actual skulls even considering inter-observer error. Statistical analysis of the measurements data comparing all of the samples (actual, virtual and prototype), confirmed the accuracy of the computer modeling and measurement technologies. Additionally, it was found the prototypes to be a valuable reproduction of the original skulls, even taking into consideration artifacts from the printing process. Future steps will be taken to explore how to reduce inter-observer error further.

By using methodologies developed and validated in this study, the researchers are now confident that anatomically accurate virtual and/or prototypic anatomical models can be produced using state of the art medical imaging and computer technology for use in a wide range of anatomical structures for use in medicine, biological anthropology and the forensic sciences.

This study demonstrates that 3-D datasets are a useful and accurate tool to the study of human anatomy for both clinical and forensic purposes. Virtual anatomy will ultimately provide the opportunity to reevaluate current methods of analysis and create new ones which will, in turn, increase the accuracy of results and expand the accessibility to anatomical specimens beyond actual contact. The ongoing study includes the validation of this method to establish a biological profile (age at death, sex, ancestry and body type) based on the accuracy of morphological features of human skulls, as well as a comparison of virtual facial approximation methods.

[1] Buikstra JE, Ubelaker DH (eds.) (1994) *Standards for Data Collection from Human Skeletal Remains.* Arkansas Archaeological Survey Research Series No. 44.

3-D Imaging, Computer Modeling, Human Cranial Anatomy

H21 What Starts as a Homicide Ends as a Forgotten Cemetery: How Medical Examiners, Law Enforcement, and State Archaeologists Work Together to Protect Archaeological Sites

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After attending this presentation presentation, attendees will understand the jurisdictional issues involved in the scene recovery and analysis of prehistoric and historic skeletal remains and artifacts (e.g., those cases involving human remains, cultural artifacts, and parcels of land that legally have no forensic significance).

This presentation impacts the forensic community by providing information to the various forensic stakeholders that become involved in cases that begin as medicolegal investigations of death that end as cases of archeological importance and therefore become the responsibility of the state archaeologist or private land owner.

The treatment and recovery of archaeological remains, cultural artifacts, and land has become a delicate issue rife with controversy. Frequently, there are questions as to the appropriate and timely participation of the state archaeologist, as well as rules governing the transfer and final interment of Native American and historic (non indigenous) skeletal remains and associated cultural artifacts. Most federal and state statutes require that when a burial ground is uncovered during a non-archaeological activity (e.g., land development, criminal investigation), all activities that may disturb the remains and burial site must cease immediately, until such time as the state archaeologist's representative makes a decision regarding the proper disposition of the remains, artifacts, and land.

By statute, law enforcement must protect the scene and the medical examiner or coroner is responsible for the remains until the arrival of and further instruction by the legal representative of the State Bureau of Archaeological Research (BAR). The BAR representative may be an archaeologist, a skeletal analyst, or both. BAR scientists will analyze the site, human remains, and cultural artifacts to determine if they are forensically significant (e.g., 50 or 75 years dead, depending on the state). If the remains are determined to be of forensic importance, the district medical examiner or coroner retains custody of the remains and law enforcement retains jurisdiction over the scene until all pertinent forensic evidence is collected and the scene is released.

The custody of remains that are not of forensic significance, as determined by BAR scientists are to be turned over to the state archaeologist (some states, such as Florida, require that this transfer of custody take place within thirty days of taking custody of the remains). Most federal and state statutes require that these remains are studied by an osteologist, who will generate a report concerning the cultural affiliation and biological characteristics of the remains in question. Usually, cultural affiliation is determined through multiple lines of evidence such as cross-referencing GPS coordinates with the BAR's master site file, taphonomic markers (e.g., coffin wear or coping), ancestry, the presence of disease markers or physical behaviors that may leave marks on bones or teeth (anemias, lack or presence of caries, or paramasticatory behaviors), C14 dating, and stable isotope analysis.

Penalties are far reaching for those who do not abide by the guidelines set forth in the Native American Graves Protection and Repatriation Act (NAGPRA) and other federal and state laws. Some states fine those who continue to disturb a burial between $5,000.00 to $150,000.00. A period of imprisonment of up to 5 years may also be imposed. In the state of Florida, the BAR tends to pursue these law breakers up to the fullest extent of the law.

In Florida, the recovery of prehistoric and historic sites that contain human skeletal material is common, especially with constant new development. As such, we have provided examples that have culminated in the smooth transition of sites to the BAR from their forensic beginnings. In these examples, medical examiners, law enforcement agencies, and BAR have provided and public service that was well received by the general public, tribal entities, and land owners. This presentation will also underscore the importance that: (1) the forensic community needs to be aware of the geophysical, skeletal, and artifact markers of archaeological sites, (2) the legislation enacted to guarantee that all reasonable efforts are taken to ensure the protection of all human skeletal remains, as well as other cultural items deemed to be archaeological, and (3) steps necessary to protect the involved remains and artifacts in accordance with state and federal laws.

Cultural Affliliation, Human Remains, Archaeology

H22 Towards a Comprehensive Theory in Forensic Anthropology

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The goal of this presentation is to examine the basis for theory in forensic anthropology. More specifically, this paper will discuss the interconnections between forensic anthropological research and investigation and broader anthropological and archaeological theory.

This presentation will impact the forensic community by illustrating the application of Agency Theory, Behavioral Archaeology, and Nonlinear Systems Theory to the understanding of forensic events. These archaeological theories can assist in building a comprehensive theory in forensic anthropology.

Even though theory has been an integral part of the discipline of anthropology since its beginning in the 19th century, the existence of a broad theoretical basis for forensic anthropology has been much debated. Because of past reliance on idiosyncratic and often unique case studies to illustrate forensic processes, some researchers have questioned whether a comprehensive forensic anthropological theory is even possible. This paper addresses this issue by proposing several current theoretical avenues toward understanding forensic events.

Lyman (2002) calls for greater dialogue between the sister disciplines of taphonomy, forensic science and archaeology and the application of interdisciplinary research beyond established boundaries. Taphonomic theory and research have certainly had a significant impact on the conduct of forensic anthropology. However, more encompassing theoretical approaches transcending middle range taphonomic theory also can provide an explanatory basis in forensic anthropology. Archaeology, in particular, shares three major dimensions of analysis and interest with forensic anthropology: Time, Space, and Form (or material and physical remains). Three theoretical approaches currently applied by archaeologists—Agency Theory, Behavioral Archaeology, and Nonlinear Systems Theory—are explored in this paper for their applications to forensic anthropology.

Agency Theory is a social/behavioral theory which focuses on the actions of individuals or groups of individuals and how their actions can conform to or transform social institutions (the structure of a society or culture) (Dobres and Robb 2005). Case studies are considered extremely important in Agency Theory, because if they are detailed enough, they can serve as illustrations of the impact (or lack thereof) of human agents in specific situations. As applied to forensic settings—especially crime scenes—it is important to consider the perpetrators, victims, and the individuals involved in recovery of remains and evidence as agents and to look at the consequences of their actions on the ultimate outcome and interpretation of the scene.

Behavioral Archaeology (Schiffer and Skibo 1997) includes certain concepts that more specifically explore the consequences of actions by human agents over a sequence of events (Schiffer's "behavioral chain" model). A behavioral chain includes activity sequences, performance characteristics (of tools or implements), technical choices by the agents, knowledge and experience of the agents, and situational factors (behavioral or environmental limitations affecting such activities as tool use, transport and disposal of material or human remains). These variables are clearly applicable to the interpretation and explanation of forensic events and their time, space, and form dimensions.

Nonlinear Systems Theory (also related to Complex Systems Theory, Chaos Theory, or Catastrophe Theory) looks at the interaction of multiple variables and their consequences often through computer simulation (Beekman and Baden 2005). Nonlinear Systems theorists emphasize multivariate analysis because complex properties (or consequences) result, in real-life situations, from the interaction of many factors. The importance of human agents as well as what Schiffer calls situational factors are recognized equally. The value of specific case studies, as well as the multivariate factors affecting archaeological and forensic settings, are recognized and considered in analysis and are particularly relevant for explaining past forensic events.

Illustrations of each of these theoretical approaches are presented in terms of their application to forensic anthropology. It is concluded that avenues for building an inclusive theory of forensic anthropology are possible. In fact, elements of these theoretical viewpoints are already being used by forensic anthropologists in the interpretation of forensic scenes. Their more explicit recognition makes it clear that forensic anthropology does indeed have a strong theoretical basis which we can continue to build upon. This theoretical base—grounded in current and well-established anthropological and archaeological theory—lends further credence to the in-court expert testimony of a forensic anthropologist.

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Theory, Forensic Anthropology, Archaeology

H23 Beyond the Fire: Taphonomic Variables of Burned Human Remains

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After attending this presentation, attendees will learn how different taphonomic variables can change or impact the condition of burned human remains.

This presentation will impact the forensic science community by introducing several important taphonomic variables that directly affects how the human body burns in a fire and what is left for forensic analysis. These variables are inherent to most fire-related deaths, be it in cases of accidental death or homicide.

Fire has the amazing ability to alter things in its path, with the human body being no exception. The victim's body is an important variable to consider during fire reconstruction since it is a fuel load and contributes to the burning process. The material properties of tissues and how they burn differs for skin, fat, muscle, and bone. Each tissue has differential thicknesses, compositions, and layered anatomical arrangements. In addition to the body, some of the most significant variables include those introduced by characteristics of the individual, heat sources, combustible materials, conditions of the environment, spatial relationship of the body in the fire, extinguishment, and in some cases, criminal modification of the body before and/or after the fire.

Individual: Variables of each victim play an important role in how the body burns and what is left for the forensic investigation, in terms of their age, sex, health, and weight.

Age: can be broken down into developmental and degenerative stages, or more specifically, juvenile, adolescence, adulthood, and elderly.

Juvenile and Adolescence: The body size of a young child differs considerably from an adult. Children typically have higher body-fat ratios than adults, and more importantly, their bones are growing and developing from birth through late adolescence and early adulthood. Young bone lacks the dense mineralization typical of the healthy adult skeleton, and has developing structures of epiphyses, diaphyses, and metaphyses, which survive the burning process.

Adult: Bodies of adults are larger and have bulkier tissue mass and denser bones than children. Health and weight also vary more in adults than in children. The burned remains of healthy adults with average body weight, good muscle tone, and strong bones will leave significant evidence for analysis. Bulkier muscles can be expected to protect bone for a longer duration than the smaller tissue mass in children but, more importantly, adult bone is fully mineralized, dense, and more durable through most taphonomic changes, including fire.

Elderly: Emaciated or poor muscle tone of elderly individuals provides less tissue protection around bone during burning in comparison to younger adults. The skeletal structure of elderly individuals, particularly those with degenerative bone loss such as osteoporosis, gradually become more fragile during life, particularly for those with osteoporosis, and burning only increases the fragility and brittleness of the skeletal remains.

Sex: Males and females differ in their body size, composition, shape, and distributions of fat and muscle, and therefore respond differently to burning. Gender differences change as individuals pass through adolescence, early adulthood, middle age, and late adulthood. The relative amounts of body fat and distributions may differ for the sexes, but remain primarily concentrated around areas of the torso, abdomen, thighs, and central body. The important variable to consider here is how body size and relative distributions of body fat for the individual contribute as a fuel load during the burning process.

Weight and Health: A person's weight is variable throughout his or her lifetime with growth and development, changes in dietary habits, and changes in their metabolic rates as one ages. Individuals who are overweight or obese have more body fat than to those who are average weight or thin. The combination of open flame, liquefied body fat, and a wicking substance such as clothing or upholstery can sustain a localized fire.

Heat Sources: A fire produces several sources of heat that affect human tissues, ranging from confected heat from superheated fire gasses, radiant heat, open flame, to direct burning of the body. A body can experience a range of injury from superficial damage of radiant heat coming from a distant room to direct flame impingement and thermal reduction of bodily tissues. Intensity of the radiant heat striking the body is a key factor, in addition to the temperature of the fire.

Combustible Materials: Modern home furnishings contain both synthetic and natural materials. The more common synthetic materials are carpet, linoleum, vinyl, foam, and plastics. Common household items made with natural products include wooden furniture and flooring, cloth and textiles, books and paper products, and other items. Each material reacts differently to heat, and influences the fire dynamics and what is left for forensic analysis.

Environment: A strong interrelationship exists among the environment, different fuels present, heat, size of the compartment/space, and how these factors directly affect a body as it burns.

House Fires: Structural fires are challenging scenes because a three-dimensional space is reduced to layers of charred debris. Structures can be houses, trailers, or buildings. House fires include a host of variables that influence how a fire travels, grows, and spreads. Spatially there is more area for a fire to travel along horizontal and vertical surfaces (walls, ceilings, furniture, and hallways).

Vehicle Fires: Within cars, most of the interior is made of synthetic fabrics, carpet, plastics, and sometimes leather. The different properties of these materials, along with the small compartment size, can make for a fast, hot fire if ample ventilation and circulation exist, thus affecting what is left of the body.

Spatial Relationships: Within a room or compartment space, the dimensions of height, length, and width influence the dynamics of a fire's growth and development. The size of a room or rooms, levels of a house or building, presence of a basement, height of a crawlspace, or presence of a solid foundation likewise are contributing factors, particularly when a structure is mostly or completely destroyed by fire.

During burning, structures of the walls, ceilings, roof, and floors begin to collapse along with contents of the house. A body may be directly affected by the disintegration of supporting structures of flooring and levels above and below. The combined effects of gravity, weight of a body, and structurally weakened flooring are optimal conditions for a body falling down to a lower level shortly after a structural fire is fully engulfed in flames.

Extinguishment: Fire suppression tactics influences survival of burned body evidence. The pressure of a direct fire hose stream is on the order of 100 psi or more. If the body is hit with a direct stream it will displace evidence of the body, particularly fragile burned bone, projecting it several inches or feet from the *in situ* position of the victim. Damage can be done to the body if supportive structures of furniture or flooring around the body are hit with a straight powerful stream, causing the body to shift its position or fall, producing fragmentation.

Criminal Activity: The use of arson to cover up criminal evidence or a victim's identity presents some of the more interesting and challenging variables in fire-death investigation. Any number of materials, fuels, and environments mentioned above can be utilized to burn a body. In some cases, the fire is set to appear as an accidental structural or car fire to throw off investigators, or to destroy evidence of the victim's identity, traumatic injury, or the victim's remains, altogether. Intentional fragmentation and relocation or scattering of burned human remains is especially challenging.

The taphonomic variables discussed in this presentation are but a handful of examples that must be considered for reconstructing and analyzing burned human remains. Each fire scene is unique because of the infinite combinations of materials and circumstances that are involved during a fire. The general principles discussed include standards utilized in the field of fire investigation. The human body adds a unique component that combines the investigative techniques and the expertise of arson, forensic pathology, and anthropology.

Taphonomy, Burned Bone, Fire Death

H24 Estimation of Bone Exposure Duration Through the Use of Spectrophotometric Analysis of Surface Bleaching and its Applications in Forensic Taphonomy

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Upon completion of this presentation, attendees will be familiar with methods for quantifying bone surface color and how this data can be used to estimate the duration of time for which bone has been exposed to solar radiation.

This presentation will impact the forensic science community by. The ability to estimate bone exposure duration will provide forensic investigators with an additional tool for refining estimates of the postmortem interval.

This presentation will report on on-going research which aims to develop a new method of determining the exposure duration of bones by analyzing surface coloration changes resulting from solar radiation exposure. To date, analyzing sun-bleached bones has provided investigators with only a fraction of the information that these naturally modified objects have to offer. The term "bleached" has generally been taken to refer to bones that have been exposed to solar radiation, which imparts unto them some unknown amount of color alteration, given some unknown amount of time. Therefore, a "bleached" bone represents a point along a continuum of time, but until now no method has been developed to attempt to ascertain where that point lies on the continuum. Detailed color analysis of bone surfaces can be gained by employing spectrophotometric technologies, and this data can be used to establish rates of change per available solar radiation. Through this approach, color communication becomes objective and bone bleaching can be defined based on geographic parameters. This new method will provide forensic anthropologists another tool in determining the postmortem interval. Preliminary research results and the potential use of these methods will be discussed.

Bone Bleaching, Postmortem Interval, Spectrophotometric

H25 The Taphonomic Effects of Agricultural Practices on Bone

Sarah A. Kiley, MS, University of Indianapolis, Archeology & Forensics Laboratory, 1400 East Hanna Avenue, Indianapolis, IN 46227*

After attending this presentation, attendees will learn how agricultural practices distribute and damage bone.

This study will impact the forensic community and/or humanity by improving search and recovery strategies for human remains dispersed in cultivated fields.

Forensic anthropologists are often asked to assist investigators in the search and recovery of human remains from a variety of outdoor contexts. The forensic anthropologist's understanding of postmortem processes that affect remains can help to guide search techniques and maximize evidence recovery. Outdoor forensic scenes in the Midwest are often disturbed and concealed by standard agricultural practices. These practices hinder the processing and interpretation of a forensic scene by altering its context and dispersing the human remains. In addition, farming instruments may cause postmortem damage to evidence and bones, complicating laboratory analysis.

In the forensic literature there are very few surveys on the effects of cultivation on forensic scenes and no experimental studies testing the dispersal characteristics of bone. However, the traditional archeological literature includes a considerable amount of experimental data on the movement of artifacts in cultivated fields, some of which may apply to forensic scenes. The direction of plowing, type of equipment, and duration of farming practices all contribute to the movement of artifacts in a field. This study tests the application of archeological models developed for artifacts and fills a research gap with a descriptive analysis of the movement of a bone sample in an agricultural field.

Bones modified by agricultural practices are expected to have a unique taphonomic profile depending on the type of farming machinery used and the number of cultivations. The spatial distribution of recovered remains is likely to parallel the dominant plow direction and should widen with subsequent cultivations. Over time, the percentage of elements recovered will likely decline due to the destructive nature of agricultural practices, weathering effects on bone, and carnivore dispersal. Bones recovered are expected to sustain a combination of sharp-force and blunt-force trauma, with more episodes of cultivation resulting in more damage.

This study used twelve nearly complete skeletonized (n = 8) and mummified (n = 4) pigs. The remains were painted different colors using exterior florescent paint to optimize the chance of recovery. Six of the pigs were placed in a sweet corn field and six were placed in a sorghum and buckwheat field. In both fields, a single datum was established outside of the plow zone. The datum was marked with a wooden stake set at ground level to permit relocation. Standard archeological mapping and recovery techniques were employed to record the positions of all visible bones in the field after plowing. Six pigs were recovered after one season of cultivation and six pigs were recovered after two seasons of cultivation.

Plowing affected the number of elements recovered, resulting in a cumulative reduction of the number of surface elements. After only one season of cultivation, plowing showed a systematic effect on the linear displacement of remains in the direction of plowing. This displacement became more pronounced after two seasons of cultivation, with bones being found further from their original deposition points. Larger bones were recovered more frequently than small bones, consistent with the archeological and agricultural engineering literature. With continued seedbed refinement, tillage equipment mixes the soil, allowing smaller elements to fall into crevices while larger elements remain on the surface. Skeletal elements recovered after one season of cultivation showed significantly less trauma than those that were recovered after two seasons of cultivation, and repeated plowing continued to fragment and damage the remains. Mummified pigs exhibited significantly less fragmentation and damage than skeletonized pigs likely due to the protection of the bones by skin and soft tissue.

The results of this study indicate plow direction has an impact on distributing remains horizontally in the direction of plowing, with each pass increasing the distribution. Overall the percentage of elements recovered after two seasons of cultivation (8%) is consistent with the archeological literature. This study will help guide search and recovery efforts when remains are dispersed in cultivated fields and thus may increase the percentage of bones recovered for analysis.

Taphonomy, Plow Damage, Bone Trauma

H26 The Reliability of Cadaver Decomposition: Can Non-Enteric Microbes Rapidly Contribute to Cadaver Breakdown in Soil?

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Following this presentation, attendees will understand that cadaver decomposition in soil is a process that can be associated with low rates of error and the rapid (< 24 hours) participation of non-enteric microorganisms.

This will impact the forensic science community by demonstrating that cadaver decomposition can be a reliable process and soil microbial ecology might be used to accurately estimate the postmortem interval of buried bodies.

Following this presentation, attendees will understand that cadaver decomposition in soil is a process that can be associated with low rates of error and the rapid (≤ 24 hours) participation of non-enteric microorganisms. This will impact the forensic science community by demonstrating that cadaver decomposition can be a reliable process and soil microbial ecology might be used to accurately estimate the postmortem interval of buried bodies.

Two topical aims of forensic taphonomy are to locate and date clandestine graves. Achieving these aims requires an understanding of the fundamental processes and error rates associated with cadaver decomposition in soil. This understanding is currently lacking. This is primarily because human cadavers are difficult to acquire for decomposition studies (and very difficult to replicate) and forensic taphonomy has relied upon case studies and anecdotal evidence rather than experimental investigation. As a consequence, forensic taphonomy currently operates on several untested assumptions. For example, traditional dogma states that anaerobic enteric microorganisms dominate cadaver breakdown until the latter stages of decomposition, when aerobic soil and/or dermal microbes become active.

This assumption was tested by incubating complete, incised, and eviscerated juvenile (8-10 days old) rat (*Rattus rattus*) cadavers in soils of contrasting texture (sand, loamy sand, clay). Soils were collected from tropical savanna ecosystems in Pallarenda (19°11'S, 146°46'E) and Wambiana (20°33'S, 146°08'E), Queensland, Australia. Pallarenda soil was a Rudosol and had a sandy texture (97.7% sand, 1.3% silt, 1% clay). Wambiana soil was a Vertosol and had a clay texture (30.9% sand, 20.8% silt, 48.3% clay). Soils were sieved (2 mm), weighed (500 g dry weight) into incubation chambers (2 litre), calibrated to a matric potential of –0.05 megapascals (MPa) and incubated at 22 °C for seven days to equilibrate. Following equilibration, rats (*Rattus rattus* L., 18 ± 1 g) were killed with carbon dioxide and subjected to experimental treatment. Treatments comprised a complete cadaver, eviscerated cadaver, cadaver with a sewn incision only (to account for the effect of the incision) and a control (soil without cadaver). Cadavers were buried on their right side at a depth of 2.5 cm. Cadaver decomposition was measured via cadaver mass loss (% wet weight), CO_2-C evolution (an index of aerobic microbial activity and decomposition) and soil pH. This experiment was replicated four times resulting in 192 samples.

Cadaver burial, regardless of treatment, resulted in a rapid (≤ 24 hours) significant increase in microbial activity, which was positively correlated to cadaver mass loss. Evisceration resulted in less cadaver mass loss and microbial activity in sand, and had no effect on decomposition in clay. It is concluded that soil and/or dermal microbial communities rapidly respond to cadaver burial and play a significant role in cadaver decomposition. These results also show that soil type can significantly affect cadaver breakdown.

The relative variation (standard error/mean) of mass loss and CO_2-C evolution show that the measurement of CO_2-C was a more reliable method for assessing cadaver decomposition. The relative variation of mass loss measurements varied from 3%-47%. However, the relative variation of CO_2-C measurements ranged from <1% to 21%, with variation increasing during the latter stages of breakdown. These results provide further evidence that processes associated with cadaver decomposition can be associated with a low rate of error and might be developed into methods to accurately estimate the postmortem interval of buried bodies.

Forensic Taphonomy, Reliability, Microbial Activity

H27 The Influence of Penetrative Trauma on the Rate of Decomposition

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The goal of this presentation is to aid a better understanding of the influence that penetrative trauma has on the process and rate of decomposition. This will assist in the more accurate assessment of postmortem interval (PMI).

This presentation will impact the forensic science community by presenting research that suggests that penetrating trauma cannot be considered a major factor in the rate of decomposition and time to skeletisation of a gunshot trauma victim. It also supports other work that suggests disturbance may be an influential factor in decomposition (Adlam, 2005; Adlam and Simmons 2007).

Forensic Anthropologists utilise their knowledge of the processes of decomposition to estimate postmortem interval (PMI). An understanding of the factors that affect these processes and the degree to which factors, such as temperature, pH, and trauma influence the rate of decomposition is important for the accurate estimation of PMI.

Previous work by Mann *et al.* (1990), Vass *et al.* (1992) and Campobasso (2001) suggest that penetrating trauma may accelerate decomposition. Although a more recent experimental PhD study (Kelly, 2006) found no such influence, it is generally accepted that penetrating trauma may accelerate decomposition and time to skeletisation.

An experimental study was carried out in the North West of England using the domestic pig (*Sus scrofa).* Two experimental groups, one having gunshot trauma to the head, body and limbs and the other without trauma were left to decompose on the ground surface. A further control group of pigs with gunshot trauma were used to assess the effect of investigator disturbance. Decomposition was measured by using weight loss, total body score (Megyesi, 2005) and changes in soil pH as indicators of soft tissue destruction. The attraction of arthropods to the carcases and sites of oviposition and maggot activity was also observed and recorded.

Diptera were preferentially attracted to natural orifices, particularly those of the head in both groups. Attraction to and oviposition followed at the gunshot entrance wounds. However, in both groups oviposition also occurred at skin creases, such as those found between both fore and hind legs, simultaneously with that occurring at trauma sites. Although maggot masses were observed to become established more quickly in areas of trauma, other maggot masses at the non-trauma sites followed. No difference was found in time to skeletisation. No significant difference was found in weight loss between the two groups with p=0.544. Likewise, with total body score (p=0.8237) and changes in soil pH (p=0.6838), no significant differences were found. The effect of investigator disturbance was significant to

weight loss (p=<0.000) with undisturbed pigs losing weight more rapidly than disturbed pigs. This may be due to a disruption of insect activity each time data is collected.

During the later stages of this study (post 300 ADD), the experimental site experienced unusually high levels of rainfall. This impacted on the activity of arthropods, particularly *Coloeoptera*, which were highly active at this point. Time to skeletisation occurred beyond our estimate of 642 ADD. This suggests that heavy rainfall and its effect on arthropod activity may increase time to skeletisation.

Forensic Anthropology, Decomposition, Trauma

H28 Debugging Decomposition Data

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After attending this presentation, participants should gain an understanding of the relative effects of environmental variables on soft tissue decomposition.

This presentation will impact the forensic science community by transforming decomposition data into linear equations allows comparisons across multiple environments and variables when energy input and time are measured using ADD. This has demonstrated that insect activity is the primary effector of decomposition rate, although carcass weight plays a secondary role.

Comparison of data from a variety of environments and ambient temperatures shows no difference in the progression of decomposition when measured using a logarithmic scale of Accumulated Degree Days. The major effector of change in decomposition rate was the presence or absence of insects, regardless of: terrestrial (surface or buried) or aquatic environment, natural or laboratory setting, species, or season.

When carcass weights are divided according to Vass, et al.'s (1992) 50 pound broad weight categories, carcass size appears to have a limited effect on the relationship between decomposition rate and ADD. Smaller carcasses decompose at a relatively faster rate than larger ones. The difference appears to be statistically significant; however, this is based on a small sample size of data derived from limited sources. Therefore, it is not possible at this time to differentiate between the effects of carcass size and data source. Recent research (Brand 2007) indicates that there is no significant difference in the decomposition rate among carcasses in the 0-50 pound category in a controlled experiment. These data were derived from experiments conducted in the presence of insects and it is not possible to compare weight category data in the absence of insects at this time.

This paper compares previously published data with recent experimental data and retrospective studies from taphonomic research conducted in the United Kingdom. The data was wide ranging in experimental environment; from Tibbet and Carter's (2006) 1.5 g cubes of meat decomposing in a bucket of soil to human bodies floating down various UK river systems. Simple conversions were used to present all timescale data in ADD, and to convert weight loss data to decomposition scoring systems (Adlam and Simmons, 2007; Brewer Heaton, 2006; 2005; Megyesi et al., 2005). This conversion allows comparison across multiple environments and experiments. Weight loss shows a strong correlation to decomposition score and they describe the same process (Adlam and Simmons, 2007). Duration of immersion and average daily water temperature were used to calculate ADD for the aquatic cases, in the same manner in which ADD was calculated from duration of environmental exposure and average daily air temperature for the terrestrial cases and experimental subjects.

Plotting decomposition score or weight loss against log ADD allows for the exponential progression of decomposition to be expressed as a simple linear equation. Regression analysis of the data shows no significant difference among environments or ambient temperature; whereas presence of insects has a significant effect on the rate of decomposition, accelerating it considerably. Thus, the significance of the differing rates of decay seen in aquatic versus terrestrial human cadavers appears to be solely related to the absence of insects rather than a product of a different decomposition process.

This study once more emphasizes the crucial necessity for future taphonomic work to be conducted using ADD and standard scoring systems (Adlam and Simmons, 2007). Although anecdotal data has previously suggested that e.g., aquatic and terrestrial decomposition differ, or that ambient temperature will alter the rate of decomposition, these variables have no discernible impact on the process, and data from experiments using these variables all fall within the same regression equation. Further studies of carcasses in different weight categories conducted in controlled settings comparing decomposition in the absence of insects are warranted.

Decomposition Rate, Insects, ADD

H29 Beyond Taphonomy: Craniometric Variation Among Anatomical Specimens

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The audience will be introduced to the variation observed in anatomical cranial specimens and to methods beyond taphonomic indicators for discriminating these specimens from forensically significant remains.

This presentation will impact the forensic community by documenting the pattern and magnitude of variation among anatomical crania, beyond taphonomy.

Prior to 1987, the majority of human remains purchased in the United States originated from and were prepared in the modern Republic of India. In 1987, under pressure from human rights groups, the ruling government of India banned the exportation of human remains. However, the skeletal material purchased from India and used in classrooms, teaching laboratories, and medical schools in the United States is commonly encountered during routine forensic anthropological investigations. Unfortunately, craniometric data for anatomical specimens originating from India is not currently available, probably due in large part to the lack of provenience information for these specimens. Yet, the cranial material traditionally associated with anatomical warehouses is variously described as a single, homogenous group (e.g., a shared taphonomic history) or as an extremely diverse and biologically heterogeneous jumble of populations.

This presentation will examine the pattern and magnitude of cranial variation among anatomical cranial specimens, using a procedure outlined by Jantz and Owsley (2001—AJPA 114:146-155). This study uses the traditional linear craniometric data and three-dimensional coordinate data from 35 crania purchased from North American biological supply companies prior to the 1987 ban. In order to determine whether anatomical specimens can be considered an homogenous group, Mahalanobis distances (D^2) were calculated between all pairs of anatomical specimens using a pooled within sample variance/covariance matrix calculated using Howells database. Next, a Defrise–Gussenhoven test between the paired distances was used to test the likelihood that the pairs of crania were drawn randomly from a single population. A sub-set of known Russian anatomical material was included to act as a test of the method. The calculated distances suggest the presence of at least three groups. The Russian sample and a spatially homogenous group of 7 anatomical specimen were distinct from the remaining twenty-two; the latter representing skeletal material likely from the Republic of India.

The calculated Mahalanobis distances were then used to calculate the "typicality" probabilities for each of the anatomical crania relative to Howells worldwide sample of cranial material. Understanding that these crania did not originate from any one of the Howells groups, the typicality probability was used to evaluate the observed variation within the anatomical specimens. The general pattern supports the Defrise– Gussenhoven test. The 22 homogenous crania show greatest similarity to several Southwest Pacific groups (e.g., the Andaman from the Andaman Islands in the Bay of Bengal and the Atayal from Taiwan) and to European groups like the Berg from Carinthia,

Austria. As expected, the Russian sample bears greatest similarity to European groups (e.g., Bergs and 20th century American Whites). The remaining 7 crania were most similar to African groups (e.g., Bushman and American Blacks).

The taphonomic indicators typically associated with anatomical specimen include the presence of reconstruction hardware, taphonomic indications of reconstruction hardware—for instance, rust stains, holes drilled for screws, etc.—patina, and betel nut staining on the teeth. The crania used in this analysis exhibit at least one of these taphonomic profiles. However, staining on the teeth associated with betel nut chewing was documented only on the homogenous group of crania believed to have originated in India. The overall pattern of cranial variation and the associated taphonomic indicators suggest some level of homogeneity among anatomical crania purchased from India, but as expected, not among all anatomically prepared material.

Anatomical, Variation, Mahalanobis

H30 Decomposition and Postmortem Interval: A Critical Analysis of British Medico-legal Investigation and Trends in South Yorkshire, 1995-2002

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This paper offers a systematic review of decomposition cases in a British urban environment, and analyses the efficacy of reporting decomposition by Home Office pathologists. Upon completion, participants will have a broad overview of the nature of the decomposition cases encountered by Home Office pathologists in South Yorkshire, and how this compares to the nation as a whole. There will be a clear break down of the different types of decomposition cases regularly seen in a British context, and a discussion of how the extent of decomposition visible on the body varies with time since death, and thus how it is valuable to the estimation of postmortem interval. The participants will learn how this potentially valuable resource is used by British pathologists, and how improvements can be made to ensure that the maximum amount of information is gathered. Suggestions will be made about increasing the depth of co-operation between pathologists and anthropologists in order to optimise decomposition data, and it is hoped that the participants will draw conclusions about the significance of such collaboration.

This paper represents a critical assessment of the degree to which the extent of decomposition is used routinely in the estimation of postmortem interval. It confronts some of the existing problems with recording standards, and offers suggestions for improving reporting techniques and quantitative analysis of decomposition data. It should impact the forensic science community by challenging the status quo in Britain at the moment and advocating a more far-reaching, deeper collaboration between pathologists and anthropologists, to make the most of multidisciplinary expertise in everyday forensic cases. It highlights the differences between decomposition research in Britain and elsewhere, and analyses the translation of academic decomposition data into the practical forensic context. It is hoped that this presentation will pave the way for discussion and collaboration between forensic pathologists and anthropologists to improve estimation of postmortem interval.

Estimations of postmortem interval based on the extent of decomposition are often sketchy and can be reliant on comparisons with case histories, data using less-than-ideal animal analogues, or on data from environment-specific collections. The authors suggest methods of addressing this problem by improving recording standards of decomposition cases through cooperation between forensic anthropologists and pathologists, to facilitate cross-region comparisons and research. This paper offers a systematic review of decomposition cases in a British urban environment, and analyses the efficacy of reporting decomposition by Home Office pathologists. It represents a critical assessment of the degree to which the extent of decomposition is used routinely in the estimation of postmortem interval, and offers suggestions for improving standardisation of reporting and quantitative analysis of decomposition data. Individuals resident in South Yorkshire whose postmortem examinations were performed at the Medico-Legal Centre, Sheffield, were studied. Cases were chosen for inclusion in the study based on home address and a reported presence of decomposition. The reporting of decomposition according to time since death is compared against an expected model for indoor and outdoor cases. The quality of assessment made by the investigators is discussed, with reference to the opportunity for cooperation between pathologists and forensic anthropologists to improve the application of decomposition data to routine cases.

Decomposition, Forensic Anthropology, Postmortem Interval

H31 Basement Bodies: The Effect of Light on Decomposition in Indoor Settings

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The aim of this presentation is to introduce participants to the specific aspects of decomposition in indoor ambient with conditions involving access to insects but no or minimal access to light. During the presentation, examples of a serial homicide case of bodies found in the cellar will be demonstrated for comparative purposes, and the accuracy of their PMI estimation will be discussed.

This presentation will impact on forensic sciences by making attendees aware of the importance of light as a variable, and the potential danger of bias in the estimation of postmortem interval (PMI) for human remains found in advanced stages of decomposition in basement settings such as cellars, subterranean vaults, metros, tunnels, caves, or crypts.

The review of forensic entomology studies indicated that maggot development is almost entirely dependent on the ambient air temperature, but is nevertheless reduced in sunlit areas. Fully developed maggots are further recorded as largely sensitive to direct sunlight, resulting in the higher succession of shaded body parts. Since the impact of maggot masses on decomposition process in a mostly dark indoor ambient is unknown, the author hypothesized that given the favorable temperature conditions for larvae development, the remains exposed to the indoor ambient with no or minimal access to light will decompose faster than the remains exposed to direct sunlight or shaded indoor areas with same temperatures.

Inasmuch as pig as an animal model is an acceptable substitute for human cadavers, three *Sus scrofa* ranging from 18 to 20 kg were used in the experiment. Pig carcasses were placed on purpose built flat steel mobile platforms on three levels of a building with identical humidity and room temperature throughout the experiment. The main animal model was in the cellar with no access to the light. Second controlled carcass was on the next level with natural exposure to daylight cycle, and the third controlled model was constantly exposed to light either natural or artificial. The study lasted from 03 May 2007 until 25 June 2007 when signs of skeletonization were shown on all pig models. Experiment control procedure included observations of decomposition at various times of day for the sample exposed to natural light; during the day for sample exposed to constant light, and during the night for sample in the cellar. Internal body temperature and insect activity was recorded regularly. Body mass was weighted by sliding the platforms with carcasses into immediate floor drive-thru scales to minimize disturbance. Average indoor temperature conditions were assumed in the experiment; temperature was controlled by air-conditioning system at 15˚C constant, and humidity of 40% was controlled by humidity generator.

General patterns of decomposition to include bloating, deterioration, disintegration and the decay were observed on the samples. Fly succession on all three floors was noted within fifteen minutes from the start of the study

with the subsequent insect succession following the familiar pattern. A significant site of insect activity was recorded on the main carcass in the cellar that decomposed considerably faster than the two control samples. Insect succession did not follow the usual pattern of preference to body openings. Maggot masses were noticed on all parts of the carcass allowing the succession to proceed relatively evenly. A sixteen day difference in decomposition was noted between the main and the first control sample exposed to natural day and night cycle, and the 22 days difference with the second control sample exposed to the light throughout the experiment.

In addition to other variables that cause alterations to PMI estimation, changes introduced by the effect of light in indoor ambient must be considered, particularly with bodies found in basement settings. For this reason principles of decomposition patterns in dark indoor ambient for the purpose of PMI estimations are recommended across the board for medico-legal investigators.

PMI, Indoor Decomposition, Light

H32 Taphonomic Effects of Vulture Scavenging

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Upon completion of this presentation, attendees will understand how vultures accelerate decomposition rates, leave markings on remains, and disperse elements. They will also recognize how this information affects interpretations made by forensic anthropologists.

This presentation will impact the forensic community and humanity by highlighting important factors for forensic anthropologists to consider when interpreting taphonomic events and determining accurate postmortem intervals in scavenging cases.

One of the goals of forensic anthropologists is to understand and recognize the processes that occur at, during, and after death. Scavenging is one of these taphonomic processes that affects the decomposition and dispersal of an organism after death, or postmortem. Many published studies of scavenging focus on the effects of terrestrial scavengers, while relatively few concentrate on avian scavengers. In the New World, vultures range from Canada to the southern tip of South America. The most common vulture species are the Turkey Vulture (*Cathartes aura*) and the Black Vulture (*Coragyps atratus*). Because these birds inhabit wide ranges and their main dietary component is carrion, it is important for forensic anthropologists to examine changes in decomposition, the extent of bone alteration, and the degree of bone scatter/movement that result from vulture scavenging activity. Isolating and analyzing the specific effects vultures have on remains will help in the evaluation of scavenging cases.

In the summer of 2007, three pig carcasses (*Sus scrofa*) were placed outside in a large, grassy area in central Texas. The carcasses were exposed to vultures in succession, only one being offered at a time. Each was placed in the middle of a sixteen by sixteen foot fenced area to prevent access by terrestrial scavengers. A fourth pig carcass, used as a control for the rate of decomposition, was positioned in a large wire cage in the same area. The cage, wrapped in additional chicken wire, prevented vulture access but allowed for the same exposure to the elements and insects. Pigs were chosen as a substitute for humans due to their similarities in internal structures and progression of decomposition. To best represent adult human weights, each pig carcass utilized in the study weighed at least 100 pounds. Modification of the carcasses was recorded through the use of two motion-sensing digital cameras and daily on-site observations. Date and time stamp features on the cameras provided an accurate record and timeline of events.

Both the Turkey and Black Vultures waited approximately twenty-four hours after placement of the carcasses before beginning to scavenge, and did not feed at night. After their arrival, vultures alone completely skeletonized the exposed pig carcasses in less than twelve hours. In the midst of feeding, vultures were observed dragging, carrying, and dispersing elements of the carcasses around the original deposition site, leaving identifiable scratches and cuts on the bones. Turkey and Black vultures returned repeatedly to the remains, even after skeletonization, and continued to disturb and distribute elements. In at least one instance, elements were found outside of the six-foot tall enclosure. The movement of the carcass and markings on the remains are specific indicators of vulture scene modification and body alteration. While the carcasses exposed to vultures were skeletonized less than forty-eight hours after placement, the unexposed carcass took weeks to reach the same state.

The significantly accelerated rate of decomposition, the signature markings on the bones, and the degree of bone scatter and transportation discovered in this study are important factors for forensic anthropologists to consider when interpreting taphonomic events and determining an accurate postmortem interval at vulture modified scenes.

Taphonomy, Scavenging, Vultures

H33 Computer Simulation for Drift Trajectories of Objects in the Magdalena River, Colombia

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After attending this presentation, attendees will understand the application of computer modeling in the analysis of taphonomic process (specially transport) related to bodies disposed in water systems.

This presentation will impact the forensic community by serving as an example of the use of technological tools in the investigation of forensic cases and the interdisciplinary collaboration.

Within the field of forensic science there is a growing trend towards the use of computer models to represent transport and degradation processes to which human carcasses are subject along rivers. These may also be used to predict downstream distance traveled by such bodies under likely scenarios, thus helping both the search for victims and the identification of feasible points of entry.

In studies of bodies disposed in moving waters, many problems arise since the bodies not only decompose but also are exposed to transport, disarticulation and dispersion. In such cases, computer modeling has proven to be an invaluable tool leading towards the understanding of former cases and the prediction of the flow pattern of bodies (Ebessmeyer and Haglund, 1994; Carniel *et al.*, 2002).

In this paper a one-dimensional hydraulic model has been coupled with an object transport model in order to predict the object drift trajectories and distance traveled with time. The object transport is modelled taking into account buoyant, hydrostatic and dynamic forces calculated using velocity, discharge and depth computed by the numerical hydraulic model. Results and information from previous research studies were incorporated into the modelling framework to represent the transport of living and dead human bodies of different densities and specific gravities (Krzywicki and Chinn, 1967; Donoghue and Minniguerode, 1977).

The model was calibrated by means of physical experiments carried out in the Teusacá and Magdalena rivers (Colombia). Objects of 21 kg and 44 kg and densities ranging from 0.98 to 1.02 g/cm^3 were placed into the rivers, and their movement and drift trajectories were monitored and registered. Detailed hydraulic data during the experiments was gathered and the objects' travel times were measured. The information was used to calibrate and validate the coupled hydraulic and object transport numerical model.

Objects disposed at high flow velocity sections were observed to travel downstream with the main flow. Along bends, the objects typically followed a path close to the external river banks. In most of the cases, the objects moved after the bend with the main surface flow from the external river bank in the direction towards the opposite bank. Objects disposed at low flow velocity sections near the river bank were observed to get trapped for a long time before a circular motion forced the bodies back into the main flow. The

presence of debris and snags in the river banks altered the direction and velocity of the surface flow, producing whirls and eddies where the floating body got trapped, reducing its effective longitudinal velocity. Along the 10 km long experimental stretch of the Magdalena River the actual observed ratio between the 44 kg (ρ = 0.99 g/cm^3) object velocity and the mean flow velocity was 0.91 for a flow discharge of 950 m^3/s. In turn, along the 50 m long experimental stretch of the Teusacá River the correlation between the 21 kg object (ρ = 1.02 g/cm^3) velocity and the mean flow velocity was 0.9 for a discharge of 1.97 m^3/s.

The calibrated model has been applied to a 400 km stretch of the Magdalena River – Colombia in order to simulate objects´s transport, and to predict their location after being disposed into the river at a certain time. The river model was implemented using hydrograph time series of data provided by the Institute of Hydrology and Meteorology of Colombia and hydraulic data gathered by the Hydraulic Laboratory of the National University of Colombia (1998 -2003). Travel times between 7.5 and 11 days and a loss of mass of about 4.6 kg, were computed for human bodies traveling the 400 km river stretch.

The study concludes that the density and the wetted surface area of the body are the main factors affecting the pattern of movement and traveled distance during a specific time interval along a river. Extrinsic factors related to the geometric configuration of the river and the physical and environmental conditions at the banks also affect the pattern of transport. In the studied Magdalena River stretch, the predicted body transport velocity is lower than the mean flow velocity by a factor ranging from 0.7 to 1.1, depending upon the presence of dead zones, and flow storage zones of recirculating water where the body can get trapped.

Object Drift Trajectories Along Rivers, Hydraulic and Object Transport Numerical Modeling, Magdalena River

H34 Experiential Education: The Use of Simulation in Training in Forensic Anthropology and Archaeology

Margaret Cox, PhD, Cranfield University / Inforce Foundation, Shrivenham, Swindon, UNITED KINGDOM*

After attending this presentation, attendees will have an increased understanding of the use of simulations as components of training in forensic anthropology and archaeology.

This presentation will impact the forensic community by increasing their appreciation of the complexities, benefits and potential pitfalls of using experiential education (simulations) in training forensic anthrologists and archaeologists in aspects of mass fatality response. This may range from investigating mass graves and mass disaster scenes, to working within temporary mortuary.

One of the most effective ways of teaching any subject is to combine qualitative and quantitative approaches via appropriate teaching vehicles. Much can be taught theoretically and practically in the lecture or seminar room, or in the laboratory or field. What cannot be taught via those modes is the ability to apply the skills learnt to a scenario that approximates to a 'real' event or set of circumstances with complete participation by trainees. Mass fatality response, whether to crimes against humanity, natural catastrophe, transportation accident or terrorist attack, is a context that by definition has no "norm", other than it will involve multiple fatalities. It is a context that is distressing and stressful and one that often has inappropriate and inadequate resources and personnel involved. It may involve a context where cultural and religious norms may be unfamiliar, where inappropriate authority may prevail, and where dangers to the health and well-being of responders are significant. Despite that, it is a context where we have a moral obligation to be able to respond effectively and efficiently for both judicial and humanitarian reasons.

Experiential education has a role in such teaching and training. It is a teaching vehicle that ranges from computer simulations to employing teaching modes that mimic reality to a greater or lesser degree. The key with experiential education is that trainees are required to engage intellectually, emotionally, socially and often physically. They have to take the initiative, make decisions and be accountable for results. Very often such learning is done through unrelated activities that are totally removed from the context and subject area in which trainees are engaged. This is "safe" as those who do not perform effectively are doing so in a context removed from their area of normal professional practice.

Experiential teaching vehicles should not be confused with "field-work" or "laboratory sessions" which provide a semi-realistic setting for what is a formal and formative educational approach. In such, the level of responsibility for the outcome on individual trainees is generally low. Only rarely is such teaching a "real" group effort where success or failure of the overall task depends upon effective team work and where accountability rests on trainees.

Experiential training for mass fatality respondents that is set within a "realistic" context (for example, simulated temporary mortuaries and scenes of mass fatality incidents) is extremely challenging for all involved. Trainees are required to implement skills and roles in a 'real-life' simulation that sets them in a context that mimics not only the reality of the roles they may be required to play, but significantly, also employs their day-to-day professional skills. This is a high risk approach to teaching. If it works it has immense benefits. If it does not it is extremely damaging to those directly affected. In this situation the stakes are high and should not be underestimated. If participants consider they have not performed well or 'failed' in a context that mimics their professional role then the consequences can be significant – depending on how they react. This creates a highly charged teaching environment and emotionally challenged and exhausted trainees, and of course trainers.

What is crucial in such training is that the trainers have the educational experience and understanding to recognize what is happening and take action to mitigate against adverse impacts before damage is done. It is not sufficient to put trainees into a difficult situation and leave them to cope. Such teaching must included periodic reviews that invite reflection on progress and on possible alternative strategies to challenges. This presentation examines aspects of this complex, risky but potentially hugely beneficial teaching strategy in light of the simulated mass fatality incident training sites (air-crash sites), mass graves, and temporary mortuaries designed and delivered by the Inforce Foundation.

Simulated Mass Graves, Simulated Temporary Mortuaries, Training in Mass Fatality Response

H35 Realism in Simulation Training: Examples of Mass Grave Excavation and Mass Fatality Incident Mortuary Simulation Exercises

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After attending this presentation, attendees will have an increased understanding of the role that realism plays in simulation training and exercises and how different levels of realism can be achieved.

This presentation will impact the forensic community by increasing their understanding about the importance of realism at certain stages in training and exercise programs and how different levels can be achieved to serve different purposes.

Following on from Professor Margaret Cox's presentation entitled "*Experiential Education: the use of Simulations in Forensic Anthropology and Archaeology,"* this presentation will focus on the important role that realism plays in simulation training and exercises. Different levels of realism can often be achieved relatively easily and with a minimum of extra effort and often without negative impact on budget. In most cases, the correct and most appropriate level of realism can be achieved by combining the expertise of experienced educators and experienced field practitioners.

This presentation will first outline the role that different levels of realism can and should play at different stages in training and exercise programs. It will continue to explore the relevance such appropriate levels of realism and how they can benefit the trainee.

Using two main examples, the methodology of applying realistic scenarios to simulation training will be demonstrated and how they can be achieved. It is not just a question of making scenarios as realistic as possible. At some stages in the training process, very high levels of realism can have a negative impact such as information overloading or taking emphasis away from basic procedural concepts.

When realistic scenarios need to be developed, a number of criteria needs to be observed: the scenarios must be relevant to the trainees; the environment in which the training takes place must match the scenario; the prior level of professional knowledge of the trainees must be incorporated into the training; and the 'realistic scenario' has to be truly based on actual and real experience from field operation. It cannot be stressed enough that whatever realistic element is introduced to a training and exercise program, it needs to be relevant to the trainees. This means that the team that plans and carries out the program is either knowledgeable with respect to the trainees' background or that they seek such advice prior to planning the training. Training people in scenarios that is not relevant to their environment is rarely justifiable and most often a waste precious resources.

The presentation will finally look at the possibility of incorporating research into such training programs. Since they are designed to simulate reality, a number of questions that confronts forensic practitioners can be addressed during simulation exercises. Not to do so is again a waste of resources and opportunity.

Realism is a powerful tool that can be used in simulation training, but only if it is used at the right time, in a relevant context and by experienced educators and practitioners.

Training in Mass Fatality Response, Simulated Mass Graves, Simulated Temporary Mortuaries

H36 The Effects of Body Mass Index on Cremation Weight

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The goal of this presentation is to determine the relationship between cremains weight and perimortem body mass index (BMI) in a multi-regional United States sample. Additional contributing factors, sex, and age-at-death, are examined for their effect on cremains weight.

This presentation will impact the forensic community by demonstrating the utility of cremains weight in the estimation of age and sex. Furthermore, cremains weight may be used to validate their association with an individual whose body mass index may be calculated from known stature- and weight-at-death.

Cremation has become an increasingly popular funerary practice. Through this process bone is incinerated and mechanically reduced into particles comparable to sand or silt, ultimately removing most diagnostic features. Cremation is occurring with greater incidence in forensic contexts, presenting new challenges to forensic anthropologists in issues of evidence destruction, unethical disposal of remains, or disputed identity.

Most research on burning and charring of skeletal material takes the form of controlled experimentation and case studies. A small body of research has amassed on the physical properties of cremains. Previous research includes that of Warren and Maples (1997) sourced from Central Florida, and that of Bass and Jantz (2004), using samples from the Eastern Tennessee area. These studies investigated cremation weight and the relationship with individual sex and age-at death. Both established a few general principles: cremains are derived almost exclusively from osseous material, and the heavier average weight of male versus female samples. In Bass and Jantz' sample of 306 individuals, the male average outweighed female average by approximately 500g; while Warren and Maples' male average was heavier by nearly 600g. In both studies, age-at death produced an expected negative correlation with advanced age.

Although results are comparable, geographic variation exists. A third study comparing regional cremation weights by Van Deest (2007) introduced a sample of cremations from California. Results for sex and age correlations were consistent with the previous studies. Notably, the Tennessee sample was consistently heavier across both variables of age and sex; a result Bass and Jantz attributed to higher incidence of obesity in Tennessee, inducing higher bone mass.

The present study addresses this issue, investigating the relationship between body composition and cremation weight. Body mass index (BMI) was adopted by the World Health Organization (WHO) in 1995 as the standard measurement of body fat in both health and epidemiological studies. Several difficulties surrounding BMI's predictive value exist, including the inability to distinguish between subcutaneous adiposity verses lean mass. However, for the purposes of this study BMI remains the only available method.

To obtain a sufficient sample size, data was combined from Warren and Maples (1997) anthropometry research, the William M. Bass Skeletal Collection of Knoxville, Tennessee, and the University of Tennessee-Chattanooga Donated Collection. All cremains were rendered through a commercial crematorium; amputees, bone donors, and skeletally immature samples were excluded from analysis. Total sample size contains 99 cremations, consisting of 61males and 38 females.

For each sample, body mass index (BMI) was calculated as weight divided by height squared: $(kg)/(m)^2$. WHO designates three levels of BMI: 18.5 to 24.99 "normal", 25.00 to 29.99 "overweight", and 30.00 marks the threshold of obesity. Individuals of unknown perimortem stature or weight were also eliminated, for inability to calculate BMI. The relationship between BMI and cremation weight was assessed using a correlation coefficient and multiple linear regression, using SAS 9.3.1 and NCSS 3.0 statistical software.

Pearson's Correlation Coefficient Test demonstrates a clear association between BMI and cremation weight ($r = 0.56$; $R^2 = 0.32$; $p = <0.0001$). However, multiple linear regression reveals that additional factors, sex and age have a significant association ($t = 7.198$; $t = -2.5$ respectively). When BMI, sex, and age are regressed in conjunction, they contribute approximately 67% of all variation observed in cremation weight ($R^2 = .668$). Explanations include bone modification resulting from increased loading-stress, as well as glucose-intolerance and altered metabolic pathways related to obesity.

References:

1 Warren MW, and Maples MA. The anthropometry of contemporary commercial cremation. *Journal of Forensic Science* 1997; 42:417-423.

2 Bass WM, Jantz RL. Cremation weights in East Tennessee. *Journal of Forensic Science* 2002; 49:1-4.

Forensic Anthropology, Cremation, Body Mass Index (BMI)

H37 The Influence of Body Fat on the Rate of Decomposition in Traumatized Pigs

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This presentation will demonstrate the effects of body fat on the rate of decomposition in surface decomposing pigs as measured in ADD from fresh to skeletonization.

The results of this research will impact the forensic community by demonstrating the percentage body fat will not influence decomposition and hence time since death estimations/postmortem interval estimations.

The high prevalence of obesity worldwide is raising concern among forensic scientists and nutritionists. This trend in developed, first world countries due to the sedentary life styles and the increased intake of foods

with higher amounts of fats (Prentice and Jebb 1995) are of concern to the forensic scientists who must attempt to determine the time since death, or postmortem interval (PMI), from the stage of decomposition exhibited by a human corpse (Megyesi, et al. 2005). Body fat is among the factors identified to influence the process of decomposition, yet the relationship is anecdotal (Mann, et al.1990). A pilot study of the effect of body fat on pig decomposition suggested that higher fat content increases the rate of decomposition (Jessen 2005). The aim of the current research was to determine the influence of percentage body fat on the rate of decomposition in traumatised pigs (*Sus Scrofa*). At approximately 45 ADD periods over a period of 9 weeks (734.8 ADD *en toto*), decomposition was measured as the amount weight lost in 37 pigs with different weights, sexes and percentages of body fat. The research was conducted at a facility in northwest England during the spring/summer of 2007. For each pig, the weight, soil pH, total body score, ambient, carcass, and ground interface temperatures and carrion insects were monitored.

There were no significant difference in weight lost in carcasses with different percentages of body fat ($F= 0.475$, $p= 0.875$, $\alpha= 0.10$) and body fat does not influence weight loss ($F=0.12$, $p=0.73$, $\alpha= 0.10$) and changes in pH ($F= 0.0074$, $p=0.9317$)**;** however, the interaction of weight loss and time (ADD) was shown to influence soil pH ($F= 59, 2395$; $p<0.000$). Changes in ground temperature were correlated to changes in ambient temperatures. Arbitrary grouping of carcasses into high and low fat groups also showed no differences in mean weight loss. Carrion insects associated with decomposition were primarily of the Calliphoridae and Silphidae families.

The lack of significant differences in weight loss in pigs with different percentages of body fat rules out the suggestion that increased amounts of body fat promote the numbers and activity of bacteria during decomposition. These bacteria are said to disseminate through the greater volume of a fatter body, thereby causing liquefaction and hence accelerating decomposition (Campobasso, et al. 2001; Mann, et al. 1990) as bacterial activity is temperature dependant (higher temperatures promote their activity). The low mean ambient temperatures observed over the duration of most of this study could influence the observed results. During certain periods where ADD accumulated more rapidly due to higher daily ambient temperatures, decomposition of the internal structures and external structures continued, promoting bacterial and maggot activity and hence aided biomass removal. However, the abdominal contents of some carcasses remained till the end of the study, probably due to the influence of lower mean temperatures rendering bacteria and maggots less active. There was no observed difference in the numbers of flies visiting the carcasses of different fat or size, suggesting that there were no preference of flies for carcasses with greater amounts of fat (Jessen 2005; Hewadikaram & Goff 1991).

The northwest of England experienced its highest ever recorded rainfall during the months the experiment took place, and the influence of rain resulted in the formation of adipocere. This retarded carcass depletion and resulted in water-logging, weight gain, migration and inactivity of most carrion fauna. Dry periods observed thereafter resulted in a new wave of fly activity and reduction in soft tissue once again. This confirms an earlier observation (Archer 2003). With increasing ADD, and hence weight loss, and leaching and accumulation of sulphur and nitrates, changes in pH with weight loss resulted.

This study shows that percent body fat does not influence the rate of weight lost and hence decomposition. Thus, estimations of PMI will not be influenced by different body compositions (percentages of body fat), thus contributing to aim of increasing the accuracy of PMI estimations.

Body Fat, Decomposition, Pigs

H38 Saw Cut Marks in Bone Created by Atypical Saws

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After viewing this poster attendees will have an understanding of the properties of saw cuts in bone created by saws without traditional blades.

This presentation will impact the forensic community by adding additional means of documenting dismemberment in homicide and other investigations.

The documentation of saw cuts in bone is well established. Each class of saw blade is characterized by class features: the number of teeth per inch (TPI), push versus pull stroke cutting, tooth offset, and tooth width (blade thickness).

Today there are saws commercially available which do not use teeth as the cutting medium. In having no teeth these saws lack most of the class defining traits used in saw identification including the lack of directional cutting (push versus pull stroke). For this study two saws were chosen.

The "MXZ" brand carbide saw has been advertised on television and the internet. This saw has a short blade (13 cm in length) encrusted with carbide chips. This saw is advertised to be able to cut through various materials including steel, concrete, and tile.

The zip saw is common to hunting outlets and is used in field dressing deer to cut through the pelvis at the pubic symphysis. The saw consists of a fine braded chain of three stainless steel wires 48 cm in length. Smaller irregular segments of wire have been welded to the main wires creating a cutting edge. The cutting wire is attached to two short handles.

In the absence of saw teeth one of the few practical properties of both saws is the cutting width or diameter. For the MXZ saw 10 measurements were made perpendicular to the blade recording the maximum width across the carbide chips. This width ranged from 1.85 to 2.23 mm with an average width of 1.99 mm. For the zip saw 10 measurements were made perpendicular to the long axis of the saw in the center segment of the saw recording the maximum width across the cutting wires. This ranged from 1.40 to 1.59 mm with an average width of 1.51 mm.

Experimental saw cuts were made using long bones of the white tailed deer (*Odocoileus virginianus*). Partial (false starts) and complete cuts were made. Kerf widths were measured for the partial cuts, and both partial and fully cut surfaces were examined for class-specific characteristics.

The MXZ saw does not cut so much as gouge bone like sandpaper. The kerf width at mid cut ranged from 2.02 to 2.50 mm. This is greater than the measured width of the blade and is attributable to the lack of teeth to maintain blade control through the cut. Despite this the superior margins of the partial cuts were parallel throughout their range. Chipping was evident along the superior margins of both sides of the cut. The kerf floor was marked by parallel striations running the length of the floor. The kerf profile can be characterized as U-shaped with roughly parallel walls. The fully cut surfaces display fine striations similar to those of toothed saws. The striations were less sharp than in toothed blade cuts, however.

The zip saw chisels bone more like a toothed saw but like the MXZ saw lacks the regularity provided by saw teeth. The zip saw also cuts in a curved axis with the cutting force varying in application with how the saw is applied to the bone. The kerf width at mid cut ranged from 1.50 to 1.60 mm. This is nearly the same as the measured width of the blade. The superior margins of the partial cut surface were parallel throughout their range. Chipping was evident along only one side of the superior margin of the cut surface. Given the flexible blade this reflects the direction of pressure applied to the bone. The kerf floor was marked by parallel striations running the length of the floor. The kerf profile can be characterized as semi-circular with well rounded walls at the base. The fully cut surfaces are marked by fine curved striations similar to those created by circular and gigli saws. The curved striations were most obvious at the beginning and end of the cut. This corresponds to the most curved pressure being applied to the bone surface.

In conclusion the absence of teeth, while removing a substantial amount of saw information, does not negate the possibility of identifying saw class.

Bone, Cut Marks, Saws

H39 DNA Quantification of Burned Skeletal Tissue

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After attending this presentation, attendees will understand the effects of temperature on gross morphology and DNA degradation in bone. The study will in turn provide an aid in producing a standardized protocol for extracting and processing DNA from burnt bone.

This presentation will impact the forensic community by demonstrating high temperatures promote DNA degradation in skeletal tissue and that DNA is unlikely to be extracted from bone exposed to temperatures above 200°C. The use of PTB in DNA extraction has shown to increase DNA yields. PTB is a potential agent in increasing DNA yields for DNA profiling from small bone samples.

Forensic anthropologists are often enlisted to utilize investigative techniques for the identification of human remains. Identifying human remains using conventional anthropological methods does not necessarily produce a successful positive identification. In such cases, other techniques, including DNA typing, may be pursued. Recovered human remains may have become too fragmented or may have lost their integrity for successful physical identification or may be accompanied by soft tissues that are too decomposed for DNA typing. As the only viable sample that may be available for identification, skeletal tissue is an extremely important source of DNA. Identifying individuals using DNA profiles derived from bone samples is becoming increasingly important and has been used to successfully identify victims from a wide range of scenarios including natural disasters, terror attacks and armed conflicts. Like all forensic samples, skeletal tissue can be recovered from a wide variety of environments. After death, nucleic acids can undergo spontaneous degradation, which can be accelerated by environmental factors including pH, temperature and other chemical exposure. These can all hinder DNA profiling. It is well documented that high temperatures promote DNA degradation in bone. However, the literature concerning DNA typing from skeletal tissue exposed to high temperature has thus far been inconclusive and lacks suitable controls. This study will compare two different DNA extraction techniques and determine the correlation between DNA degradation and temperature. This study will in turn provide an aid in producing a standardized protocol for extracting and processing DNA from burnt bone and establish potential links with gross morphology as a possible predictor of quality and quantity of DNA that can be extracted.

Using *Bos taurus* as an animal model, eight radii were burnt using a muffle furnace at 100 °C, 200°C, 350 °C and 500 °C for one and three hours. An untreated sample of fresh radii was used as a control. Using two different extraction techniques, one using phenol: chloroform: isoamyl alcohol and the other using phenol: chloroform: isoamyl alcohol plus N-phenacylthiazolium bromide (PTB), DNA was extracted from each sample and compared. Samples were then semi-quantified on an agarose gel with appropriate ladders.

From the results it is clear that an increase in temperature and time decreases the volume of DNA that can be extracted. High molecular weight DNA was extracted from untreated samples and samples that were exposed at 100°C for both one and three hours. Though lower molecular weight DNA was extracted from samples exposed to 200°C for one and three hours there was a distinct decrease as the exposure period increased. DNA from samples that have been exposed to temperatures of 350°C and 500°C for both one and three hours could not be extracted suggesting that the majority of DNA has been degraded. There was also a clear difference in gross morphology. Samples where DNA was extracted had little color change and intact integrity, while those where DNA extraction was unsuccessful had charcoal appearance and lateral cracking.

There was also a difference in the volume of DNA extracted when using the two different protocols. PTB is an agent that cleaves advanced-glycation end-products (AGEs) and results from nonenzymatic glycosylation. Glucose and other reducing sugars have been shown to react nonenzymatically with DNA and have been shown to affect both the physical and biological properties of DNA. AGE formation increases with age and temperature and may explain the fact that, of all the samples where DNA was extracted, the yield of DNA was increased when using PTB.

This study has shown that temperature has a detrimental effect on DNA degradation. It has been seen to increase DNA yields from those where DNA was extant. PTB therefore may be an ideal reagent to increase DNA yields from small sample sets.

DNA, Bone, Temperature

H40 Early Diagenesis of Bone and DNA Preservation

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After attending this presentation participants will understand the impact of microbial degradation on the preservation of bone and DNA. Factors that influence early postmortem degradation of bone will be characterized.

This presentation will impact the forensic community by providing a straight forward method to estimate and anticipate DNA preservation in bone.

Skeletal remains are an important resource for forensic identification, not only for osteological characteristics, but also as a source of DNA. Unfortunately degradation processes affecting bone can be detrimental to DNA survival. A major pathway of degradation in human bone is destruction of the bone structure by micro-organisms such as fungi and bacteria. This, presumably, has a significant effect on DNA preservation as bone porosity is increased and biomolecular material is removed. In a study on the preservation of archaeological bone it was found that intact human burials show more bacterial alteration than fragmented and processed bones. Based on this and other work it was hypothesised that bacterial alteration starts early postmortem during putrefaction of the body and is mainly caused by commensal bacteria that initially arrive in the bone via the vascular system. This type of degradation will, in that case, not occur in situations where putrefactive bacterial growth has been inhibited (e.g., extreme temperatures, bactericidal chemicals), or where putrefactive bacteria have had no opportunity to access the bone (e.g. fragmentation or butchering).

In the framework of an European Union Marie Curie Fellowship (FP6; project number 22210), human bone material sampled for DNA at the Central Identification Laboratory (CIL) has been analysed for degradation using histology and backscattered electron scanning electron microscopy (BSE-SEM). Histology is a useful technique to determine both extent and type of microbial degradation in bone. The aim of the project is to characterise early degradation of bone, as well as investigate the relationship between bone preservation and DNA results. More than 70 samples from long bones were analysed at the CIL, from different sites in Europe, Asia and Oceania. The extent of preservation of the samples, as well as the pathway of degradation (microbial, physico-chemical) was assessed.

From the preliminary results it becomes clear that significant microbial alteration takes place within the first 40-50 years postmortem in the majority of cases. Microbial alteration seems generally less extreme in the middle of the transversal bone section, indicating this as a preferred area for DNA sampling. The type of incident – e.g., plane crash or ground loss - influences whether bacterial alteration takes place, perhaps explaining unexpected DNA success in some fragmentary remains. Histology results will be compared to DNA yield to assess the influence of different types of degradation.

After attending this presentation participants will understand the impact of microbial degradation on the preservation of bone and DNA. Factors that influence early postmortem degradation of bone will be characterized.

This presentation will impact the forensic community by providing a straight forward method to estimate and anticipate DNA preservation in bone.

DNA, Bone Preservation, Histology

H41 The Effect of Carcass Weight on the Decomposition of Pigs (*Sus scrofa*)

Heather J. Brand, BA, 422 Queen Anne Heights, Victoria, British Columbia V8S 4K6, CANADA*

Participants to this presentation will gain knowledge of the factors that influence decomposition, particularly the effect of carcass size on rate of decomposition. Participants will also come to understand the variability associated with rate decomposition and the difficulty of standardizing a method of postmortem interval estimation.

The results of this experiment will benefit forensic science in the fields of postmortem interval estimation and rate of decomposition research. The research demonstrates that carcasses weighing between 10-20kgs decompose at a rate that statistically is not significantly different. These results will further understanding of the effect of carcass weight on rate of decomposition when calculating postmortem interval.

Establishing postmortem interval (PMI) is a complex procedure, which is influenced by many factors including rate of decomposition. Research is necessary to understand the precise effect of each influencing factor in order to increase the accuracy of PMI estimations. The aim of this study, conducted at the University of Central Lancashire, UK, is to determine the effects of carcass size on the rate of decomposition for surface depositions using domestic pig carcasses (*Sus scrofa*). Three weight groups of three carcasses each were established within the total sample size of nine pigs: 10kgs, 15kgs, and 20kgs. Each pig was humanely dispatched with a captive bolt to the cranium, which was plugged with a pithing cane to minimize physical trauma to the carcass. Carcasses were laid out wrapped in chicken wire to prevent vertebrate scavenging while still allowing insect access.

Data collection was performed approximately every 45 ADD (accumulated degree days) between May 19 and July 15, 2007. Each pig's rate of decomposition was recorded using Megyesi et al (2005) body region and total body scoring (TBS) method. Several factors known to influence decomposition were also documented: soil pH, regional weather conditions, rainfall, body temperature, interface temperature, lux, and carcass weight loss. Additionally, as part of the data collection procedure, Ppotographs were taken of the each carcass and maggots were collected from various bodily regions and reared for identification. According to Vass et al (2001) a total of 214 ADD is required for skeletonization of carcasses weighing between 0 and 49lbs (0-22kgs) based on a study with seven cadavers. However, ater this study's conclusion at 734 ADD, complete skeletonization was still not observed. The author believes that this is due to record high rainfall experienced during the experiment, which deterred insect activity.

Using a Pearson's Correlation, a positive correlation was shown between ADD and carcass TBS, $r(151) = .97$, $p < .001$ and a negative correlation was shown between ADD and percentage of carcass weight loss, $r(151) = -.95$, $p < .001$. Statistical analysis, using SPSS 14.0, indicates that no significant difference exists between carcass size and decomposition score, $F(8, 144) = .202$, $p = .990$, carcass size and percentage of weight loss, $F(8, 144) = .280$, $p = .972$, or any of the other factors controlled for.

Carcass Weight, Decomposition, Accumulated Degree Days (ADD)

H42 Patterns of Perimortem Fracture From Military Aircraft Crashes

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After attending this presentation, the attendee will understand the patterns of perimortem fractures of the extremities from fatal military aircraft crashes.

This presentation impacts the forensic community by demonstrating how anthropological analyses of perimortem fractures augment traditional inquires of aviation pathology. This research is discussed within the historical context of aviation pathology, while drawing attention to applications of perimortem fracture analyses.

This paper presents fracture pattern analysis among the six antimeric long bones; specifically, the frequency of fractured elements, the location of fractures within these elements, and the distribution of fracture types among the elements are evaluated. The authors hypothesize that given various incident parameters, such as aircraft performance power to weight ratios and seating position, the distribution of fracture types and locations among the six antimeric long bones will enable probability statements for differentiating individuals, thereby aiding identification of passengers from multi-seated aircraft by reducing the list of potential identities associated with specific sets of remains. With regard to seating position, it follows that the location of pilots and crew at the time of impact is important to this study. That stated, the particular activities of pilots and/or crew prior to a crash are not certain; undoubtedly, a pilot attempting to egress during decent will experience different fractures than one who remains at the aircraft controls. However, based on historic documentation we feel that the cases used herein include those representing controlled flights into terrain.

The aircraft accidents reported in this study span a 27 year period from 1942 to 1969 and include incidents from World War II, Korean War, and Vietnam War, with the majority of the samples from WWII. Frequency data are made available due to the efforts of the Joint POW/MIA Accounting Command Central Identification Laboratory (JPAC CIL) in fulfillment of the mission to recover and identify deceased U.S. service members. Therefore, the distribution of fractures discussed herein represents what is expected from non-survivor populations. Evidence-based data are recorded from CIL photographs, analytical notes, identification reports, and/or direct observation of skeletal remains. Fracture frequency data are compiled from 32 individually-identified decedents involved in 18 separate aircraft crashes. For every case each long bone of the upper and lower extremities is divided into fifths and a complete inventory of elements by region is recorded as absent, present, or present with at least one perimortem fracture. If a region contains observable perimortem fractures then the fracture type is recorded as comminuted, oblique, transverse, spiral, and/or longitudinal. Prior to fracture analysis, sample bias is assessed since data are derived from archaeologically recovered remains. Fracture patterns are established by comparing ratios of fracture presence to total presence of elements and element regions.

Recovery frequency of 85% is determined as a ratio of element regions present to total expected for the 32 individuals, suggesting relatively good preservation and recovery for the samples used in this study. Results of frequency tabulation and fracture pattern analysis are described. The frequency of fractures between right and left elements is equable, suggesting no significant difference among right and left elements for this study. Observations between upper and lower extremity fractures for the 32 casualties are consistent with that previously reported ($\chi^2 = 4.370$, df = 1, p-value = 0.037) suggesting that the higher frequency of fracture in the lower extremities (0.61) relative to the upper (0.50) is not by chance alone. Interestingly, stratifying data by natural breaks in aircraft performance power-to-weight ratios the overall fracture distribution between aircraft that have a power-to-weight ratio ≤ 0.056 hp lb^{-1} is significantly different from those that have a

ratio ≥ 0.15 hp lb^{-1} (χ^2= 4.841, df = 1, p-value = 0.028). Of particular interest however, is the fracture pattern of pilots compared to non-pilots, regardless of aircraft performance. In this study, pilots display a greater frequency of perimortem fracture (0.63) than non-pilots (0.41) for all elements evaluated; and in fact, pilots are expected to display fractures just over two times that of non-pilots (χ^2 = 14.615, df = 1, p-value = 0.000). Based on the distribution of fracture ratios per element region, pilots experienced midshaft fractures with a greater frequency and consistency than non-pilots, suggesting odds of a pilot with a midshaft fracture is just over two times that of non-pilots. The greatest difference between pilots and non-pilots occurs at the tibia midshaft where odds of fracture are nearly four times that of non-pilots. Of all midshaft fractures (n = 75) 45% are comminuted fractures relative to the other four fracture types recorded.

Demonstrated is the biomechanical response of bone to multiple acute forces and the relationship to the forward seating position through comparison of perimortem fracture frequencies of pilots and non-pilots that did not survive their respective crash incidents. Fractures resulting from multiple forces including longitudinal compression and angular and axial forces are typically displayed at the location of greatest load. As evidenced by the data collected in this study the area of greatest load experienced by bones of the extremities is at midshaft. In this study, discernible patterns of perimortem fracture among bones of the extremities emerge through anthropological analyses.

Trauma, Perimortem Fracture, Aircraft Crash

H43 Predicting the Location of Scattered Human Remains: When Will Heads Roll and Where Will They Go?

Gretchen R. Dabbs, BA, MA, University of Arkansas, 330 Old Main, Fayetteville, AR 72701*

Attendees of the presentation will be able to identify the slope at which fleshed and skeletonized heads will begin to roll downhill in a forensic setting.

This presentation will impact the forensic community by providing Information useful to identify when it is feasible for investigators to identify slope as a factor in the distribution of skeletal remains, as opposed to other vectors such as carnivores. Additionally, GIS technology will be applied to the data to recognize potential for modeling the predicted final deposition of skeletal remains.

The skull is one of, if not the, most forensically significant skeletal elements in the human body. Whether it be through assessment of non-metric traits, or through the more complex collection of craniometric data, the skull provides the only reliable information for assessing ancestry. It can be used in the assessment of both sex and age, when the pelvis is either unavailable or ambiguous. The maxilla and mandible house the dentition, which is an easy and inexpensive method of positive identification via comparison with antemortem dental records. Unfortunately for law enforcement and forensic scientists, the old adage "Heads will roll!" takes a quite literal interpretation in forensic work. Recent case work in Northwest Arkansas has provided the inspiration for this pilot study. Situated in the foothills of both the Boston and the Ozark Mountains, the forested areas of Northwest Arkansas find level ground a scarce commodity. Whether it be due to carnivorous activity or the hilly terrain, the most common situation law enforcement and field recovery teams encounter include the obstacle of scattered body elements, which complicates the recovery process to the nth degree, and often results in the loss of information via incompletely collected remains. When the unrecovered elements include the skull, massive amounts of vital information have been lost. This work addresses one of the two major elements responsible for the scattered nature of skeletal remains in Northwest Arkansas, and many other areas of the country, the hilly terrain and its potential to disperse remains downhill. The results of a pilot study designed to ascertain the feasibility of continued research in the quantification of the degree of slope at which heads will begin to roll downhill in the forensic context are reported in this work. In a highly controlled laboratory setting, a single fleshed head from a cadaver donated for scientific research, with the first three cervical vertebrae attached, was experimentally rolled down a slope a total of 120 times, starting in three different positions. These three positions include facing uphill, facing downhill, and with the face towards the ground. It was physically impossible to place the skull in an anatomically correct position on the back of the skull, facing skyward, because the weight of the mandible pulled the rest of the head down and over onto the caudal surface of the attached vertebrae. This position was eliminated from the study early on in the process. Preliminary data suggests that the starting position of the head relative to the hillside influences the degree of slope required to break gravitational inertia and begin the downhill roll. In fleshed head experiments, the nose presented a hurdle that must be overcome for the head to roll downhill. First round research shows that heads facing uphill will roll on hills with lower slopes than heads positioned facing downhill. Further testing on the skeletonized crania is required and planned to identify the pattern unique to skeletonized remains. Additionally, this study uses GIS technology to examine the potential applicability and feasibility of this research in the design of field recovery plans. It is hypothesized that watershed analysis will allow the researcher to easily predict the areas of greatest likelihood of deposition of scattered remains based on the terrain and conditions of each specific recovery site quickly and easily using readily available United States Geological Services terrain maps.

Forensic Recovery, GIS, Forensic Anthropology

H44 Identifying Sharp Force Trauma on Burned Bones

Daniel W. Jackson, MA, and Pamela M. Steger, MS*, Travis County Medical Examiner's Office, 1213 Sabine Street, PO Box 1748, Austin, TX 78666*

After attending this presentation, attendees will have a better understanding of the effects that liquid accelerant-only fires have on the identification of pre-existing sharp force trauma to the radius, ulna, carpals, and metacarpals.

This presentation will impact the forensic community by demonstrating experimental research under controlled settings in order to confirm or deny interpretation of perimortem defects on burned remains.

The role of the forensic anthropologist has become vital to fire investigations that involve human remains. It is likely that the forensic anthropologist will be asked to assist in interpreting skeletal defects that may have been caused by such forces as heat exposure and/or trauma to bones. To successfully complete this task, the anthropologist must be familiar with the various effects that fire has on human remains, as well as knowledge of fracture patterns and cut-mark morphology indicative of trauma. This study investigates the effects that liquid accelerant-only fires have on the identification of pre-existing sharp force trauma to the radius, ulna, carpals, and metacarpals. Wounds to these bones are commonly called defense wounds because they are created when victims try to defend themselves from a sharp instrument attack.

This study tests the hypothesis that various forms of sharp force trauma produced on fresh bone and then subjected to fire will still retain identifiable cut morphology that can be used to differentiate the sharp force trauma from the fragmentation effect of the fire. Included in this study are several variables not combined together in previous experiments, making this investigation a unique approach to the problem of identification of sharp force trauma. These variables included multiple types of instruments, uncut remains used as study controls, outside observers for conducting blind testing, and use of a variety of different liquid accelerants.

The experimental design used the distal half of pig (*Sus scrofa*) forelimbs to simulate human forearms. The limbs were acquired with the soft tissue still intact. In other words, there were no alterations to the limb to more closely approximate the fresh tissue state of a human inflicted during an attack. After five limbs were cut with a different instrument (meat cleaver,

an ice pick, a common straight edged kitchen knife, a machete, and a serrated steak knife) they were placed together on a metal grate inside a large metal pan along with one uncut limb as a control. Subsequently, one gallon of a liquid accelerant was poured on top of all the limbs and into the pan. Only one accelerant was used at a time, and there was no mixing of liquids. The fire was started, allowed to burn until the liquid accelerant was completely consumed, and the fire was completely out. This procedure was repeated four times with four different accelerants. The accelerants included 87 octane unleaded gasoline, diesel, kerosene, and turpentine. With six limbs being used for each of the four accelerant burning episodes, a total sample size of 24 limbs was used in the experiment.

The analysis phase consisted of attempting to identify sharp force trauma (if any) on the remains without knowing which tool was used. The attempt to identify injuries was done at the macroscopic level only. If no trauma was found, the remains were recorded as uncut. However, if evidence of sharp force trauma was found, an attempt was be made to correctly identify which particular tool was employed.

While the destructive force of fire does often produce fractures, it has been demonstrated that defects caused by the sharp force trauma would still be identifiable after the fire. This experiment, then, is a test of the ability of forensic anthropologists to locate possible sharp force trauma on human remains in cases that involve fire.

The results of the post-fire analysis compared with the pre-fire data made it clear that there are some limitations in the identification of sharp force injuries to burned remains. The current study showed that while the presence or absence of sharp force trauma was identifiable most of the time (73.9%), the presence of sharp force trauma was missed six times. The missed trauma was mostly due to extreme fragmentation of remains from their burning. Most often, it was the radius and ulna that were broken into numerous small pieces, making it difficult to find cut marks on these elements.

Forensic Anthropology, Sharp Force Trauma, Burned Remains

H45 Fracture Patterns in Fleshed and De-Fleshed Pig Femora Inflicted With Various Ammunition Types

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Upon the completion of this presentation, those in attendance will have received a broader knowledge of the field of ballistics and a greater understanding of the effects of bullets of varying construction, velocity, energy, and calibre impacting on the femur before and after being de-fleshed.

The findings of this study will assist the forensic community in exploring new methods of estimating calibre size and ammunition type from long bone fracture patterns, which will assist investigators in identifying and/or excluding potential types of ammunition and weapons in the absence of fired cartridge casings. Discovering if there is a significant difference between bullet impact on fleshed and de-fleshed bones will help researchers conduct meaningful, accurate studies.

In order to examine wound ballistics on long bones, controlled experiments were preformed on pig femora. The fleshed femora were shot from a distance of 1.5 feet between the muzzle of the gun and the target. Four replicates of the following ammunition were inflicted on separate femora: 9 mm jacketed soft point (JSP) bullets, 9 mm full metal jacket bullets (FMJ), .38 calibre jacketed soft point bullets, and .357 calibre full metal jacket bullets. Two replicates of the same ammunition were inflicted upon de-fleshed femora. The resulting wound ballistics was analyzed in order to make correlations between fracture patterns and specific ammunition.

The aim of this study is to test the hypothesis that if a certain combination of calibre and type of ammunition is used to inflict injury on a femur, then the specific ammunition will produce fracture patterns and dimensions unique to that ammunition. This study also aims to determine if experiments on fleshed bone will produce similar results to experiments on de-fleshed fresh bones. Through an examination of parameters such as fracture patterns, number and length of fractures, and the number and size of bone fragments, it will become apparent whether or not there are significant differences between commonly used bullet calibres and types, as well as between fleshed and de-fleshed bones.

The findings of this study will assist in exploring new methods of estimating calibre size and ammunition type from long bone fracture patterns, which will assist investigators in identifying and/or excluding potential types of ammunition and weapons in the absence of fired cartridge casings. Discovering if there is a significant difference between bullet impact on fleshed and de-fleshed bones will help researchers conduct meaningful, accurate studies.

The impact of bullets on bones that were shot while the bones were fleshed was different from those that were shot when they were de-fleshed. The fleshed bones broke into fewer fragments and fewer fracture lines were formed around the entrance. In addition, only rarely did butterfly fragments form when the fleshed bones were shot; however, every bone shot after being de-fleshed presented butterfly fragments.

In the first group of bones that were shot while fleshed, ammunition of the same calibre and from the same gun, but of differing bullet types, produced completely different results. The 9 mm JSP bullet caused more fragmentation, fracture lines, and more complex fractures than were presented in those bones shot with the 9 mm FMJ bullet. Though the 9 mm FMJ has a slightly higher kinetic energy, the energy transferred to the bone was more with the JSP bullet. Instead of penetrating straight through the specimen, the JSP bullet tends to deform and expand, causing the bullet to lose more energy, and hence cause more destruction, in the bone.

In the group of bones shot when de-fleshed, both the 9 mm JSP and the .357 FMJ caused entrance wounds that did not produce a circular defect with a measurable diameter. The entrance wounds were of similar size, however, the exit wound of the .357 FMJ was larger than that of the 9 mm JSP. This shows that although the construction of the JSP bullet should result in more destruction because of deformation of the soft point bullet, the ammunition with greater kinetic energy caused more damage.

Each 9 mm JSP and .38 JSP ammunition showed a complex spiral fracture with more than 3 intermediate fragments as well as complex irregular fractures with shattering, while the .357 FMJ and 9 mm FMJ showed only complex irregular fractures with shattering as labelled through the A/O Classification System (Orthopaedic 1996).

The slight differences in calibre among the .38, .357 and 9mm did not seem to affect the specimen.

Ballistics, Fracture Pattern, Gunshot Wound

H46 Decomposition Scoring as a Method for Estimating the Postmortem Submersion Interval of Human Remains Recovered From United Kingdom Rivers - A Comparative Study

Abigail C. Lagden, BSc, and Tal Simmons, PhD, Department of Forensic and, Investigative Sciences, University of Central Lancashire, Preston, Lancashire PR1 2HE, UNITED KINGDOM*

This presentation will make attendees aware of how a scoring system that reflects decomposition can be used reliably to estimate the postmortem submersion interval when human remains are recovered from an aquatic environment. They will also be provided with evidence that indicates how a single scoring system may be applicable across different aquatic environments.

This presentation will impact on the forensic community by providing a better understanding of the variables that affect decomposition in aquatic environments and showing how this knowledge has been used to produce a reliable method for estimating postmortem submersion interval, that could be applicable across different aquatic environments.

When human remains have been submerged in water for any length of time, estimation of the postmortem interval becomes difficult. This is due to the limited amount of research that has been carried out into the changes that occur when a body undergoes decomposition in an aquatic environment and what variables influence these changes. It is accepted that these decompositional changes, and the rates at which they occur, are different to those observed in terrestrial environments, but it is unclear how they differ and whether they also vary from one aquatic environment to another. This study aims to provide an understanding of how the decomposition of human remains progresses in the River Mersey, UK and whether it differs from decomposition as observed in other UK rivers.

A fifteen year retrospective study was carried out of forty nine cases where human remains were recovered from the River Mersey, UK. Information was obtained by reviewing coroner's case files, containing records of the individual's demographics, police reports and postmortem examination reports. For a number of cases it was also possible to view postmortem and scene photographs.

For each case, the body was divided into three areas; the head and neck; the torso; and the limbs. Information was then recorded for each area, detailing the characteristics of decomposition observed in the postmortem photographs, and those described in the pathologist's report. Using this information, a scoring system was produced for each area to reflect the sequential stages of decomposition observed in the study sample. Each case in the sample was then scored using this system, and the three resulting scores summed to provide a Total Aquatic Decomposition Score (TADS).

Multiple regression was carried out to establish which independent variables (sex, BMI, age, salinity, level of clothing, season of entry, postmortem submersion interval {PMSI} and accumulated degree days {ADD}) had an effect on the assigned decomposition score. Only PMSI and ADD showed a significant correlation with TADS, and separate regression models were produced to estimate each of these variables from TADS.

Similar models had previously been produced for cases recovered from the River Thames, UK and the River Clyde, Scotland, UK, and comparisons were made among the three sets of results. An analysis of covariance (ANCOVA) was used to compare the regression models (TADS vs. ADD) for each of the three rivers. This revealed no significant difference between the models derived for the Mersey and the Clyde. The Thames model, however, was shown to have a significantly different intercept from the other two rivers, although there was no significant difference between the gradients. It is thought that this may be explained by inter-observer differences, as the scoring system produced for the Thames study was difficult to apply to the Mersey cases, resulting in similar scores for cases with very different decomposition characteristics.

A further 21 cases were reviewed of human remains recovered from canals throughout Merseyside and Cheshire. Each case was scored using the system developed above and a regression model was applied to show the relationship between TADS and PMSI. When ANCOVA was used to compare this study sample with those from the three rivers, there was no significant difference between the canal, Mersey or Clyde models. The Thames model, however, was again shown to be significantly different to the other models.

These results indicate that the stages of decomposition and the rate of decomposition in relation to ADD are consistent across the UK rivers studied. It also suggests that a single model for estimating PMSI may be applicable to other aquatic environments.

Decomposition, Aquatic, Postmortem Interval

H47 Sealed for Your Protection, Part I: The Effects of an Unknown Corrosive Agent on Human Bone

Laura C. Fulginiti, PhD, Forensic Science Center, 701 West Jefferson, Phoenix, AZ 85007; Kristen Hartnett, PhD, Office of Chief Medical Examiner, Forensic Anthropology, 520 1st Avenue, New York, NY 10016; Frank Di Modica, Phoenix Police Department, 620 West Washington Street, Phoeniz, AZ 85003; and Diane Karluk, MD, Maircopa County Office of the Medical Examiner, 701 West Jefferson, Phoenix, AZ 85007*

Upon reading this poster, the participant will learn that human bone can be completely destroyed by exposure to corrosive agents such as muriatic acid.

The impact on the forensic community will be to raise the level of awareness regarding the detrimental effects of common household corrosives on human bone and teeth.

After attending this presentation, attendees will be aware of the potential corrosive effects of common household chemicals on human skeletal remains. Characteristics of the chemical and methods to determine the type used will be presented.

On July 7, 2001 a woman and her two children left home in Phoenix, Arizona to visit relatives in the Midwest. They never arrived. On August 21, 2001, the woman's husband was arrested based on blood and circumstantial evidence found at the residence. On April 1, 2002 he was convicted of three counts of first degree murder and given the death penalty.

For the next three years, a variety of tips poured into the Maricopa County Sheriff's Office regarding the location of the remains of the woman and her children. The lead author participated in several excursions to the house and surrounding desert areas to search for remains. Every skeleton recovered was thought to be the missing woman. At one point, the lead and third author were called to a county north of Phoenix to participate in the excavation of a mine where an informant claimed that the husband had said he dropped the body and covered them with tons of dirt and rock.

On October 19, 2005 a crew crating palo verde trees in order to relocate them discovered two fifty gallon drums submerged in the rocky soil. The first drum was badly damaged by the backhoe and the contents thrown to one side. When the second drum was uncovered, the backhoe caught the edge of the lid and flipped it off to reveal the contents. A woman's foot was sticking up out of the drum. When the workers went back to the first drum, they discovered that the material was human tissue. A third drum was discovered two weeks later after an extensive search. Sheriff's detectives assumed that the adult victim was the missing woman and that the other two drums contained her children. The lead, second, and third authors participated in all of the search and recovery phases for each of the drums.

The autopsy and subsequent anthropological and dental examinations of the bodies revealed that they represented portions of the missing victims. Age-at-death for the children was determined by radiographic and gross examination of the epiphyseal plates. The adult female received a standard anthropological examination and was subsequently circumstantially identified by dental radiographs. The original antemortem radiographs were flipped and therefore could not be used to establish positive identification.

The remains of the adult female exhibited both perimortem traumata and postmortem damage. They were fairly complete however the tissue and bone appeared to be corroded, as if by some form of acid. There was damage to the facial skeleton, the arms and the legs of the victim. The female child was represented solely by portions of the pelvic girdle and proximal femora. She too exhibited the effects of some sort of corrosive substance, particularly on the shafts of the femora. The male child was represented by six fragments of bone. They were also from the pelvis and femora, but had the appearance of tree bark.

In each of the areas where the drums were located, items of evidence supported the use of some type of corrosive material. There were numerous white plastic protective seals with "Sealed for your Protection" written across them; nine were recovered around the male child's drum alone. In addition, the adult victim's drum had breached into the soil and a large amount of

greenish, yellow stained earth was located around the bottom of her drum. This material had a ph of 3.34 (acidic) with mostly chloride ions, which could be consistent with hydrochloric or muriatic acid.

This poster presents the various aspects of this case including the search and recovery, the age-at-death determinations and the investigation of the corrosive material used to "dissolve" the remains. Ongoing research in the lab regarding the effects of different acidic materials on bone, teeth, hair, skin, tissue and muscle will be presented at a subsequent American Academy of Forensic Sciences meeting.

Taphonomy, Acid Etching, Skeletal Remains

H48 Mummification and Palynology: What We Can Learn in Regards to Time and Location of Death

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This research is dedicated to the amount of time it takes for the mummification process to take place in piglets, while being buried in different materials such as; a tarp, a rug, a plastic bag, and a fleece blanket. These piglets were documented periodically for changes in decomposition using soil analysis and also for pollen deposition. Acetolysis will be used to process and stain the pollen for identification and imaging purposes. It is has been proven beneficial to use swine in order to determine different aspects of the decomposition process which helps death investigators to accurately determine time of death issues. Also, checking different types of pollen present in different regions of Nebraska has been proven very beneficial in determining location and season of death as well. The piglets were buried in multiple locations around Omaha, NE. They were buried in Ashland, NE; Bennington, NE; Atkinson, NE; and Valley, NE. The soil types were identified and certain results regarding pH, conductivity, and moisture content were recorded. Currently, we are also considering lipid phosphate and fatty acid methyl ester analysis (along with nitrogen and carbon content) to give us more input concerning the certain soil changes that occur during the decomposition process. In the end, a timeline and pollen profile will be constructed based on the data obtained to help investigators understand the time it may take for small human victims to reach natural mummification status and also assist in determining the location (season) death.

Mummification, Soil, Pollen

H49 Forensic Osteology Research Station (FOREST): A New Facility for Studies of Human Decomposition

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Those attending this presentation will come away with an overview of Western Carolina University's new outdoor laboratory for decomposition studies and an understanding of the nature of the research that will be carried out in the outdoor laboratory. Attendees will learn why it is important for there to be more than one outdoor decomposition laboratory in the United States.

This work impacts the forensic community by its contribution to our collective knowledge and understanding of how humans decompose, how the timing of decomposition changes depending on the environment and how the environment is altered by decomposition. The forensic community will be further affected by this presentation because it includes a call for collaboration among researchers at other institutions with outdoor decomposition laboratories and those planning future decomposition laboratories.

One of the questions forensic anthropologists are often asked is: how long does it take a body to decompose? The answer depends on numerous variables many of which have to do with the environmental conditions in which the decomposition occurs. Observations of decomposing human remains can help us formulate an answer in a given location. In order to formulate answers applicable to broader areas we must focus on collecting decomposition data and associated environmental data in more than one or two locations so that patterns specific to physiographic regions may be identified. There is a need for at least one outdoor decomposition laboratory in each physiographic region of the United States. There is a need to identify classes of data that will be collected similarly in each region.

A new outdoor decomposition laboratory has been established in the mountains of Western North Carolina. It is touted in the popular press to be the second such facility in the nation although plans for several others are underway. The Western Carolina University outdoor laboratory has been dubbed the "FOREST" (Forensic Osteology Research Station). Its internal dimensions are roughly 17 meters by 17 meters and it is delimited by a wooden privacy fence and a chain link protective fence topped with razor wire. The FOREST is located in a rural area adjacent to Western Carolina University in Cullowhee, North Carolina on a 500+ acre undeveloped property recently acquired by the university. The surrounding terrain is mountainous and the facility is on a steep slope and is surrounded by and encloses moderately dense forest vegetation.

It is known that the environment affects decomposition and that decomposition changes the environment in the vicinity of a body. Prior to placing the first corpse at the FOREST an environmental survey of the interior of the facility and the area immediately surrounding it was conducted in order to provide baseline data of the plant and animal life present as well as soil composition and chemistry. Future plans include repeating this survey seasonally as long as the facility is in use.

Decomposition, Environment, Physiography

H50 Biomechanics of Blunt Ballistic Impacts to the Forehead and Zygoma

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Upon reviewing this poster, investigators will gain insight into previously unknown biomechanics governing the impact response and tolerance of the forehead and face to blunt ballistic impacts. Injury criteria will be explored to identify key engineering parameters linking specific fracture morphology to impact characteristics.

This presentation will affect the forensic community by offering a totally unique scientific data set on skull and facial fracture tolerance and morphology due to blunt ballistic impacts. Investigators will gain insight into the biomechanics of skull and facial fracture and be presented with a complete set of fracture morphology data with linked with biomechanical parameters measured through leading edge instrumentation. This data will assist investigators in forensic reconstruction of skull and facial trauma.

Circumstances leading to skull and/or facial trauma may not always be known due to the lack of witnesses, inability of the patient to recall or articulate the events that led to the trauma or patient death. A forensic biomechanist may be brought in to work with a forensic pathologist or a forensic anthropologist to relate the mechanics involved with causing particular types of fractures. He/she may perform evaluations of various impact scenarios using biomechanical surrogates and injury criteria to assess the likelihood of producing fractures that match the physical evidence. Unfortunately, the current biomechanical surrogates and injury criteria developed by automotive safety researchers fall short of providing necessary information for the reconstruction of specific fracture types due to a lack of controlled impact studies. Head injury criteria and biomechanical data are needed to extend the understanding behind blunt ballistic impact tolerance and for fracture-specific risk assessment. The primary goal of this research was the advancement of

fracture-specific head injury criterion for the assessment of localized blunt ballistic impacts to the forehead and zygoma.

Experimental impact testing was performed on five (5) isolated, unembalmed postmortem human subjects. Specimens were impacted to the frontal and zygoma regions of the face with a 38 mm diameter rigid impactor, launched via a ballistic air cannon. Specimens were instrumented with a nine-accelerometer array to document global head response. Local bone response was measured by Rosette-style strain gages attached to the outer cortical layer surrounding the impact sites. Soft tissue was left intact at the impact sites. Impact force was calculated from a 20,000 g accelerometer mounted to the rear aspect of the impactor. High speed video captured the impact at 10,000 frames per second. Post-test CTs were obtained along with detailed autopsies documenting resulting fracture patterns. Fracture criteria were explored through logistic regression analysis of measured parameters and compared with previously developed head injury criteria. Goodness of fit was evaluated by the chi-squared statistic, p-value and Nagelkerke R^2. Significance levels were set at $p < 0.05$.

Twenty (20) impacts were performed in total with ten impacts to the frontal bone and ten to the zygoma regions. Of the ten impacts to the forehead, fractures were produced in four cases. Fractures ranged from local linear to depressed, comminuted. Of the ten impacts to the zygoma, fractures resulted in four cases. Fractures were primarily of the "tripod" type in addition to comminuted fracture of surrounding bone. Peak fracture forces for the frontal bone and zygoma ranged between 4,413 to 9,438 N and 575 to 2,746 N respectively. Acceleration data from the array indicates that the skull does not respond as a rigid object under these loading conditions which limits the ability to utilize the nine-accelerometer array for estimating center-of-gravity acceleration. This indicates deformation-based measures should be investigated further in future experimental studies.

Logistic regression results indicate that strain-based measures were statistically significant predictors of fracture followed by acceleration of the head ($P < 0.05$). While impact force demonstrated increase risk of fracture with increasing force, this was not a statistically significant predictor of fracture.

Current biomechanical models are not equipped to measure skull deformation or strain. These measures are currently most effectively measured through finite element models. The basic biomechanical data from this study will first and foremost serve as validation for advancement of finite element models of the head to the blunt ballistic impact environment. Additional efforts can then be put forward into development of an advanced fracture-prediction model. The current results indicate that effort should begin with strain-based criterion for blunt ballistic forehead and facial fracture.

Biomechanics, Skull Fracture, Ballistics

H51 The Effectiveness of Papain in the Processing of Remains

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The goal of this presentation is to demonstrate the potential of the papain enzyme in the process of soft tissue removal.

This presentation will impact the forensic community by demonstrating a simple, non-aggressive method of soft tissue removal, with applications in both forensic investigations and osteological collection curation.

The removal of soft tissue to allow for direct examination of bone poses an important challenge to forensic anthropologists. The researcher is confronted with the issues of using a nondestructive method while remaining within time constraints. At present, the main alternatives available are based on maceration in either plain water or in solutions of chemicals or enzymes. True maceration in plain water is slow and infamously odiferous. Bleach or detergents serve both to speed the process and to mitigate the odor, but are much more aggressive to the bone tissue, requiring close monitoring. Heat treatment can be added to both types of maceration to increase reaction speed, but at the cost of significantly increasing their aggressiveness.

The present study tests the utility and efficiency of papain for soft tissue removal in forensic settings. Papain is a proteolytic enzyme (protease) derived from the papaya fruit (*Carica papaya*). Proteases are highly specific enzymes that induce protein decomposition (proteolysis), by promoting hydrolysis of the peptide bonds that link amino acids. Therefore, these enzymes would primarily target the protein content of muscle and connective tissue (ligaments, tendons, and cartilage), rather than the mineral or tightly packaged organic matrix of the bone. Papain offers the advantage of being a versatile enzyme with a multitude of uses, including medical applications in the removal of scar tissue or herniated discs, or as a component of household meat tenderizers. This translates in a widespread commercial availability and, importantly, in a moderate cost.

This experimental design was constructed to: (1) test the efficiency of a pure papain solution against those of other alternative solutions and a blank control, in terms of time and bone integrity, (2) assess the minimal effective concentration of papain required for significant tissue removal (an important factor in relation to the cost/efficacy ratio of the method), and (3) estimate the effect of papain concentration and time on bone integrity.

Nonfrozen store-bought chicken (*Gallus gallus*) legs were used as an animal proxy in this study. Chicken legs were selected for study due to their uniformity and availability, allowing for more effective randomization and larger sample sizes. Additionally, the lower density and relative wall thickness of avian bones, as compared to mammals, was expected to result in higher ratios of organic to mineral bone content, and therefore higher rates of enzymatic bone destruction. This confers a necessary conservative approach to the bone destruction estimates, in comparison to those expected in human remains for the same concentrations of the enzyme.

The chicken limbs were randomly assigned to different solutions of equal volumes of distilled water and varying concentrations of papain BioChemika powder from Sigma Aldrich, a solution of household meat tenderizer, and a control of water. All solutions were kept at a constant heat of 50°C. Soft tissues were manually removed at fixed times, avoiding the use of any aiding or surgical instrument, and the wet weight of the removed and remaining tissue (including bone) was recorded. Wet weight was also recorded before treatment, and wet and dry weights after treatment, in order to control for bone degradation in terms of weight loses.

Differences in bone degradation were tested through a repeated measurements ANOVA design, with initial wet and final dry weights as dependent variables. Time differences were assessed through a one-way ANOVA analysis of the times required for complete tissue removal. Finally, linear regression techniques served to assess the influence of papain concentration on time for complete tissue removals.

The results strongly suggest that papain maceration is a viable and efficient method for tissue removal, significantly reducing processing time and the risk of bone damage, deserving further research and application in forensic and curation contexts. The concentrations of papain necessary to obtain useful results place the method within a reasonable rank of cost-effectiveness, especially in those cases where bone integrity and time constraints play a significant role. Pending a more detailed study, a preliminary yet reliable processing protocol for papain is provided.

Papain, Maceration, Enzyme

H52 Beating a Dead Pig to Death: An Actualistic Test of Archaeological Assumptions

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After attending this presentation, attendees will understand how forensic taphonomy can inform archaeological interpretations of a specific type of anthropogenic mark on bone.

This presentation will impact the forensic community by demonstrating whether damage to human bone which has previously been attributed solely to the action of hammer and anvil could also result from trauma caused by interpersonal violence with stone weapons.

When anthropogenic abrasion is observed on the surfaces of fractured archaeological long bone specimens, this taphonomic feature is generally assumed to indicate that that the bone was absent of flesh at the time it was broken, allowing the tools to abrade the bone surface. Several archaeological investigations of human remains recovered from pre-Columbian, ancestral pueblo sites of the Southwest have concluded that the assemblages represent cannibalized remains (most recently, see White 1992; Turner and Turner 1997; Hurlburt 1999 and 2000; Lambert, Billman and Leonard 2000; Kuckelman, Lightfoot and Martin 2002). Abrasion of long bone surfaces along the fracture margins is among the suite of taphonomic traits which forms the basis of a cannibalism interpretation, with the assumption that this abrasion results from the use of hammer and anvil stone tool technology on defleshed human bone surfaces in order to exploit the marrow within (Turner and Turner 1999).

This research tests the hypothesis that vigorous assault to fleshed skeletal elements with a stone weapon can produce abrasion on long bone surfaces which mimics that caused by hammer and anvil breakage of defleshed bone. It is hypothesized that violent interpersonal conflict—in which a stone club is wielded with sufficient velocity to shatter the underlying bone—could cause similar bone surface abrasion as the weapon head tears through skin and muscle and makes contact with underlying skeletal structures.

It has been well established that modern analogues and experimental models can inform archaeological taphonomic interpretations (see for example Binford 1981; Bunn 1983 and 1989; Shipman and Rose 1984; Behrensmeyer, Gordon and Yanagi 1986; Blumenschine 1988; Fiorillo 1989; Gifford-Gonzales 1989; Pickering and Wallis 1997; Saul and Saul 2002). This actualisitic study used fleshed hind limbs of pigs (*Sus scrofa*) as analogues for human limbs, with one leg from each pair of limbs (n=5 pair) fixed vertically with pipe vises, in order to simulate the semi-fixed response of a weight-bearing limb. Each bone was struck with a replica stone club with force approximating a blow given during warfare, and recorded in digital video format. The five antimeres were manually defleshed, then cracked open over an anvil rock using a hammerstone replica, which was also recorded in digital video format. All specimens were then macerated in hot water and examined for abrasion. Observed abrasion was recorded, photo-documented, and compared to archaeological samples displaying putative hammer and anvil damage. Results supporting the hypothesis will suggest that taphonomic agents other than perimortem hammer and anvil breakage could generate this form of abrasion, whereas results rejecting the hypothesis will provide further evidence for the extant osteoarchaeological interpretation.

Taphonomy, Trauma, Archaeology

H53 Gunshot Residue (GSR) on Bone as a Potential Indicator of Gunshot Trauma in the Absence of a Bullet Wound Defect — A Noteworthy Observation

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Attendees will be shown a rib with fracture morphology consistent with blunt trauma that was produced by a bullet. Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Analysis (EDXA) is used to confirm the presence of gunshot residue (GSR) along the fracture surfaces, and serves to clarify fracture mechanism.

The use of an SEM and EDXA on bone fractures has the potential of impacting the forensic community by providing a means of determining whether a bullet was involved and a mechanism of trauma.

During a recent examination of skeletal case for bone trauma, a fractured rib was found with missing bone fragments. It was conjectured that the fracture resulted from gunshot trauma, but it lacked the characteristic bevel of an entrance or exit wound. An examination of the bone fracture surfaces with a scanning electron microscope was proposed to search for microscopic particles from the bullet (i.e., bullet wipe) as a means of confirming the mechanism of trauma. However, upon examination no metal residue was found. The question then became whether it is possible to fracture a bone with a bullet without leaving microscopic metal particles.

Pork ribs were used as a bone model. Each of four ribs, with approximately one inch of attached muscle, was placed inside a plastic bag and shot once at close range (i.e., 12 inches). The first three were shot with Remington .38 caliber, 158 grain, round nose lead bullets and the fourth with a Winchester .45 caliber, 185 grain, full metal jacket bullet. After each rib had been shot the muscle and as much of the periosteum as possible was physically removed. Each rib was then placed in a paper bag to dry in an incubator at 40º Celsius (approximately 104º Fahrenheit) for five days in preparation for the SEM. After the ribs were dry they were allowed to cool.

The fracture pattern on each of the ribs was examined to verify bullet direction. The intended path was through the plastic bag, through approximately one inch of muscle and then through the rib, passing from external to internal. The bullet defect in the first three ribs produced the expected entrance wound bevel. The bullet missed the fourth rib completely, but the bone was nonetheless fractured by the proximity of bullet. The bone was likely missed due to the obscuring, overlying muscle, coupled with the inaccuracy of the shooter (i.e., first author). Had these bones been recovered from a skeletal case, three of them would have been interpreted as gunshot trauma; however, the rib not directly impacted by the bullet would have likely been interpreted as blunt trauma. The fracture morphology of this rib defines areas of tension and compression indicating an external to internal bending and associate plastic deformation typically associated with slow loading.

Each rib fragment was placed in the Hitachi S-3400 SEM for visual analysis. The specimens were not coated with carbon or gold, as is the usual case. Although the four bones examined did not exhibit macroscopic evidence of bullet wipe, the surfaces near the fractures all exhibited microscopic concretions determined by the Oxford INCA Energy 200 Dispersive X-Ray Analyzer as lead, antimony and barium (i.e., GSR). GSR is a common finding on a shooter's hand or on other objects near the gun after firing, but it is surprising to find it on bone covered by muscle tissue and enclosed within a plastic bag. Additionally, GSR was present on both the entrance and exit side of the bone. The mixture of antimony, barium and lead from the primer may accompany the bullet as a vapor and eventually deposits on the bone as it cools.

This simple finding of GSR on both the entrance and exit side of the bone is both surprising and promising. The most obvious application of this observation—if borne out by future research—is its use as an indicator of bullet related trauma in bone fracture cases that may present as blunt trauma. Despite the forceful removal of soft tissue necessary to prepare the bones for this study, the GSR deposits remained intact. Future tests will be needed to determine whether GSR integrity on bone can be maintained through the decomposition process. With increased sample size, differences in amount or perhaps ratio of barium, antimony and lead could serve to indicate bullet direction. Observations, such as soot, stippling and powder residue, are currently used to estimate weapon to victim distance. Perhaps with additional research, GSR on bone could provide another means of determining weapon distance applicable to both autopsy and skeletal cases.

The use of an SEM and EDXA on bone fractures has the potential of impacting the forensic community by providing a means of determining whether a bullet was involved and a mechanism of trauma.

Gunshot Residue, Gunshot Trauma, Terminal Ballistics

H54 Use of Facial Indices for Comparative Metric Facial Identification After Parametrical Superimposition

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The goal of this presentation is to prove the somatic correspondence between the criminal and the suspect by means of a mixed superimposition image.

This study will impact the forensic community by demonstrating the possible use of facial indices for personal identification after a parametrical superimposition. The parametrical superimposition is a tested technique in which each suspect is positioned exactly in the same place and with the same posture assumed by the subject to identify, filmed during a crime, usually bank rubbery.

If parametric superimposition is positive and close up of the face of the rubber is available then it is possible to perform a metric analysis between the image of the face of the criminal and the image of the face of the suspect obtained at the end of the best mixed parametrized superimposition in order to have personal identification on statistic basis. Different parameters can be used for comparing metric analysis between analogous marked points on the two faces in comparison (absolute distances, relative distances, triangle perimeters and area, form factors, facial indices).

In a previous study we showed that no statistic comparison can be reliable unless prior parametrical somato-physical superimposition of the images of the subjects in comparison. At the current state of art, no comparison between facial indices can be accepted for identification purposes unless supported by positive findings in a prior parametric somato-physical superimposition.

It is also supposed in anthropology that facial indices are not influenced by head movements. As a consequence we decide: (1) to test the opportunity to use facial indices as metric parameters to compare the two faces obtained at the end of parametric superimposition, and (2) to determine if facial indices evaluated on photo are not really influenced by head movements, in order to justify a metric comparison even in the case of a not perfect parametric superimposition.

Materials and method: 20 subjects were invited to take up a precise series of different head positions and then filmed in two different times. Image acquisition was made, taking care to place each subject exactly on the same environment, position and attitude using the same lighting, filming equipment and technique. All the films were taken with diffuse, known studio lighting, using a professional video camera with variable focus fixed at a distance of about 4 mt. A prior superimposition, correctly carried out, was essential for the subsequent metric analysis of compared images. Two sets images of the face were taken for each subject from different facial angles (frontal, rotated 15° and 30° to the right and left, 20° flexion and 20° extension). In each images it was possible to identify accurately anthropological points such as glabella, nasion, gnathion, subnasal point, super and subauralis points, etc. The *height of the face* was measured as the distance between the nasion (the deepest point of the root of the nose) and the gnathion (the lowest point on the median sagittal plane of the front of the chin); the *height of the nose*, defined as the distance from the nasion to the subnasal point (apex of the naso-labial angle on the median sagittal plane); the *height of the chin*, defined as the distance between the stomion (the point where the median sagittal plane converges with the labial commissure, with the mouth closed) and the gnathion; the *height of the* ears, defined as the distance in a straight line from the apex of the helix to the lowest point of the lob). The following facial indices were thus calculated: Index X: (chin height/morphological height of the face); Index Y: (nose height/morphological height of the face); Index Z: (ear height/morphological height of the face).

The four facial indices were then calculated from each image; the aim was to verify if there were substantial statistic differences comparing the index values of the face belonging to the same subjects taken in different time and in the same position of the head and then to verify if there were statistical differences comparing facial indices belonging to the same subjects taken in different time and in different position of the head.

A dedicated program was used for the statistical analysis.

Results showed: (1) the high reliability of discriminated power of the facial indices for personal identification just for images of the two faces in comparison placed in the same attitude, (2) the poor reliability of discriminated power of the facial indices in personal identification for face images in different position.

These results stress the opportunity to use facial indices as metric parameters for personal identification in facial comparison only if a full positive previous superimposition is performed.

Personal Identification, Facial Index, Parametrical Superimposition

H55 Ancestry Informative Markers (AIMs) and Forensic Anthropologist's New Competition: Understanding the Theories, Methods, and Techniques for Allocating Ancestry in the Field of Forensic Genetics

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The goal of this presentation is to better understand the present technological ability of geneticists to determine population affinity of individual humans. A brief history of the field of genetic contributions to understanding human phenotypic and genotypic variation and its role within forensics will be discussed. In addition, the presentation will review the current standing of this new genetic competition for determining ancestry, while considering the differences and similarities of the anthropological and genetic methods and theories for making this determination. The presentation will also examine the future roles for both fields in determining population affinity of human remains while discussing the capabilities and limitations unique to each.

This presentation will impact the forensic science community by making attendees aware of the advances in the field of genetics that show potential for the ability to assess ancestry. Understanding the future roles for both anthropologists and geneticists in determining population affinity of human remains and the capabilities and limitations unique to each will aid in our understanding of one of the most complex questions in our field: ancestry, race, and morhpological variation.

The goal of this presentation is to update the forensic anthropological community on the advances in the field of genetics that show potential for the ability to assess ancestry. After this informative presentation, the audience will better understand the present technological ability of geneticists to determine population affinity of individual humans. A brief history of the field of genetic contributions to understanding human phenotypic and genotypic variation and its role within forensics will be discussed. In addition, the presentation will review the current standing of this new genetic-based technique for determining ancestry, while considering the differences and similarities of the anthropological and genetic methods and theories for making this determination. The presentation will also examine the future roles for both fields in determining population affinity of human remains while discussing the capabilities and limitations unique to each.

This new genetic technology called ancestry informative markers, or AIMs, and other types of population sorting genetics were originally developed for understanding population-based diseases or the prevalence of certain diseases in specific populations. Along with this research that utilized portions of the genetics sequence of populations, it became possible to look for genetic characteristics that were unique to each sampled population. With the discovery of these unique AIMs, the questions of race, region, and ethnicity have made their way into genetic studies. Sampling techniques, population boundaries, and preconceived ideas about race all play a major role in the interpretation of the genetic data. Additionally, the ethical

treatment of data and public access to the data are presently disputed topics. Current discussions in the field of population genetics focus on these issues and how to approach these topics with an air of objectiveness—something that forensic anthropologists have sought to attain for decades.

Though geneticist are far from reaching a conclusion, these dialogues often parallel those within forensic and physical anthropology surrounding race and morphological population variation. With the onset of a different field of expertise attempting to allocate and understand ancestry in the forensic context, it is the responsibility of the forensic anthropologist to understand how these assessments are made and how we can collaborate with the field of forensic genetics to initiate a more accurate understanding and ability of the allocation of ancestry.

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Ancestry, Genetics, Race

H56 Introduction to the Use and Limits of Elemental and Isotopic Analysis for the Forensic Provenancing of Unidentified Human Remains

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The presentation is focused on familiarizing forensic anthropologists with elemental and isotopic analysis of human remains as part of the special session "new technologies in forensic anthropology."

This presentation will impact the forensic science community by providing a basic understanding of what information elemental and isotopic profiling can and cannot provide. In this presentation, attention will be giving to sampling techniques, test design, calibration and validation of the instrumental techniques, risk factors, and methods for interpretation. A quick overview of the state of the art and the directions for future research will be included.

The ultimate goal in the investigation of unidentified human remains is establishing the identity of the individuals. DNA analysis and odontology are the only truly confirmative techniques but the identification requires reference samples and/or ante-mortem data. In cases where (initially) reference samples and/or ante-mortem data are not available geographical provenancing with environmental markers can provide the investigators with possibilities for more effective searching by excluding options.

Of the environmental markers with a systematic and documented geographical distribution, pollen and the bio-available elemental and isotopic markers from water, soil, plants and livestock are the most promising for forensic investigations.

Large scale systematic, roughly latitudal, spatial differences in the hydrogen and oxygen isotopic composition of rainwater and subsequently drinking water are transferred to humans and can be used for large scale geographical provenancing. Regional differences in bedrock geology, soil mineralogy and reflect themselves in the elemental and isotopic composition of regional food supplies which again are transferred to humans. In pre-modern populations with limited traveling and often local sourcing of food strong geo-chemical links can be observed with the regional elemental and isotopic profiles in the environment. In modern populations inter-regional travel and intercontinental sourcing of food can confound the theoretical characteristic regional fingerprints.

Although contamination of the remains during environmental exposure or burial can confound the interpretation of the results the same analysis can often also indicate if such contamination has actually taken place.

Consideration should be given to which parts of the remains will be sampled for analysis as different parts of the skeleton have different turnover rates and thus the analysis will give different results for different parts. Although the teeth are best preserved they will probably not be the best indication of the latest regional environmental background shortly before death.

Nutritional status, disease and sex may affect both the elemental and isotopic profiles, e.g., heamochromatosis affecting iron status and the natural iron isotopic composition.

Especially for the isotopic analysis it is useful to compare results to databases or spatial models and maps. However the test design and the analytical accuracy between different laboratories needs to addressed first and the effects on the interpretation needs to be assessed. A proper test design and investigation need also to deliver statements about the (spatial) uncertainty or likelihood of the results.

Examples will be given of this research in which we investigate how to bring together all relevant case information, e.g., DNA profiles, physical anthropological traits, elemental and isotopic information, palynology and other environmental markers in one regional Geo-graphical Information System which will allow a new level of complexity and thus also a new level of querying and ultimately interpretation and provenancing of unidentified human remains.

Forensic Anthropology, Human Provenancing, Geochemistry

H57 Extending the Biological Profile Using Stable Carbon and Nitrogen Isotope Analysis: Prospects and Pitfalls

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After attending this presentation, attendees will learn about potential contributions of stable carbon and nitrogen isotope analysis in forensic anthropology. This paper will highlight areas where stable isotope analysis can contribute novel information to the biological profile of unidentified individuals, and will address some practical and theoretical limitations of these applications.

This presentation will impact the forensic community by demonstrating a theoretical basis for applications of stable isotope analysis in forensic anthropology, and its potential for aiding in the positive identification of unknown individuals.

Although stable isotope analysis has been used extensively by anthropologists since the 1970s to examine diet and migration patterns in prehistory, it has had very limited use in forensic anthropology. Stable isotope analysis is a commonly used tool by other forensic chemists to trace the origin or composition of soils, drugs, tainted foods, and poached animals. These same principles can be used by forensic anthropologists to provide a more comprehensive biological profile of unidentified remains, especially when standard

methods of identification are unsuccessful. Although the biological profile typically consists of sex, age, ancestry, stature, and antemortem characteristics, stable isotope analysis can provide additional information regarding diet and migration history. Juarez[1] recently provided multi-elemental isotopic data using teeth from native-born Mexicans that may help to identify the birthplace for unidentified remains of border-crossers. Similarly, Regan et al.'s[2] multi-elemental isotopic study showed a high level of discrimination between dental remains of East Asian origin and those of U.S. servicemen and women, which has implications for identifying war-dead from past conflicts.

Isotopes are atoms of the same element that have the same number of protons but a different number of neutrons. Unlike radioisotopes, stable isotopes do not undergo radioactive decay over time, and thus record chemical signatures of biological and geological processes in nature. Isotopes of the same element are chemically similar, but react at different rates in chemical reactions due to differences in atomic mass. This results in the differential incorporation of one isotope over the other, a process known as "fractionation", which accounts for isotopic variation in nature. Stable isotope ratios are measured through mass spectrometry and values are reported relative to an international standard using the delta (δ) notation.

Information on human diets is usually acquired through the study of stable isotopes such as carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$), which are incorporated into body tissues and provide a chemical record of plant and animal foods consumed. Carbon isotopes in nature vary based on the different photosynthetic pathways (C3, C4, CAM) of plants, which are passed up the foodweb to humans. Nitrogen isotopes vary based on diet, habitat, and aridity, and can also record the trophic level of protein resources consumed. $\delta^{13}C$ and $\delta^{15}N$ values from bone record the average isotopic composition of the diet over the past 10-15 years of life. However, $\delta^{13}C$ and $\delta^{15}N$ values from dental tissues provide a permanent record of childhood diet as teeth are forming. Carbon and nitrogen isotopes from hair and keratin provide a more recent dietary record acquired during their period of growth.

Despite recent advances in isotopic applications in forensic anthropology, several limitations need to be addressed. The global scale of food exportation, popularity of bottled water, and lack of baseline information on modern populations are all limiting factors. Stable isotope data will continue to be most useful in cases where osteological indicators and contextual information suggest that an individual is non- native to the area in which they died. This paper will present data from case studies derived from prehistoric, historic, and modern contexts to highlight potential uses, abuses, and limitations of stable carbon and nitrogen isotope analysis in forensic anthropology.

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Stable Isotope Analysis, Forensic Identification, Biological Profile

H58 Studies in Isotopic Variability: Investigating Human Tooth Enamel

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After attending this presentation, attendees will learn about the various types and opportunities for isotopic variability within human tooth enamel studies. In particular issues of inter-tooth and intra-tooth variability, and sampling techniques will be discussed.

This presentation will impact the forensic community by investigating and highlighting the sources of isotopic variability in tooth enamel studies that are of most concern to forensic anthropologist performing isotopic analysis.

Stable isotope analysis has provided the forensic community with a powerful tool for determining region of origin and migrational patterns in modern populations. However, for forensic scientists isotopically analyzing region of origin in living populations sample consistency can be difficult to maintain. There are a number of scenarios that can affect the isotopic outcome ranging from dissimilar comparative samples to differing sample techniques. Creating baseline comparatives and even comparing samples between populations works best when samples are chemically similar (same tooth or bone type). Unfortunately, similar samples from a given population maybe difficult to obtain, and there are few studies on modern populations documenting the isotopic variability present within different teeth of a given individual or within the enamel of a given tooth. After attending this presentation, attendees will learn about the various types and opportunities for isotopic variability within human tooth enamel studies. In particular issues of inter-tooth and intra-tooth variability, and sampling techniques will be discussed. This presentation will impact the forensic community by pinpointing the sources of isotopic variability in tooth enamel studies that are of most concern to forensic anthropologist performing isotopic analysis.

Anthropologists have been using stable isotope technologies to investigate the dietary habits and migrational patterns of archaeological populations for decades. However, stable isotope analysis of modern humans within a forensic context is relatively recent. Since 2000, forensic anthropologists have begun to explore the application of stable isotopes to studies on migration and region of origin determination of modern populations. The isotopic analysis of modern forensic material presents unique obstacles previously non-existent within archaeological populations. For forensic anthropologist, investigating region of origin the major obstacles of concern are the isotopic effects of the modern diet, and sample population similarity. Each of these areas represents major points of potential variability within modern samples. . In addition to the inherent isotopic variability of modern samples, sample collection methodologies and mass spectrometry choices can contribute variation to value outcomes. Unfortunately, the literature contains few references investigating the effects of these obstacles for modern population studies. For researchers, understanding and investigating these obstacles is critical to the maintenance and reporting of quality science

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Stable Isotope Analysis, Variability, Tooth Enamel

H59 X-ray Diffraction (XRD) Analysis of Human Cremains and Concrete

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The goal of this presentation is to propose a new technology and method for the analysis of human cremains to distinguish between legitimate and contaminated ashes.

This presentation will impact the forensic science community by. The attendee will have increased awareness of x-ray diffraction technology to enhance the scientific analysis of powderized human cremains, which is the standard product of the crematory industry and which typically has no visually recognizable bone fragments.

In the continuing pursuit to objectively characterize human cremains and to identify those that have been substituted or contaminated, we have determined the mineralogy of cremains and Portland cement and a combination thereof using powder x-ray diffraction (XRD). Previous research used inductively-coupled plasma optical emissions spectroscopy (ICP-OES) to sort these same samples based on their chemical composition. The present study has demonstrated that, although chemistry is a good discriminator, the presence or absence of specific crystalline substances, as determined by XRD, may distinguish potentially contaminated cremains that were not identified as such by ICP. This methodology for analysis of cremains had not been proposed in the forensic anthropology literature at the time of the Tri-State Crematory Incident (February 2001, Noble, Georgia).

Powder XRD is used to measure the very small (angstrom-scale) dimensions between atomic planes in crystal structures, which serve to identify and characterize crystalline materials. Sample preparation requires only that the material be ground to a flour-like consistency (1 to 5 µ) and loaded into a sample holder. For the present study, using a Philips diffraction patterns were acquired for 5° to 90° 2θ radiation, and standard procedures PW1830/3550/3710 diffractometer, Cu K and analytical conditions. To identify crystalline substances, diffraction patterns were compared with the ICDD reference database.

Samples used for the present study include the known cremains of 8 adult humans (six white males, two white females) and one *Canis familiaris*, one questionable set of cremains returned from the Tri-State Crematory, one sample of Type I general purpose Portland cement, and one sample of a 50/50 mixture of known human cremains and Portland cement. All 12 samples were submitted to the XRD lab at UTC without any identifying labels, with only the knowledge that the samples include human cremains.

Peaks due to hydroxylapatite (56 peaks in combined reference patterns 24-0033, 09-0432, and 34-0010, 5° to 80° 2θ) dominate diffraction patterns for the eight samples of human cremains and that two of *Canis*. Numerous extra peaks (not matched by hydroxylapatite) in these patterns suggest minor abundances of lime, sphalerite, sal ammoniac, sylvite, or other phosphates, but have proven difficult to match with certainty and may reflect chemical and structural complexities of biological hydroxylapatite and its cremation-related alterations. Although the sample from the Tri-State Crematory was found to contain hydroxylapatite (Hap) and was classified as human cremains based on ICP analysis, it was also found in the present study to contain significant amounts of mullite (Mul), kyanite (Kya), and corundum (Cor), common ingredients of refractory furnace linings and patching products. Calcium silicates (Ca3SiO5 and Ca2SiO4) were identified in the sample of Portland cement; the absence of hydroxylapatite in this sample rules out the presence of cremains. Although the 50/50 mixture was not recognized as such in the blind analysis, it was suspected of being contaminated cremains based on the identification of hydroxylapatite and the undue complexity of the diffraction pattern (31 unmatched peaks, some prominent). Upon subsequent examination of diffraction patterns for the 50/50 mixture and its components, their relation is clear. These results are summarized below:

Sample #	Material	XRD Result (Identity)	Unmatched peaks)□(5° to 80° 2
1	human cremains	Hap	12
2	human cremains	Hap	5
3	*Canis* cremains	Hap	27
4	human cremains	Hap	12
5	human cremains	Hap	11
6	human cremains	Hap	12
7	Tri-State cremains	Hap, Mul, Kya, Cor	5
8	human cremains	Hap	16
9	human cremains	Hap	14
10	human cremains	Hap	14
11	Portland cement	Ca3SiO5, Ca2SiO4	6
12	50/50 #6/#11	Hap	31

In conclusion, powder XRD may be sufficient to discriminate cremains from those that are substituted or substantially contaminated. Undoubtedly, the combination of powder XRD, to identify crystalline substances, and ICP, to determine chemical composition, more perfectly authenticates cremains based on more complete compositional criteria. XRD is simpler in laboratory prep time, costs less per sample, and is widely available. These high-tech laboratory instruments, coupled with traditional anthropological methods (weight, color, fragments, artifacts) when applicable, take the analysis of human cremains to an unprecedented level of scientific objectivity.

Human Cremains, X-ray Diffraction, Hydroxylapatite

H60 Characterization of Lead, Transition Metal, and Rare Earth Element Composition of Human Bone by ICP-MS and LA-ICP-MS

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After attending this presentation, attendees will be better informed about the capabilities for compositional and isotopic analysis of trace elements in human bone by traditional ICP-MS techniques. The suitability of lead, strontium, and rare earth element isotopic compositions for geographical sourcing of human bones will be discussed. Lead isotopic analysis will also be used to differentiate between the anthropogenic sources of human lead exposure. Laser ablation ICP-MS will be used to provide spatial resolution of trace element concentrations within various bone tissues (cortical vs. trabecular).

This presentation will have an impact on the forensic science community by demonstrating the utility of trace element systematics, isotopic composition, as well as LA-ICP-MS techniques for the analysis of human bone.

Inductively Couple Plasma Mass Spectrometry has become an accepted method for highly sensitive, rapid, and reliable elemental analysis of human bones and biological tissue. Traditional ICP-MS techniques can provide accurate elemental composition at or below 1 ppb in human bones. In this study the utility of Laser Ablation (LA)-ICP-MS applications which can be used to provide rapid and accurate spatial determination of trace and minor element concentrations is explored. A second application will explore the ability of ICP-MS to determine the isotopic compositions of lead to determine the source of environmental lead in the body for trace elements (i.e., Pb, Sr, and REE).

Laser ablation ICP-MS, will be used in an attempt to provide finite spatial resolution for trace metal concentrations within human femoral heads. Previous research has established that the residence time of trace elements can vary by more than an order of magnitude depending on the type of bone tissue (i.e., Pb: trabecular: 2-3 years vs. cortical ~30 years). LA-ICP-MS

analysis has the ability to rapidly determine minor and trace element concentrations across bone transects. For this reason, it is expected that LA-ICP-MS determination of trace element concentrations (Pb, Cd, Zn, etc.) may be used to quantify and differentiate between long term, time-integrated trace element exposure versus more recent anthropogenic or environmental inputs.

Various geochemical isotopic techniques have been employed in attempts at forensic provenancing (Pb, Sr, O, C, N). The trace element isotopic values of Sr are predominantly a function of soil isotopic values in the areas where food is grown or animals graze or the water consumed. As humans consume food or water from a specific region they inherit the isotopic signature of a specific environment. The application of environmental typing techniques has become increasingly difficult as humans have expanded to a 'global' diet obtaining foods at grocers as opposed to farming or local markets etc. The use of two additional isotopic techniques of rare earth elements and Pb isotopes is proposed which may provide specific uses in forensic studies.

In a similar manner to strontium isotopes, rare earth elements (REEs) or lanthanides have distinctive isotopic patterns based upon the geological history of local soils. In many cases geological fractionation can lead to very identifiable REE isotopic patterns in geographical regions. Traditionally REEs have been thought of as having concentrations too low to have a significant use for biological investigations. ICP-MS analysis can provide accurate quantification of REEs at the low ppb level. The fact that REEs also have exceedingly low environmental concentrations with the exceptions of those used in highly specific medical procedures (Gd as a contrast-enhancing agent for magnetic resonance imaging and Sm as radionuclide therapy for painful bone metastases) provides the opportunity to use REEs for specific forensic applications. Unlike Ca or Sr which have fairly substantial concentrations in drinking water, REE concentrations are exceedingly low in drinking water and therefore are almost entirely indicative of food supply or medical procedure. REEs may provide an alternative method of addressing geographical provenance free of external environmental influences. REEs have also proven useful in older fossil analysis as REEs are more resistant to the effects of diagenesis unlike other environmental isotopes.

Unlike Sr, O, C, N, and REEs, the source of Pb to humans is largely environmental. The source and magnitude of trace metal exposure have changed in the last 30 years as environmental regulations have become more stringent (i.e., the removal of Pb from gasoline in the mid 70's and the removal of Pb oxide as a primary pigment in white paint). This study initially looks at Pb isotopic composition in cortical and trabecular bones. The authors expect that as the environmental sources of Pb have changed, we may expect to find isotopic variations between cortical bone and trabecular bone, with residence times of greater than 30 years and 2-3 years respectively for Pb retention. As the major sources of Pb contamination have been removed from the environment, cortical bone is expected to have high concentrations and a mixture of soil, gasoline, and lead paint Pb isotopic values. Conversely, trabecular bone formed in the last few years may have lower concentrations with isotopic values indicative of a mixture between modern lead sources (coal combustion, smelters, and a more significant input from natural soil lead). Initial results of Pb isotopic analysis of human bones from our study and others indicate a mixture of Pb from numerous environmental sources as well as geographic provenance which will be further explored. Pb isotopes can be useful for provenance in cases where subjects are from distinct geographic regions (i.e., Australia vs. U.S.) with specific Pb isotopic compositions. However, we intend to focus on the use of Pb isotopic compositions of anthropogenic sources as related to environmental exposure. The isotopic patterns of lead ores are distinct yet consistent and therefore can be used for environmental analysis and potentially forensic studies. For example until 1975 Pb was added to gasoline as an anti-knocking agent. As most refineries in the United States are near the Gulf of Mexico, Mississippi Valley lead ore deposits were used as the Pb source. The distinct isotopic composition of this lead ore has been used in various environmental studies to determine the source of lead and may be useful in forensic studies.

Unlike geological applications of Pb isotopes, which rely on accurately determining exceedingly small variations in isotopic composition, environmental, and forensic studies can differentiate source by using a three isotope plot (208Pb/206Pb vs. 207Pb/206Pb) of the stable radiogenic Pb isotopes. Utilizing all Pb isotopes allows for easy determination of drastically different isotopic values. Traditional geochemistry employs thermal ionization-MS with 0.05-0.1% analytical error. This method is expensive, which may be limiting to financially deplete departments. The method also requires complete specimen destruction. A comparison of lead isotopic data to traditional TIMS methods will be performed. Lead analysis by ICP-MS can achieve an analytical error ~1% and can easily differentiate between environmental sources of lead. This study will demonstrate the suitability of ICP-MS and LA-ICP-MS for a quick and reliable method of screening for both provenance and environmental isotopic variations of lead isotopes and trace element patterns.

Lead, Bone Chemistry, LA-ICP-MS/ICP-MS

H61 Comparison of Portable X-ray Florescence and Inductively Coupled Plasma Mass Spectroscopy in the Measurement of Lead in Human Bone

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After attending this presentation, attendees will be better informed of the use of portable X-Ray Florescence(pXRF) instrumentation in analyzing human bone for lead (Pb) concentration as compared to a traditional laboratory-based method of Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) and laser ablation ICP-MS (LA-ICP-MS).

This presentation will have an impact on the forensic science community by demonstrating the utility of portable instrumentation for rapid, non-destructive analysis of inorganic elements in human bone.

Portable XRF is a relatively new technology that has benefits of being non-destructive to specimen samples, easy to operate, and convenient to transport between laboratories or for use in the field. Portable hand-held units are routinely used in geology, scrap metal sorting, and environmental monitoring, most notably for the determination of unsafe levels of lead in soils and paint. XRF analysis in general is capable of giving a rapid reading of the elemental composition of inorganic material with good sensitivity for elements above phosphorus in the periodic table. Lead (Pb, Z = 82), for example, has a detection limit between 10 – 100 ppm. Additionally, the unit used in this study is built with a miniaturized X-ray source for atom excitation instead of a radioactive isotope, eliminating the need for special transportation permits as well as reducing the potential occupational exposure hazard of operators.

The goal of this study is to explore the reliability of pXRF results with those of a "gold standard" of inorganic analytical analysis in bone chemistry, ICP-MS. The study will also explore the utility of laser ablation ICP-MS (LA-ICP-MS). Traditional ICP-MS requires destruction of a sample and acid digestion prior to analysis, while LA-ICP-MS requires minimal destruction of <200um ablation spot size with extremely accurate spatial resolution of chemical composition. Both pXRF and ICP-MS provide simultaneous multiple-element results. This study will report results of lead (Pb) concentrations using both pXRF, ICP-MS, and LA-ICP-MS in bone samples (femoral head and neck) from patients undergoing hip replacement surgery for indications of either osteoarthritis or fracture.

Femoral heads were obtained from Highland Hospital and Strong Memorial Hospital Departments of Surgical Pathology after routine processing and pathologic diagnosis. The specimens of 60 patients were intercepted prior to discard with the approval of the University of Rochester Human Subjects Institutional Review Board. Patient information was de-identified and coded with a study number to preserve patient confidentiality.

The study group was divided evenly with 30 femoral heads with a diagnosis of osteoarthritis and 30 with a diagnosis of fracture. Bone sections were cut using an Isomet precision low-speed saw set at 300 rpm, resulting in a 3mm thick section of coronal plane of mid-femoral head. A section of cortical bone was removed from the femoral neck. Bone samples were dried in a 60 degree C oven for four days to a constant weight.

The portable XRF is automatically prompted for standardization prior to any sample analysis. To further check accuracy of the analyzer, a NIST Standard Reference Material (SRM1486) of bone meal was analyzed.

Portable XRF was performed on a sample of trabecular bone and cortical bone from each individual femoral head and neck. Analysis run times were set at 120 seconds per specimen. Pb concentrations were reported in ppm. ICP-MS analysis was performed on the same samples using clean lab procedures and standard acid digestion protocols. LA-ICP-MS was performed using a 266nm Nd:YAG from CETAC, USA. The NIST (SRM1486 bone meal) standard was analyzed by each technique. Results were reported in ppm. Discussion of the comparison of the pXRF, ICP-MS, and LA-ICP-MS results will be given in the presentation.

Portable XRF analysis of bone is an important tool in the arsenal of portable instrumentation available to anthropologists, archaeologists, odontologists, and crime scene investigators. A pilot study of the utility of portable XRF in analyzing cremated bones and teeth showed promising application. Portable XRF has shown to be of great utility in classifying inorganic components of restorative resins in teeth. This study is the first to report on the use of portable XRF instrumentation in the analysis of intact, relatively fresh human bone samples. The study is also the first to report on the reliability of the results via pXRF as compared to ICP-MS. The ease of use of the pXRF analyzer is attractive for applications of commingled remains, or the rapid analysis of a large number of samples, whether bone, teeth, or other material containing inorganic elements. The capability of the equipment to measure more than one element per analysis may show to be useful in constructing elemental ratios between different fragments of material, to perhaps establish provenance to a single individual. This presentation will only focus on the inorganic element of Pb, with bone serving as the biomarker of environmental exposure.

Portable X-ray Florescence (pXRF), Lead (Pb), Bone

H62 Species Identification of Fragmented Bone: Evaluation of a New Method of Pyrolysis and X-ray Diffraction Analysis

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After attending this presentation, delegates will have been introduced to the method of pyrolysis and X-ray diffraction analysis for species identification of bone.

The presentation will impact the forensic community through the availability of a quantitative analytical technique for species identification and is of interest to a wide range of forensic investigators. It is relevant to a wide range of forensic situations such as murder investigations, mass fatality response, customs investigations, quality assurance of crematoria practices, and quality assurance of animal feed production.

When bone is recovered in forensic scene examinations or confiscated through customs investigations, the establishment of species identity is often crucial. In most cases, this is achieved by identifying unequivocal morphological features of a particular species on the recovered bone. However, species identification can be challenging when bone lacks any distinguishing morphological characteristics. Such situations arise, for example, with severely fragmented or powdered bone. In these cases, the limitations of the existing techniques that are currently available to forensic investigators restrict their success at species determination.

This paper introduces a new means of species identification of bone; a combined method of pyrolysis and X-ray diffraction analysis. Research and development of this technique has shown that variation in the crystallographic characteristics of bone mineral exist between different animal species. Human bone, in particular, is distinct from that of other species studied. The method quantitatively discriminates between species based on this variation in bone mineral chemistry.

The results of this research are evaluated and discussed with particular consideration of inter and intra species variation. The potential value of the method is also discussed in comparison with other techniques currently available to forensic investigators, in the context of their validity, reliability, and relevance as evidence in court.

Species, Identification, Bone

H63 Estimating Body Mass From Bone Mineral Density of Human Skeletal Remains

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The goal of this presentation is to enable forensic anthropologists to estimate body mass from human skeletal remains.

This presentation will impact the forensic science community by showing a strong correlation between body mass and bone mineral density of the proximal femur and significant differences between different weight classifications for white females.

This research explores the relationship of body mass and bone mineral density of the proximal femur using Dual Energy X-ray Absorptiometry (DEXA). The ability to estimate body mass from the human skeleton has received considerable attention, but previous research has failed to take into account extremes of body mass due to the restraints of the research collections. The William M. Bass Donated Skeletal Collection at the University of Tennessee, Knoxville offers a unique opportunity to study modern individuals of known age, height and weight.

According to functional morphologists, bones need to be light enough for locomotion but strong enough for support. Bones must be strong enough to support the body mass of the ambulatory individual or otherwise fracture. As individuals become obese or emaciated, this relationship becomes exaggerated. The authors propose that body mass will correlate well with bone mineral density and could be used to estimate the body mass of unidentified human remains.

Our research focuses on the proximal femur of a sample of skeletal remains of 23 modern white females between the ages of 32 and 84 with a mean age of 58. Height and weight data was available for all individuals to determine the body mass index (BMI)(kg/m2). All femora were cleaned and dried. Each femur was placed in a plastic container filled with dry white rice to a depth of approximately 12 cm. The rice served as a soft-tissue density equivalent for the DEXA scans, as suggested by GE, the producer of the DEXA Lunar scanner. A 2 cm thick cube of low-density foam was placed under the lesser trochanter to approximate anatomical position.

Standard measurements of bone mineral density (BMD)(g/cm2) were calculated automatically for the femoral neck, Wards triangle, the greater trochanter, proximal shaft and total BMD. The Pearson correlation coefficient for total BMD and BMI is $r = 0.73$ and for the proximal femur and BMI, the correlation is $r = 0.75$. ANOVA and two-tailed paired t-tests were used to evaluate whether significant differences existed between different weight classifications. When comparing obese (BMI>30) individuals to emaciated (BMI<18) individuals, the results were significant ($p<0.05$) at all locations. When comparing obese to average weight individuals, higher values were found for total BMD, greater trochanter and for the proximal shaft.

In conclusion, bone mineral density has a strong correlation with body mass in the proximal human femur for white females. These results support previous research by the first author, which showed a strong correlation (r = .82) between BMI and cross-sectional area of the femoral mid-shaft. It was unexpected to get such a high correlation in the current research without controlling for age. Furthermore, there are significant differences in bone mineral density between different weight classifications in white females. This correlation may not exist in males, as males tend to have vocations or avocations that require heavy lifting. To simplify this analysis, we chose only white females. Future research will explore density patterns in males and non-whites.

When unidentified human remains are found, it is the responsibility of the forensic anthropologist to estimate age, sex, stature, and ancestry in order to narrow down the possible matches to missing persons. With the prevalence of obesity in our society, the ability to estimate body mass from the skeleton would add one more useful tool for the forensic anthropologist to establish identification. Furthermore, this research could be applicable to the bioarchaeologist or paleoanthropologist to reconstruct past cultures.

Body Mass Estimation, BMD, DEXA

H64 Preservation of Skeletal Collections: The Viability of DNA Analysis After the Application of Chemical Preservative

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The goal of this presentation is to demonstrate that the application of instant glue or cyanoacrylate can help to prevent damage to teeth in skeletal collections without preventing subsequent DNA analysis.

This presentation will impact the forensic community by providing a way to help preserve essential skeletal collections for future study.

Skeletal collections are essential to forensic anthropologists and are used to establish criteria for the examination and identification of forensic skeletal cases. Vital information regarding population variation can be ascertained to determine biological guidelines regarding age, sex, stature and affinity. Reference collections therefore must be preserved for continued research and assessment.

The Department of Anthropology at The University of Tennessee, Knoxville houses modern skeletal collections containing roughly 700 individuals. These Forensic and Donated Skeletal Collections were initiated by Dr. Bill Bass in 1972 and 1981 respectively. Each year these collections are examined by researchers from around the world and have provided data to establish criteria for the identification and analysis of forensic skeletal cases. The importance of these collections and others like them is well documented in the hundreds of journal articles and scholarly presentations generated from the study of these curated skeletons. Unfortunately, because of the antiquity of some of the samples, preservation concerns have arisen. In particular, cracking and breaking of the teeth of older specimens has been observed.

Instant glue or cyanoacrylate can help to prevent damage and degradation of teeth in skulls that undergo a great deal of handling such as those in study and reference collections and like those used during facial reconstruction. While cyanoacrylate protects teeth from successive damage, it is unknown if its chemical presence will preclude other types of future analyses such as DNA testing. This project investigates the viability of subsequent DNA analysis from teeth after the application of cyanoacrylate for preservation.

The DNA from twelve teeth was examined. Six teeth were treated with cyanoacrylate and six teeth were untreated to serve as controls. Each set of teeth consisted of two incisors, two premolars and two molars. DNA was extracted using a silica/guanidine thiocyanate extraction procedure. DNA was quantified by qPCR as well as gel electrophoresis. Mitochondrial DNA sequence analysis was performed for each of the teeth to examine the quality of DNA after treatment as well as to assess any potential contamination contributed by researchers. Strict controls were employed to preclude and detect external DNA contamination.

The quantity of DNA amplified from untreated samples was greater than the DNA from treated samples. Most likely a portion of the cyanoacrylate is not alleviated during the extraction process and carries over into PCR analysis and having an inhibitory effect on amplification. Although treated tooth samples had a diminished DNA quantity, all teeth were successfully analyzed. Mitochondrial DNA sequence analysis was possible from both untreated and treated teeth. Extraction and PCR blanks were void of signal and sequence data did not match that of any researchers involved in the study.

Skeletal Preservation, DNA, Teeth

H65 Forensic Bone Toxicology

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The goal of this presentation is to introduce a new direction in bone chemistry research that aims to identify what types of drugs or toxic metals are recoverable from skeletonized remains and how their presence and/or concentration will benefit medicolegal death investigation. The audience will learn the history of published research and case reports on this subject, as well as the development of a pilot study on how drug use affects skeletal and dental health.

This presentation will impact the forensic community by identifying new toxicological data that can be obtained from skeletonized or badly decomposed remains. Such information can aid victim identification and/or determining circumstances surrounding the manner of death. The impact of chronic drug use and abuse on systemic skeletal health has significant clinical applications and will likely benefit future anthropological evaluations of remains in a medicolegal context.

Many forensic anthropologists agree that future research needs to elucidate the meaning of the molecular structure of hard tissues. The application of stable isotopic bone chemistry, for example, to the identification of geographic origin of deceased Mexican immigrants (Juarez 2007) or potential U.S. war dead (Beard and Johnson, 2000), is a novel use of an investigative tool long used in bioarchaeological research. Bone biochemistry changes continuously from birth to death because of its role in mineral homeostasis, acid-base balance, responses to changing mechanical forces, and hematopoiesis. In addition to digestive byproducts, bone can incorporate drugs and/or their metabolic byproducts as well as trace metals from blood, although the pharmacokinetics of their distribution and uptake into the organic and inorganic phases of bone are not understood.

The first anthropological application of "forensic bone toxicology" of which the author is aware is the case summarized by Stout and Ross (1991). With only small bone fragments recovered, Dr. Stout employed microscopic and histomorphometric techniques (Milch et al. 1958) to identify tetracycline (an antibiotic) incorporated for some length of time into the victim's bones. DNA ultimately confirmed identity of the victim, who had taken the drug for several months prior to her murder. Other forensic reports of finding drugs in bone samples are limited. The only published summary of drugs recoverable from bone is McIntyre et al. (2000). Noguchi et al. (1978), who showed that amitriptyline could be recovered from bone, thus confirming that the decedent had committed suicide, published the first paper urging others to analyze skeletal remains for toxicological evidence. Subsequent published case reports mostly document intentional or accidental drug overdoses. These reports include Terazawa and Takatori (1982; aminopyrine, cyclobarbital), Benko (1985; amobarbital, glutethimide), Bal et al. (1989; dextropropoxyphene, chlorazepate potassium), and Horak and Jenkins (2005; citralopram). Chronic alcohol abuse also can be assessed from rib marrow soon after death (Schloegl et al., 2006). Case studies on overdose and

homicide victims buried from seven months to five years show that drugs can still be recovered from bone and/or marrow despite a lengthy postmortem interval (Terazawa and Takatori, 1982; Kajima et al., 1986; Kudo et al., 1997; Maeda et al., 1997; Raikos et al., 2001). Acute metal toxicity has also been determined from bone (aluminum, de Wolff et al., 2002; fluoride, de Menezes et al., 2003; lead, Lech, 2005). Controlled animal studies indicate that certain benzodiazepines (midazolam, Gorczynski and Melbye, 2001) and morphine (Cengiz et al., 2006) can be recovered from bone/marrow. Additional references for bone marrow research using animal models are listed in Schloegl et al. (2006). Bisphosphonates are the largest class of drugs that target bone mineral, but their use is widespread and less informative to forensic investigation (Russell and Rogers, 1999).

Chronic substance use can have systemic effects on skeletal health in living patients. This presentation will address how the long-term use of alcohol, nicotine, statins, NSAIDS, antidepressants/-epileptics/-psychotics, heroine, methamphetamines, and other drugs adversely affect skeletal health in addicts. A developing research project will be outlined. Because drugs can be detected in bone, anthropologists should pursue toxicological analysis of skeletal remains. Further research is needed to assess bone pharmacokinetics, the diagnostic value of bone-drug concentrations, and the effects of the postmortem interval. Skeletal and dental pathology caused by chronic substance use might one day be recognized in human skeletal remains.

Bone Chemistry, Toxicology, Drugs

H66 In Vivo Facial Tissue Depth Study of Adult Chinese Americans in New York City

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After attending this presentation, attendees will understand the basic principles of facial soft tissue depth studies, differences between facial soft tissue depth studies by populations, anatomical differences between Chinese-Americans and other American populations, and the elements and applications of forensic facial reconstructions.

This presentation will impact the forensic community by providing key information to help identify remains from the underrepresented Chinese-American population in the American forensic community.

The Chinese population has increased dramatically in the urban areas of the United States in the last five years. Despite this increase in population size, facial tissue depth information is limited for the population. As a result, when forensic facial reconstructions are created for Chinese individuals, datasets for other Mongoloid populations must be used. Previous studies have shown that different racial populations have varying facial tissue depth and this practice can result in inaccurate reconstructions that diminish the possibility of a positive identification. It is detrimental that each racial population has their own facial tissue depth dataset.

Forensic facial reconstructions are created by forensic artists as a means of identification of skeletal remains when other conventional methods to produce an identification are unsuccessful. Traditional American methods of creating three dimensional facial reconstructions require the use of facial tissue depth datasets. Facial tissue depth datasets comprise of measurements collected at various facial landmarks. The number of landmarks used in data collection and facial reconstructions are at the forensic artist's discretion. Some researchers obtain measurements from as few as 14 to as many as 54 facial landmarks for their datasets. Rubber markers are placed at the landmarks and clay is placed around the stoppers and slowly built up to resemble a human face. Soft tissue areas such as the nose and the ears are open to artistic interpretation.

Various methods have been employed to collect facial tissue depth data. The oldest and most commonly used method for facial tissue depth data is the needle puncture method. Sooted needles are inserted into facial landmarks on cadaver subjects and the portion of the needles without soot is measured. Variations of the sooted needle method, including the needle and rubber stopper method, were used to collect facial tissue depth measurements. In recent years, ultrasound, CT, and MRI techniques have replaced the more traditional needle methods. In addition to these new techniques, cadaver studies were abandoned in favor of using live subjects. The use of live subjects for data collection produces accurate measurements and subsequently, more exact facial reconstructions. In vivo datasets are the measurements of living individual whereas cadaver datasets try to mimic living individuals using measurements taken in the prone position and from recently deceased individuals.

The subjects of these facial tissue depth studies range in weight, body mass index, and age. The first studies divided the subjects into three weight categories: emaciated, normal, and overweight individuals. Emaciated individuals have the thinnest facial tissue whereas overweight individuals have the thickest facial tissue. The weight categories are divided using the body mass index. Age categories are divided at the researcher's discretion, usually spanning ten years.

The authors will present an in vivo adult New York City Chinese-American facial tissue depth dataset. The dataset consists of measurements from 101 individuals and 67 of the individuals are of normal weight. Normal weight is identified as individuals having a BMI of 19-25, as designated by the Center for Disease Control. The individuals range from ages 18-90. The results of the study show noticeable differences between the Chinese individuals and those of other racial populations.

Forensic Facial Reconstructions, Chinese Americans, Facial Tissue Depth

H67 Who Is This Person? A Comparison Study of Current 3-Dimensional Facial Approximation Methods

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This presentation will provide insight into the current state of the field of facial approximation by providing the results of a unique three-dimensional study conducted on a living individual by an international team of human identification specialists. The results of the clay modeling and advanced computerized facial approximations will be compared both visually and quantitatively. The strengths and weaknesses in each method will be addressed and comparison images will be provided.

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 cranial identification. It will also attempt to advance current understanding of facial approximation methods which are commonly utilized by law enforcement to identify unknown individuals.

The goal of this project was to test current three-dimensional facial approximation methods currently used by forensic identification researchers and specialists.

Facial approximation is a common tool utilized in forensic human identification. Three-dimensional imaging technologies allow researchers to go beyond traditional clay models to now create virtual computed models of anatomical structures. The goal of this study was to compare the accuracy of available methods of facial approximation ranging from clay modeling to advanced computer facial reconstruction techniques.

Anatomically accurate virtual models of both the skull and of the surface contour of the face were computed from CT image data of the head

region of a living individual. The individual was CT scanned and the volumetric data from the scan was taken into the visualization software *Mimics* (© Materialise). A FloodFill method of seeding the image was done to select only the bone pixels in the data set. This 3-D volumetric pixel grouping was then filtered of artifact holes and closed to create one unsegmented structure. The data set was then rendered into a 3-D Model and exported as a Stereolithographic file (STL). The virtual facial approximation participants were provided with the STL files and a standard biological profile determined by a forensic anthropologist. Virtual models were created using *3ds Max* © (v.9). An accurate full size prototype of the skull was then produced from the computed virtual skull model using a 3D ZPrinter 310 (© ZCorp) printer which was then submitted to the clay model specialist.

A face was constructed on the skull prototype by an experienced, professional forensic visual identification specialist from the Federal Bureau of Investigation using traditional clay facial approximation techniques.

Virtual facial approximations were also produced using two computer-based techniques. One method, utilized by law enforcement in the United Kingdom and developed by experts at the University of Sheffield, uses the software package, *3ds Max* © (v.8) to create virtual clay models over the skull. The other method in this study tested the FBI's new facial approximation software program, *Reface* ©.

In the University of Sheffield's *FaceIT* method, the skull image obtained from the CT was imported into *3ds Max* © (v.8). A plane was constructed and placed to represent the Frankfurt Horizontal Plane to enable standardization of views. Tissue depth markers, represented by pyramids, were placed at 32 craniometric landmark points on the skull. Based on the anthropologist's biological profile, the depths were taken from previously established data sets for the corresponding individual's profile. A prefabricated facial muscle set was then scaled and deformed to match the morphology of the skull. Other anatomical features such as the eyeballs, lips, and ears were also imported from a feature data bank based on established anthropological characteristics.

A visual information specialist from the Federal Bureau of Investigation was enlisted to test their most current computerized facial approximation method, *Reface* © software. The FBI's software imports the STL files and creates a mask over the virtual skull based on a database of standard craniofacial features. The software package allows the user to make adjustments to the mask on a sliding scale for age and weight.

The results from all three methods (clay and virtual) were compared visually to each other and collectively to the actual features of the living individual to determine the level of accuracy and detail that each provided. A quantitative study was also conducted to establish the accuracy of each method. This project demonstrates the wide range of variation between commonly used facial identification methods. The benefit of this study was having a living individual to test the strengths and weaknesses of each method. Resulting images and models will be available for conference participants to review to provide additional input into our evaluation process.

Facial Approximation, 3-D Modeling, Human Identification

H68 Advances in Computer Graphic Facial Recognition Software: Matching Facial Approximations to Antemortem Photographs

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After attending this presentation, attendees will understand the introductory nature of automated facial approximation technologies and the use of facial approximation software in comparative isolation of images from large photographic image data sets to identify unidentified human remains.

Conventional facial approximation techniques suffer from a range of subjective inaccuracies that prevent human observers from accurately identifying an approximation with a known photograph of the victim. The use of automated facial recognition technology to analyze automated facial approximations will eliminate much of the subjectivity from the traditional process and strengthen the reliability of identifying unknown remains.

A recent Bureau of Justice Statistics preliminary report states there are over 40,000 sets of unidentified human remains curated by medical examiners, coroners, and forensic anthropologists in the United States.[1] Additionally, hundreds or thousands of mutilated/disfigured and/or decomposing remains may result from genocide, warfare or mass natural or human-made disasters. Traditional methods of facial approximation are unable to effectively address these issues. Clearly, there is an urgent need to be able to systematically and correctly process large numbers of victims in a cost-efficient and expeditious manner.

One such method in development is a computerized facial approximation system termed ReFace (Reality Enhancement Facial Approximation by Computational Estimation). Developed by the Federal Bureau of Investigation with General Electric Global Research, the prototype extrapolates an approximation of a face from a skull using a database library of computed tomography (CT) scans of living individuals. The purpose of this collaboration was to determine whether facial recognition software could more accurately match computer images with antemortem photographs than could be achieved by human examiners. Previous research has tested the success of the subjective human examiners in matching ReFace generated approximations with antemortem photographs.[2]

Facial approximations from 50 skulls from the William M. Bass Donated Skeletal Collection at the University of Tennessee were prepared using prototype facial approximation software. Antemortem photographs of the test subjects were added to the photographic database of the facial recognition software. Each facial approximation was entered into the facial recognition system as an "unknown" with the anticipation that the actual antemortem photograph of test subjects would be selected as a potential match by the facial recognition software.

The results were analyzed by those not involved in the approximation preparation or with the recognition testing. These results and the applicability of this method for forensic casework will be discussed.

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Facial Recognition, Facial Approximation, Computer Prototype

H69 Accreditation of the Small Skeletal Laboratory: It is Easier Than You Think!

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Upon the completion of this presentation, the participants will have a greater understanding of the importance of accreditation to the small skeletal laboratory, problems faced by laboratories working toward accreditation and effective work-arounds and solutions. Effective management strategies employed during the accreditation process, and the assistance available from the CIL in order to obtain accreditation. Additionally, the participant will gain an appreciation of the importance of accreditation in elevation the forensic anthropology profession.

This presentation will impact the forensic science community by demonstrating how quality assurance programs in forensic laboratories and activities have been a growing trend over the past decade. Since 1999 the

Joint POW/MIA Accounting Command, Central Identification Laboratory (JPAC-CIL) has implemented a stringent quality assurance program to ensure the scientific integrity of its casework. The CIL's quality assurance program ultimately led to the Laboratory's accreditation in trace evidence by the American Society of Crime Laboratory Directors Laboratory Accreditation Board (ASCLD-LAB) in 2003–the first forensic skeletal identification laboratory to be so credentialed. However, smaller skeletal laboratories, lacking the resources of the CIL, have been reluctant to undertake accreditation. Assistance and guidance outlined in this presentation may ease their accreditation process. Once additional skeletal laboratories are accredited, human identification can become a separate recognized discipline within ASCLD-LAB.

Accreditation of forensic laboratories is becoming the norm in the forensic profession with some jurisdictions now legislating accreditation. With accreditation becoming almost universally accepted in the forensic profession, failure to achieve this milestone may have serious jurisprudence implications for deficient laboratories in the coming years. The human identification profession and forensic anthropology in particular, has lagged in efforts to have its laboratories accredited—with one notable exception.

Since 2003, the Joint POW/MIA Accounting Command, Central Identification Laboratory (JPAC-CIL) has been accredited under the American Society of Crime Laboratory Directors Laboratory Accreditation Board (ASCLD-LAB). The CIL sought accreditation for the following reasons:

- To improve the quality of CIL services provided to the POW/MIA mission.
- To develop and maintain criteria that can be used by the CIL to assess its level of performance and to strengthen its operation.
- To provide an independent, impartial, and objective system by which the CIL can benefit from a total operational review.
- To offer to the POW/MIA mission and to other users of CIL services a means of determining that the CIL has met established standards.

Admittedly, the CIL was in a very favorable position to achieve accreditation relative to other skeletal identification laboratories. This research had ample budget, support from the higher echelons of command, and a management staff dedicated to the effort. As such, numerous obstacles were surmounted, including but not limited to:

- SOP writing and implementation
- Security upgrades
- Facility improvements and expansion
- Hiring of a full time Quality Manager and additional staff to offset declines in productivity
- Equipment modernization
- Available time
- Progressive attitude of those involved

During the initial accreditation process, and in the intervening years now leading to re-accreditation, the CIL gained an appreciation to just which obstacles are the most formidable for the smaller laboratory. The findings are surprising. All of the above obstacles have relatively easy and inexpensive fixes and uncomplicated work-arounds. Save one—the quality and quantity of staff involved.

In this regard, the smaller laboratory has the advantage. A small staff with little annual turnover is easier to train, monitor, and to exercise corrective action over. In the CIL, with a staff of over 70 frequently deployed personnel (including managers), and an annual turnover rate of 12-20 %, accreditation becomes increasingly difficult as management involvement with accreditation becomes diluted in favor of other issues. This is exacerbated by the fact that laboratory policies and SOPs naturally become more intricate as the quantity of staff increases. Add the fact that CIL case work (and human identification, in general) is more diverse than other forensic disciplines. Taken together, training is consistently a problem as there is almost no instance where the entire staff can be assembled and trained more than superficially on the current SOPs. In effect, as staff size increases, control is lost, in favor of a "herding cats" scenario.

Other obstacles noted above seem formidable but chances are the small skeletal laboratory already has rudimentary systems and programs in place that would only need minor adjustments to bring them into compliance for accreditation. For example, existing intrusion detection systems (IDS) on university buildings may lend themselves to relatively inexpensive upgrades to achieve the desired standard. One university related that they already had an IDS in order to keep unauthorized persons from tampering with their x-ray machine. This university imposed safety requirement was adapted to evidence security. Evidence was eventually stored in a locked cabinet co-located in the room with the x-ray machine. Laboratories situated on the second floor or above do not need bars or similar barriers on the windows in most instances. These types of work-arounds are numerous and widely varied and, are limited only by the imagination of the staffs involved.

As the CIL continues to expand it quality assurance programs, to include seeking re-accreditation under the more stringent ISO 17025 standards, new sets of problems are generated. One is the issue of the competency of its subcontractors. Under ISO, the CIL is responsible to prove the competency of those it selects to subcontract tasks. Accordingly, the CIL has a certification program where we send our staff to certify the quality of operations of a subcontractor by conducting an on-site survey of their facilities and operations.

For smaller skeletal laboratories that have the potential to act as a CIL subcontractor, the certification program is a valuable tool with which to achieve accreditation. Using ASCLD-LAB standards, the CIL will survey your laboratory and provide guidance and advice on what need to be done to achieve accreditation. A certification by the CIL means that the assisted laboratory can perform subcontracted work for the CIL and only has minor obstacles to over come to achieve full accreditation. In addition to sending teams to your laboratory, the CIL will help your laboratory get started by making its laboratory manual available to the participants. This will improve the quality of your laboratory from the onset while saving your organization hundreds of man-hours in work and staffing.

In conclusion, the CIL believes it is in the best interests of the small skeletal laboratory to become accredited. Many of the staff in these facilities eventually become employed at the CIL. Additionally, until the qualifications of obtaining diplomate status in ABFA become more inclusive and less exclusive, working in an accredited laboratory may be the only professional credentials enjoyed by the majority of anthropologists. Finally, ASCLD-LAB is amenable to adopting Human Identification a recognized discipline provided more skeletal laboratories become accredited. Once this is done, anthropologists will have a stake in formulating the criteria for accrediting skeletal identification laboratories.

Accreditation, ASCLD-LAB, Central Identification Laboratory

H70 Testing the Demirjian Method and the International Demirjian Method on an Urban American Sample

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After attending this presentation, attendees will understand how to use the Demirjian[1] dental aging method for subadults and the international Demirjian[2] dental aging method for subadults, as well as, understanding the validity of using the Demirjian method in America.

This presentation will impact the forensic community by widely introducing a validated subadult dental aging method for the biological profile that works when ancestry is unknown. It will also highlight a subadult aging method that is commonly used by forensic anthropologists in Europe,[3] but that is not well known in the United States. Hopefully, this will lead to more integration of forensic anthropology techniques in the future.

It is important to start testing the validity of the methods commonly used in forensic anthropology and begin to quantify their effectiveness. The Demirjian method[1] of subadult aging was based on a French-Canadian sample and the international Demirjian method[2] of subadult aging was developed using a sample composed of Australians, Belgians, English, Finns, French, French-Canadians, South Koreans, and Swedes. The international

Demirjian method[2] was created for instances when ancestry was unknown. The international Demirjian method was also examined in this study to see if it was appropriate for the USA. The aim of this study was to test the applicability of the both the Demirjian method and international Demirjian method for estimating chronological age from dental age in a sample of multiple ancestry subadults from Detroit, Michigan.

Digital panoramic dental radiographs of 104 males and 96 females of known age and sex between the ages of 6 and 12 years were collected from the University of Detroit Mercy Dental School. Thirteen individuals were excluded from the final study due to pathology. Ancestry was not controlled for and was only provided in 90 individuals' case files. Even with limited recording, it is clear that the sample is very diverse, being made up of individuals of European, African, Latino, Middle Eastern, and Asian ancestry.

The dental age was determined for all cases using both the Demirjian and international Demirjian methods. The total sample and the sample divided by age category was statistically analyzed to determine if the methods are applicable in the USA. Age categories were defined as young (6, 7, and 8-year-olds), middle (9 and 10-year-olds), and old (11 and 12-year-olds). Paired t-tests were run to determine if the means of the chronological ages (CA) differed significantly from the dental ages (DA) for each method in the study. Significance was determined at the .01 significance level. If there was no significant statistical difference between mean CA and mean DA, the method reliably estimates age.

The results for the Demirjian method using the total sample showed that there was slight over aging of the sample as a whole, but that there was no statistically significant difference between chronological age and dental age. The result for the international Demirjian Method showed slight under aging of the sample and a significant difference between the means at the .01 significance level.

Paired t-tests used on all three categories revealed a statistical difference between CA and DA using the Demirjian method in the young category, but not the middle or old categories. Paired t-test for the international Demirjian method had the opposite results with the young category, having no significant difference between CA and DA and a significant difference in the middle and old category.

The results showed that the Demirjian method had no statistical difference between CA and DA for the total sample and could be used in America even when ancestry was not known. The method was the most appropriate in the middle and old age categories, but the international Demirjian method was more appropriate for the young category at the .01 significance level.

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Subadult Aging, Dental Radiographs, Biological Profile

H71 Dental Aging Methods and Population Variation as Demonstrated in a Peruvian Sample

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After attending this presentation, attendees will understand the application of three dental aging methods to a contemporary Peruvian sample.

This presentation will impact the forensic community by demonstrating that dental aging techniques involving metrics of intact single rooted teeth – previously tested on French and American modern samples – yielded similarly accurate results in a sample from Peru. The results indicate that the accuracy of this approach appears to be minimally influenced by regional and population variation. It also demonstrates the need for further studies of this type to be conducted on new, untested populations.

Measurements of intact single rooted teeth have proven to be useful in methods of estimating skeletal adult age-at-death, especially in older adults. Lamendin et al. published such a technique in 1992 using three measurements of intact single rooted teeth: height of root transparency, height of periodontosis and total root height. This method was later tested on a contemporary French sample, which for one participant in the project provided more accurate estimates of age than other individual adult aging techniques. The study produced a mean error of approximately 10 years. Bang & Ramm (1970) conducted a similar study involving changes in root transparency with age by assessing dental sections as well as intact teeth.

In 2002, Prince & Ubelaker applied the Lamendin technique to a modern American sample, collecting data from the Terry collection at the Smithsonian Institution. The results of its application to the Terry sample proved to be as accurate, and in some cases more accurate, than its application to the original French sample. The mean error for this study was 8.23 years, which was reduced to 7.70 years when the regression equations were adjusted for the American sample. Nevertheless, the accuracy of these methods when taking into account regional and population variation beyond the French and American samples remained unclear.

The purpose of this study was to apply the above-mentioned dental aging methods to a population different from the previously tested French and American samples in order to gain insight into their accuracy in consideration of human variation. The chosen sample for this study consisted of 100 contemporary cadavers of known age and sex from various regions of Peru. These individuals consisted of 28 females ranging in age from 23 to 80 years, and 72 males ranging in age from 21 to 87 years.

Methodological approaches proposed by Lamendin et al., Bang & Ramm and Prince & Ubelaker were applied to a sample of 100 single rooted teeth (24 maxillary and 76 mandibular). A regression equation specific to the Peruvian population was developed as part of this study.

Analysis of these measurements in the Peruvian sample shows that the application of the Lamendin et al., Bang & Ramm and Prince & Ubelaker techniques to this previously untested population sample resulted in mean errors of estimation similar to those originally reported. When applied to the sample in Peru, the methods produced mean errors of 8.3 years for Lamendin et al., 8.8 years for Bang & Ramm and 7.6 years for Prince & Ubelaker. The results of the study suggest minimal impact of population variation of the features measured in the Peruvian sample, thereby increasing the reliability of utilizing these measurements in the estimation of age-at-death across various populations.

Age-at-Death, Teeth, Peru

H72 Multifactorial Determination of Age at Death From the Human Skeleton

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This presentation will summarize a new method to combine age at death estimates from four commonly used skeletal indicators. The method is simple, applicable, and robust, and has lower inaccuracy and bias statistics than any of the individual indicators separately.

This presentation will impact the forensic community by introducing forensic anthropologists to a new multifactorial age estimation method that is simple to use and reduces error in age estimation, thereby aiding in the identification of unknown human skeletal remains. This method is also applicable to South African populations.

Accurately estimating the timing of death has been the subject of decades of research, method development, and testing for human osteologists because age determination from the skeleton, whether for an individual or a population, is critical in analyzing and describing human skeletal remains. Anthropologists have been developing age determination methods since the 16th century and continue to test and revise them today. Despite an abundance of research and data, a single method for determining age at death from the human skeleton that is both accurate and precise and that appropriately combines multiple estimation methods, continues to elude osteologists.

The purpose of this study is to test and develop an easy, applicable, but valid method for combining individual aging indicators. Four of the most commonly used aging methods—the pubic symphysis, auricular surface, sternal ribs, and cranial sutures—were analyzed, first as individual indicators, and secondly as variables in several multifactorial methods. The study sample consists of 394 individuals (203 males, 191 females) from two different skeletal collections on two continents (230 blacks, 164 whites). Skeletal remains of known age, sex, and ancestry were analyzed at the R.J. Terry Collection housed at the Smithsonian Institution in Washington, D.C., and the Pretoria Bone Collection housed at the University of Pretoria, South Africa.

Summary statistics were calculated for the first three individual indicators, including mean age and standard deviation for each phase, the observed age range for each phase, and t-tests between adjacent phases to test for significant differences between means. For all of the individual indicators, the percentages of individuals' actual ages falling into the published 95% confidence intervals were calculated. An analysis of covariance (ANCOVA) was used to test for significant sources of variation while holding age constant. Finally, inaccuracy and bias statistics were calculated for each subgroup, collection, and the overall sample, for each method.

Three multifactorial methods were devised and analyzed using inaccuracy and bias statistics as well as the percentage of individuals' actual ages falling within the prediction intervals. The first was the simple average of the means from the four individual indicators. An assessment of the spatial overlap of estimated age ranges ensued. First, the Total Minimum Range was recorded for each individual, followed by the Total Maximum Range.

The final multifactorial method was linear regression. First, an all-groups regression equation was generated for the entire sample. Because of the consistent significance of ancestry in the ANCOVAs, two ancestry-specific regression equations were generated.

Inaccuracy and bias statistics indicate that the pubic symphysis is the best overall individual indicator. The ANCOVA results show that ancestry consistently contributes to variation in all of the individual indicators while holding age constant, although the effects of all variables other than age were negligible in a practical sense. Compared to the individual indicators, inaccuracy was reduced in all of the multifactorial methods. The percentage of individuals' actual ages falling into the predicted age ranges was comparable to most of the individual indicators. Ancestry-specific regression equations had the lowest overall inaccuracy and bias; however, an all-groups regression equation had only a slightly higher inaccuracy with the advantage of increased applicability.

This study has produced a simple, applicable, yet robust method for combining individual age indicators. The accuracy and effectiveness of individual aging indicators improves when they are combined. Linear regression is the best multifactorial method to use when all four indicators are present; however, the simple average or overlapping ranges can be used when human remains are incomplete. While ancestry influences variation in the aging indicators, the U.S. standards utilized in this study appear to be applicable to South African populations.

Age Estimation, Multifactorial Methods, South Africans

H73 An Evaluation of the Skeletal Aging Method Using Adult Male Vertebrae as Developed by Drukier, et al.

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After attending this presentation, attendees will have an understanding of the age-related changes that occur in the thoracic and lumbar vertebrae and their usefulness in aging an adult male through observational analysis.

This presentation will impact the forensic community by demonstrating the results of the test of the vertebral ageing method by Drukier et al. (2003) on an independent male sample. This gives the forensic anthropologist a new aging method that narrows age range estimations, and therefore gives more precise age-at-death estimation, essential in the identification of unknown human remains.

Estimating age-at-death is one of the most important roles of the forensic anthropologist. When an anthropologist sets about establishing age-at-death they are hoping to determine "chronological age from physiological changes reflective of developmental and/or degenerative processes" (Cox and Mays, 2000: 64). In adults, due to the lack of growth processes, age determination is almost entirely dependent on processes of degeneration. The series of changes occurring at the pubic symphysis have been the most useful for age determination to date (Reichs and Bass, 1998: xix). However, the methods based on morphological changes of the pubic symphysis have their practical limitations as the pubic symphyses rarely survive in large samples. The accepted methods of analysis also provide large age ranges for each stage. For instance at a 95% confidence level Suchey-Brooks ranges include stage IV = 26 - 70 years for males and 23 - 57 for females (Brooks and Suchey, 1990). The ranges, excluding stage 1, also have a large overlap, e.g. stage V = 25 - 83 years for males and 27 - 66 years for females (Brooks and Suchey, 1990).

In his original work on the pubic symphysis in Todd emphasised that the most accurate age estimation could only be made once the entire skeleton had been examined (Todd, 1920).

It was attempted to create alternative aging methods using material that is often more readily available (Iscan & Loth, 1984, 1985) or more robust areas of the skeleton (Lovejoy et al., 1985). Such aging methods reliant on alternative skeletal material decreased the heavy reliance upon the pubic symphysis, especially within the forensic context widening the anthropologist's options.

Although there are many methods of age assessment available to forensic anthropologists there is currently little research available on the systematic age related changes in the vertebral column, to the extent that the focus has been on stages of epiphyseal ring union and is therefore restricted to adolescents (McKern and Stewart, 1957, Albert and Maples, 1995). Three aspects of vertebral morphology are known to undergo noticeable change with age. Firstly, the vertebral secondary centers, the epiphyseal rings, appear during puberty and fuse to the centrum between about ages 17 – 25. Secondly, the inferior and superior aspects progress from a well-organised, ridged configuration in younger individuals to an amorphous, often porotic appearance in older individuals. Thirdly, the inferior and superior edges transform from straight to wavy to sharply lipped with age.

The method developed by Drukier *et al.* (2003) is specific to adult males and provides forensic anthropologists with an alternative/additional method to consider when attempting to age this already difficult period.

The visual assessment and quantitive scoring of the nonmetric changes in three aspects of morphology, on the vertebral bodies (the vertebral ring union, the changes at the horizontal surfaces and the edges of the vertebral body) were used to test the vertebral method of age estimation. The exclusively male sample consisted of 30 individuals of known age-at-death from the 18th-19th century Spitalfields Collection, housed at The Natural History Museum, London, United Kingdom. For each individual the last five thoracic vertebrae (T8 – T12) were assessed alongside all lumbar vertebrae (L1 – L5).

The results of the study followed the pattern described by Drukier *et al.* (2003) in that changes at the vertebral edge had the highest correlation with age, followed by epiphyseal union, and finally the horizontal surface. The relationship between the vertebral traits and age were not as strong as those achieved by the original study, yet still considered very significant.

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Vertebral Aging Method, Age at Death Estimation, Forensic Anthropology

H74 Spheno-Occipital Synchondrosis Fusion in the American Population

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After attending this presentation, attendees will have a comprehensive understanding of spheno-occipital synchondrosis fusion in the American population, with emphasis on the forensic application of aging standards developed from various methodologies and populations.

This presentation will impact the forensic science community by providing updated standards for age estimation from the basilar synchondrosis and gives insight into skeletal development in human populations.

The literature on spheno-occipital (or basilar) synchondrosis fusion reports that this maturation indicator fuses anywhere between the ages of 11 and 25. Some studies report that females fuse a couple of years before males, whereas others do not comment on sexual dimorphism in basilar synchondrosis fusion. A recent study claims that the basilar synchondrosis is a useful age indicator in males, but that its utility is questionable in females. Certainly, such disparity is not desirable in a forensic context, nor does it adequately explain the variation present in the modern American population. For example, given that spheno-occipital synchondrosis fusion has been linked to puberty and the adolescent growth spurt, fusion at age 25 would be anomalous. Presumably, these inconsistencies are due largely to the various methodologies used to develop the standards (i.e., radiographic, computed-tomography scanning, histological, direct inspection from autopsies, and direct inspection from dry skeletal material). Whereas radiographic, CT scanning, and histological studies give a more precise estimate of the onset of fusion, most forensic age estimates are based on direct inspection. Furthermore, skeletal maturation standards are population-specific and should not be extrapolated from one population to another. Finally, the established secular trend in skeletal dimensions and age-at-pubertal onset necessitates that age estimates of modern decedents be based on standards developed from modern populations.

This study presents standards developed from 113 individuals between the ages of 5 and 25 years. The sample is a modern forensic sample with death years between 1980 and 2006 (the Forensic Data Bank, or FDB). The spheno-occipital synchondrosis was scored as open, partially closed (fusing), or completely closed (fused) via direct inspection of skeletal material. Based on the raw data for females, the earliest age at which fusion was complete was 14, and all females were fused by age 20. The earliest age of complete fusion in males was 16, with all males fused by age 22. However, age ranges such as these can be deceiving because they include outliers that can extend the age range by several years due to an insignificant, unrepresentative portion of the sample. Many times this proportion is less than 1% of the sample or, as was the case in this study, just 1 individual. For this reason, a transition analysis was applied to the FDB sample in order to determine the average age at which an individual transitions from non-union to complete union (partially-fused individuals were subsumed into the non-union sample). Transition analysis provides a robust estimate of age-at-fusion that is more representative than the age ranges which include outliers. The females in the FDB sample transitioned from non-union to complete union at 13.64 ± 0.93 years, and the males transitioned at 16.90 ± 0.74 years. These results reflect sexual dimorphism in basilar synchondrosis fusion and agree approximately with average age at puberty and its sexual dimorphism.

During this presentation, the FDB results will be compared to those obtained using alternative methodologies, as well as to standards developed from non-American populations. Additionally, the secular trend in age-at-pubertal onset will be addressed by comparing the modern FDB standards to those developed from a transition analysis of an earlier population (death years in the early 20th century). Studies such as this provide updated standards for the forensic community and give insight into skeletal development in human populations.

Spheno-Occipital Synchondrosis, Age Estimation, Skeletal Maturation

H75 A Curve Where No Hand Has Touched - Vertebral Ageing Method in Females

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After attending this presentation, attendees will have an understanding of the age-related changes that occur in the thoracic and lumbar vertebrae and their usefulness in aging an adult female through observational analysis.

This presentation will impact the forensic community by demonstrating the results of the test of the vertebral ageing method by Drukier et al. (2003) on an independent female sample. This gives the forensic anthropologist a new aging method that narrows age range estimations, and therefore gives more precise age-at-death estimation, essential in identification of unknown human remains.

Determining an individual's age-at-death is crucial for Forensic Anthropologists in skeletal analysis. The methods used in age estimation involve observations of developmental and degenerative changes in bones, these

observations are then assigned an age-range (O'Connell 2005). The age ranges given for older individuals are often so wide as to be meaningless, rendering them of little use in victim identification.

The vertebral column was employed to initially investigate possible methodological refinement to decrease these ranges. To date there is limited research into the use of morphological changes of the vertebral column for estimating age-at-death. The majority of studies have focused upon the fusion of the epiphyseal ring to the vertebral body, limiting methods to younger individuals (McKern and Stewart 1957, Albert and Maples 1995).

Recent research by Drukier *et al.* (2003) used a contemporary male sample from Bosnia and Herzegovina to create a quantitative scoring system for non-metric, age-related changes in the vertebral body. The three originally examined aspects of vertebral morphology were firstly the formation and fusion of the superior and inferior epiphyseal rings to the vertebral body, secondly a decrease in bone density and increased porosity of the horizontal body surface changing from a ridged structure to an amorphous and porotic in appearance, and thirdly a transition from a firm to wavy appearance at the margins of the body leading to sharp lipping and the formation of osteophytes.

Recently Hollands (2007) used this scoring system to determine the age-at-death of individuals in an exclusively male sample.

Ageing techniques based exclusively upon a male sample like Todd (1920) and McKern and Stewart (1957) have been found to consistently overestimate age-at-death when used on females (Gilbert and McKern 1973). Variation between age estimates for males and females has also been seen when estimating age-at-death using the sternal rib end by Iscan *et al.* (1984, 1985). Certain areas of the human skeleton, notably the pelvis (Phenice 1969) and the skull (Giles and Elliot 1963), display extensive variation between males and females. In vertebral column sex differences were reported in mineral density of vertebrae and in the absolute and relative size of vertebral bodies (Snodgrass 2004) with males of ages 20 to 30 years having a higher bone mass and an age-related increase in bone size that does not occur in females, in females over 50 years of age there is a higher chance of disconnection of trabecular bone (Moskilde 2000). When using Albert and Maples (1995) method for estimating age-at-death using vertebral epiphyseal ring fusion there are separate age-ranges for males and females, highlighting the differences in vertebral growth and development between the sexes.

This current study tested the scoring system developed by Drukier *et al.* (2003) by applying it to a female sample to determine individual's age-at-death, and discover if there is any variation in vertebral development and degeneration between the sexes. The sample consisted of 30 individuals of known age-at-death from the 18th-19th century Spitalfields Collection housed at The Natural History Museum in London, UK. For each individual the last five thoracic vertebrae (T8 – T12) were assessed together with all lumbar vertebrae (L1 – L5).

Drukier et al. (2003) vertebral ageing method was evaluated by applying it to a female sample. The results were then compared to those achieved by Hollands (2007) who used the same method on exclusively male sample.

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Vertebral Ageing Method, Age-at-Death Estimation, Forensic Anthropology

H76 Investigation of Second, Fourth, and Eighth Sternal Rib End Variation Related to Age Estimation

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After attending this presentation, attendees will better understand the impact of variation throughout the rib series on age estimation. This will be achieved by explaining how the right, second and eighth sternal rib ends will be aged (i.e., under- or over-aged) with the most commonly utilized methods for estimating age at death with rib ends.

This presentation will impact the forensic community by demonstrating the necessity for continual re-analysis and updating of forensic anthropology's most commonly utilized methods for age estimation.

Estimating age at death accurately can be invaluable in answering important questions on forensic anthropology. Sternal rib ends have received a great deal of research attention as an area that uniformly changes with age. The *Daubert* decision has made rigorous testing and evaluation of forensic sciences' most commonly used methods essential, and thus, forensic anthropologists must understand the timing differences in terms of age characteristics between ribs.

Background: The most popular methods utilizing this area were developed by Iscan and coworkers[1, 2] using the right fourth rib from an autopsy population in Broward County, Florida. However, the accuracy of this method has been called into question, particularly on ribs other than the fourth and on ancestral populations other than European American. Yoder et al.[3] analyzed ribs two through ten in order to see if there was a significant difference between phase placements for rib four and all other ribs. Although most did not have significance in terms of differing phase placements, the authors did note that the percentage of differences were high for some ribs. This demonstrates that differences in terms of timing of degenerative changes are present in the rib series.

Methodology: The right second, fourth and eighth sternal rib ends from the William M. Bass Donated Collection were examined using the methodology described by Iscan et al.[1 2] The pictures, casts and phase descriptions developed by these authors were used in order to determine

phase placement. A total of 156 individuals (113 males and 43 females) of different ancestry were investigated. Eighty-five percent of the sample is Caucasian, 13% is African American and 2% is Latino. A Wilcoxon signed rank test was performed in order to determine if there was intra-observer error present in this study. Additional Wilcoxon signed rank tests were completed to demonstrate if a significant difference is present in the phase placements between the right, fourth rib and the right, second and eighth ribs. In order to better understand these differences, a transition analysis was performed for all ribs under investigation. Estimated transition ages were produced for the Iscan et al.[1] phases for comparison purposes using a means test. A last statistical procedure, t-tests, were performed in order to determine if there was significance between the transitions produced in this analysis and the transitions estimated from Iscan et al.[1]

Results and Discussion: The Wilcoxon signed rank test demonstrated that there was no significant intra-observer error in this analysis. However, significance was found between the phase placements of the standard fourth rib and both the second and the eighth ribs for the male and total sample. No significant difference was found between phase placements in the female sample. Thus, the transition analysis was only performed on the male sample. This analysis showed that the second rib when aged with the Iscan et al. methods will significantly over-age individuals, while the eighth rib will consistently under-age specimens, although in some cases not significantly (significance was determined through the t-tests). Differential levels of stress within the rib series, which are produced by numerous factors, are the most likely cause of these dissimilarities found between phase placements for the second, fourth and eighth rib.

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Sternal Rib Ends, Transition Analysis, Age Estimation

H77 Age Related Histomorphometric Changes in Fetal Long Bones

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The goal of this study is to investigate the age-related changes in histomorphometry among the six long bones of the fetal skeleton. Histological studies have become increasingly important in distinguishing fragmentary human remains from non-human remains,[1,2] as well as estimating age at death in forensic cases.[3,4] However, little work has been done with subadult material due to its distinct growth patterns and unique microscopic composition.

This study will impact the forensic community by providing a preliminary investigation into the potential of utilizing histomorphometry in the estimation of age at death of fetal remains. Microscopic methods may prove invaluable to the task of aging fragmentary remains that lack the characteristic features necessary for conventional methods.

Seven stillborn cadavers of known gestational age and sex were donated to the Mineralized Tissue Histology Laboratory of the University of Tennessee by the Medical Examiners Office of the University of Tennessee Regional Medical Center. Because an autopsy was performed on these stillbirths, either upon the mother's request or as routine protocol in a criminal investigation, permission was granted for histological sampling before incineration. The sample consisted of fetuses ranging in age from 17 to 35 weeks gestation with no two fetuses having the same gestational age. The six long bones of each fetus were embedded in epoxy resin, and thin sections were cut from the midshafts using a high-concentration Buehler Isomet low speed diamond blade saw. All sections were analyzed with a Leica DMRX light microscope at 16x, 50x, 100x, and 200x power magnification. Histomorphometric analysis was conducted using a Dell Optiplex GX270 and Image-Pro Express software. For each slide, a maximum of 111 measurements were taken: maximum sagittal medullary diameter (anterior-posterior), maximum transverse medullary diameter (medial-lateral), medullary area, maximum cortical thickness (taken at each quadrant), minimum cortical thickness (taken at each quadrant), and a maximum of 25 separate trabecular diameters per quadrant.

In order to account for potential growth retardation in these stillborn cadavers, the gestational age of each fetus was estimated via long bone length[5] and compared with actual age to quantify its developmental progress. The presence of distinct differences between actual gestational age and estimated developmental age in six of the seven fetal cadavers highlights the efficacy of analysis in terms of the latter. Considering that in the forensic setting, the actual age of a fetal specimen is unknown and that fetal death is often associated with growth retardation, all statistical analysis in this study was conducted employing developmental age as a factor.

Due to the small sample size utilized for this study and the lack of replication in gestational age among these seven fetuses, the results of histomorphometric analysis should be interpreted as extremely preliminary in nature. Future research will benefit from the utilization of a much larger sample size containing multiple fetal specimens sampled from each gestational week. Only then can the full extent of variation in fetal histomorphometry be accounted for and generalizations concerning age-related changes extrapolated to the entire fetal population as a whole.

The results of Pearson's rho correlation analysis reveal a statistically significant correlation between sagittal medullary diameter and fetal age for the femur, tibia, and fibula. Transverse medullary diameter was significantly correlated with age in the humerus, tibia, fibula, and radius. Regarding medullary area, the femur, tibia, and fibula were the only bones that possessed a correlation with age. Statistically significant correlations between both maximum and minimum cortical thickness and age were found for all six long bones. Among the six long bones, the humerus and tibia have the strongest correlations between cortical thickness and age, as roughly 65% and 56%, respectively, of the variation in the bone's cortical thickness is explained by its positive linear relationship with age.

The results of an ANCOVA employing age as a covariate indicate that age is a significant linear predictor of trabecular thickness in all long bones except the radius. The only long bone to possess an interaction effect between age and quadrant was the humerus; therefore, only in this bone does the rate of linear change in trabecular thickness with age differ by quadrant location.

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Subadult, Histomorphometry, Age Estimation

H78 Critical Study of Observations of the Sternal Extremity of the 4th Rib

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The goal of this presentation is to present a critical study from the estimation of the age at death by the sternal extremity of the 4th rib was reported. Its objectives were to assess its precision and reproductibility with a view to refining it.

The method of estimation of the age in the death by the sternal extremity of the 4th rib does not appear to correspond to the current standards. This presentation will show the results of this study which are in favor of its improvement by a Bayesian approach.

Age estimation in cadavers may clarify issues with significant legal and social consequences for individuals as well as for the justice. Methods for estimating age must have been presented to the scientific community, as a rule by publication in peer-reviewed journals, clear information concerning accuracy of age estimation by the method should be available, and the methods need to be sufficiently accurate. The sternal extremity of the 4th rib was suggested as a means of estimating age-at-death by Iscan twenty years ago. All such subsequent studies have systematically tended to overestimate the age of young subjects' and to underestimate that of old subjects. Moreover, inter- and intra-observer variability has never really been checked. The present study sought to assess the precision and reproductibility of Iscan's method, with a view to refining it. Eleven observers made two assessments, at a two-week interval, of the morphotype of three components (depth, wall and edge) of 59 4th ribs harvested from caucasian males (mean age: 48 y; range: 16-94) during forensic autopsy. Parametric (variance and mean) and non-parametric (quartile) analysis identified non-consensus ribs, and enabled a simplified protocol, minimizing the impact of observer experience and enhancing the independence of variables, to be designed. A feasibility study was then conducted on this protocol in the form of a consensus study of 54 ribs by two observers. Partial crossed correlations between the 6 predictive variables proved slight ($r_{min} = 0.003$, $r_{max} = 0.41$) at age given. A small improvement in the correlation between $\log_{age}$ and scores on these new variables as compared to the original ones ($r = 0.82$ and 0.78, respectively) was also found. These preliminary findings bode well for improving Iscan's method by a Bayesian approach.

Age-at-Death, 4th Rib, Critical Study

H79 Determination of Sex From Juvenile Crania by Means of Discriminant Function Analysis: A First Study

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After attending this presentation, attendees will understand how sex-specific growth and developmental patterns in the human craniofacial skeleton can be used to develop sex determination standards by means of discriminant function analyses for the identification of juvenile skeletal remains.

This presentation will impact the forensic community by demonstrating that it is possible to develop accurate methods for sex determination in unidentified juvenile remains.

This study examines variation of craniofacial dimensions and morphology in juvenile humans. The major outcome of this investigation is the identification of sex specific developmental patterns in the craniofacial skeleton. In doing so, the study creates a set of standard values that facilitate the accurate determination of sex and a reduction in subjective error in the development of biological profiles of unidentified juvenile remains.

Craniofacial growth variation between the sexes provides the basis for identifying sexual dimorphism in juveniles because the craniofacial skeleton reaches maturity early in life (Ackermann and Krovitz, 2002; Guihard-Costa and Ramirez-Rozzi, 2004; Smith, 1991). Growth of the craniofacial skeleton slows down from about 2.5 years of age with many of the adult features already established by the time the first permanent molar erupts (Ackermann and Krovitz, 2002; Guihard-Costa and Ramirez-Rozzi, 2004; Smith, 1991). Given the early establishment of craniofacial form, it should be expected that sex-specific features be present during craniofacial development. Thus, the craniofacial skeleton provides the best sources for sex identification in the juvenile skeleton.

To identify sexually dimorphic differences in the growth of the juvenile craniofacial complex, the study analyzed lateral cephalometric radiographs housed at the University of Michigan School of Dentistry (Riolo et al., 1974). These cephalometric radiographs represent an average local school population from the Ann Arbor, Michigan area (Dibbets, 1995). Five-hundred and ninety-eight 11x14 lateral cephalometric radiographs with a range of 5-16 years of age were randomly selected. The sample was organized according to age group with males and females equally distributed. Each radiograph was traced on 11x17 hyprint vellum using a .05mm mechanical pencil. Eight craniometric points were identified and marked film-by-film. From these points, 20 measurements in millimeters and 17 angular dimensions were recorded from each subject using a Mitutoyo Mycal E-Z 300mm sliding.

For data input and analysis, this investigation relied on The Statistical Package for the Social Sciences (SPSS) version 14.0. All data were organized according to the eruption standards of the maxillary permanent dentition. Before data analysis, a calibration scale converted raw data to natural size, since the radiographs utilized for the study have a magnification factor of 12.9%. The data were calibrated using the formula provided by Dibbets, (1995) and Dibbets and Nolte (2002).

Calculation of descriptive statistics for all variables by age cohort and sex provided initial comparative information. Multivariate statistical procedures aided in the identification of possible sex differences in craniofacial growth. The multivariate statistical analyses consisted of a general linear model procedure (GLM MANOVA), which tested the main effects of interactions between the independent and independent variables, a canonical discriminant function analysis, which facilitated the identification of craniofacial growth trends, and a backward stepwise canonical discriminant function analysis, which created a series of predictive models for sex identification for each age group category. Statistical significance was observed on the Wilks' Lambda and F statistic at the .05 level.

The results of this investigation suggest that craniofacial sexual dimorphism results from variation in the rate and timing of growth, which leads to allometric differences between the sexes. Growth varies between age group and has independent control over the face and neurocranium. A combination of neurocranial and facial measures provide the best classification models for sex. The 15-16 age group yielded the greatest accuracy with 90% sex identification. In the younger age groups, sex identification was high for the age groups 7-8 (82%), 9-10 (83%), and 13-14 (83%). The 5-6 age group (71%) and in the 11-12 age group (77%) had lowest percentage for sex identification. The reliability of sex identification depends on stage of development and developmental trends. Therefore, the results of this study suggest that measures from the entire craniofacial skeleton must be used to derive accurate predictive models for sex identification.

Sex Determination, Craniofacial Growth, Skeletal Profiling

H80 Admixture and the Growing List of Racial Categories: Clarity or Confusion for Law Enforcement (and the Public)

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After attending this presentation, attendees wil. have a clear idea of problems in trying to categorize "race" in multiracial individuals, and adding to the existing categories of race may be an hinderance to police (and the public) in finding missing people.

This presentation will impact the forensic science community by demonstrating how in publicizing missing people, law enforcement must be able to use racial categories which are most familiar to the general public in order to increase the likelihood of finding these missing individuals; the goal is to bring closure for the families.

Any subdivision of the existing racial categories into smaller units to categorize biracial or tri-racial individuals/populations might confound law enforcement and the public.

"Race" is a convenient social tool employed by law enforcement for many practical purposes, an important one being to find people when they go missing. But the steady increase in biracial or tri-racial population groups and the constant flow of immigrants to the U.S. in the last fifty years have complicated the racial picture to the point where it is becoming very difficult to fit people into their neat racial categories as depicted on job application forms. "Race" is already a questionable concept (biologically); consequently, any attempt to pinpoint hybridization phenotypically, i.e., *cablinasian* which, supposedly, is a mixture of African, Phillipino, and Asian ancestries, might be more a result of political correctness rather than reality. In practice, this *cablinasian* category will certainly cause confusion among law enforcement and the public since phenotypically these individuals would either have more *Asian* traits or more *African* traits (and less of any other traits) depending on the random sorting of genes in inheritance. In short, these individuals will be viewed as either *Asian* American or *African* American by the public.

Interracial mating in this country goes back to the 17th century. In the aftermath of the Civil Rights movement in the late 60s and 70s and subsequent enlightened attitudes about race, interracial matings have steadily increased accompanied by a parallel increase in the population of biracial children. In addition, immigration has added to an already dynamic multicultural mix. All of this has led to further subdivision of the racial categories by the U.S. Census bureau (in coordination with state governments) to reflect this multiracial population. What we see is everything! The public can identify an African American, Asian American, Latino, or someone of European ancestry (Caucasoid) very easily. This makes it very convenient for law enforcement when they publicize the social race of a missing individual. But when unfamiliar terms are used, such as *cablinasian, creole*, or *chamorro* in conjunction with a photograph of the missing individual depicting African or Asian features, confusion ensues. We live in a cultural environment where every group wants to be identified by its own category or adheres to the concept of ideal types. If politicians concede to these groups and add to the existing racial categories out of a sense of duty or political correctness, then chaos will reign: the paperwork and existing problems of bureaucratic race will become even more complex. The general public, which includes law enforcement, is more familiar with the traditional categories, i.e., *African American* or black, *Asian American*, *Native American* or Indian*, Caucasian* or white*,* and *Hispanic American* or *Latino* which include Mexican, Cuban, and Puerto Rican. Individuals who categorize themselves within new categories, such as *cablinasian*, *creole*, *chamorro*, *mestizo*, etc., can be—phenotypically—merged into the respective traditional categories.

In publicizing missing people, law enforcement must be able to use racial categories which are most familiar to the general public in order to increase the likelihood of finding these missing individuals; the goal is to bring closure for the families.

Race, Biracial, Phenotype

H81 Racial Admixture: A Test of Non-Metric Ancestry Estimation

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After attending this presentation, attendees will understand the methods of ancestry estimation used by physical anthropologists when cranial remains are assessed. They will learn the problems with these methods in the estimation of ancestry for skulls exhibiting mixed ancestral heritage. They will learn which non-metric traits tend to be used when assigning specific ancestries. Participants will also learn what the "understood" procedure is when metrics and non-metrics yield differing ancestry estimates.

As race determination has always been a topic of debate among anthropologists, this presentation will impact the forensic science community by addressing the clines of traits found in admixed individuals. It also addresses the need for standardization of which non-metric traits should be weighted heavier than others in the analysis of individuals of mixed racial affinities.

The researchers hypothesize that each observer will use a different suite of non-metric traits to establish the racial profile for a specific skull. Therefore, it is hypothesized that each observer will assign a racial affinity based on the weight the observer themselves give to various traits or trait gradations. These factors combined will affect the observer's ability to correctly classify a mixed ancestry skull into the appropriate racial group according to current anthropological standards and will result in differing ancestry estimates for the same skull between researchers.

Twelve individuals that exhibited racial admixture were selected from the skeletal collection Louisiana State University. These skulls were analyzed by researchers with various levels of experience and their ancestry was assessed, based on the ancestry standards published by Gill and Rhine (1990). After ancestry conclusions were drawn solely from the non-metric data, cranial measurements were taken and entered into FORDISC 2.0. The results of both the metric and non-metric data were then compared. When there was a discrepancy between the results of the non metric and morphometric traits, the researchers attempted to identify specific traits that would account for the differing results. Statistical analysis was employed to identify: (a) which non-metric traits each researcher noted, (b) the weight each researcher gave specific traits in final determination, (c) which traits are more dominant in persons representing two or more racial categories, and (d) the effect, if any, that the interaction of sex and ancestry may have on any given non-metric trait.

The results of this research suggested very different racial classifications based upon non-metric and metric analyses. The researchers were asked to pick one or two main ancestral affinities as most individuals identify with one particular social race. After thorough examination of each skull, the non-metric data demonstrated these individuals possessed strong traits for racial admixture, while the Fordisc 2.0 analysis suggested only one ancestral group, either with very low typicality rates or an entirely different racial category as determined by the non-metric results. The non-metric traits were analyzed to determine which traits took dominance in determining race for each anthropologist. The analysis shows that the researchers focused primarily on the traits of the upper face (eye orbit shape, nasal shape, nasal aperture, and zygomatics) when assigning race and rarely used traits such as inion hook, rounded external auditory meatus, dental arcade shape, suture simplicity, and wormian bones to alter their racial assessment.

The estimation of race from a skull is becoming increasingly more difficult as individuals are less and less made up of one specific racial affinity. As the need for an accurate race estimate is important to narrow the search for positive identifications, it is likely that different anthropologists will identify the same admixed individual as belonging to different racial categories. There is a need for standardization of this process and a need to identify which non-metric traits are more dominant in admixed individuals and thus contribute more to the overall phenotype of the individual.

Racial Admixture, Non-Metric Analysis, Metric Analysis

H82 Discriminant Function Analysis as Applied to Mandibular Metrics to Assess Population Affinity

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After attending this presentation, attendees will be familiarized with the results of a study examining the metric characteristics of the mandible and their ability to predict ancestry.

This presentation will impact the forensic community by offering another assessment of the mandible as a reliable indicator of population affinity for use in forensic casework.

Forensic anthropologists tend not to rely heavily on mandibular metric data to determine population affinity for several reasons. First, the most widely available comparison groups are usually limited to U.S. Whites and Blacks. Second, when other populations are available for comparison, the sample sizes are relatively small and are not forensically relevant to U.S. casework. Third, anthropologists are more familiar with cranial metrics rather than those of the mandible. Therefore, there is a need to develop reliable formulae for deriving population affinity based mandibular metric data. This paper examines the ability to correctly classify an unknown individual using mandibular metrics through discriminant function analysis using populations that are forensically relevant in the United States.

The study concentrates on individuals from approximately ten different populations that include American Whites and Blacks, Cambodians, Vietnamese, Central American Hispanics, Nubians, and Native Americans. The total sample size is in excess of 1000 individuals; all individuals are assumed to have late 19th to 20th century birth years, except for certain Native American groups and the Nubians. Eleven measurements were collected for each mandible in the study; eight were standard, one was a modified standard measurement, and two were newly defined. The standard measurements have been defined numerous times and the definitions given in Moore-Jansen *et al.* (1994) are followed. The two new measurements are the mandibular body breadth at the M2/M3 junction and the dental arcade width at the third molar. The modified measurement is the mandibular body breadth at mental foramen.

Step-wise linear discriminant function analyses using the Mahalanobis D^2 distance statistic were undertaken on the data. These analyses concentrated not only on two populations at a time, but also up to ten group evaluations. Male only and female only comparisons as well as pooled sex comparisons were undertaken; many analyses used males only due to relatively small female sample sizes in certain populations. When present, missing data were estimated using multiple linear regression models, by population. Each analysis was cross-validated using a leave-one-out method for accuracy assessment. Frequently, the measurements of the mandibular angle and bicondylar width did not enter into the final discriminant functions.

A two population comparison between American Whites and Blacks, sexes pooled, yielded a cross-validated accuracy rate of 85% using four variables. Other two group comparisons for males only yielded cross-validated accuracy rates between 83% and 94%. Nearly all three population comparisons, males only (for example American Whites, Blacks, and Cambodians) yielded cross-validated accuracy rates between 71% and 75%. Several five population comparisons yielded cross-validated accuracy rates around 55%, approximately three times better than the expected accuracy if based on chance alone. Finally, all groups together yielded a 47% accuracy rate, or over four times chance alone. Interestingly, secular change also is detectable in related groups over time, such as 19th and 20th century U.S. Blacks and Whites. These results are similar to the expected accuracy rates from other discriminant function analyses involving the skull, e.g., mandibular morphology and cranial metrics. Based on these results, the use of discriminant functions to assess population affinity via mandibular metrics is argued to be a valuable tool for the forensic anthropologist.

Forensic Sciences, Mandible, Ancestry

H83 A Test of Methods: Implications of Dimorphism, Population Variation, and Secular Change in Estimating Population Affinity in the Iberian Peninsula

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The educational objectives of this paper are to discuss multiple craniometric and statistical methods for estimating population affinity, test the extent to which population variation may effect sex estimation, and explore the applicability of using cross-population data for individual biological profiling.

This presentation will impact the forensic science community by providing an uderstanding of human variation and applying appropriate methods for identification across populations. Importantly it is demonstrated that population specific data are needed for accurate calibration when using metric analyses for sexual dimorphism and ancestry estimation. The outcome of this research is to demonstrate why forensic anthropologists should approach international work through a framework that accounts for population variation.

One of the key components in the identification process is the ability to determine ancestry from a skeleton. Craniofacial variation defined by skull dimensions of size and shape are estimated by a proportion of both intrinsic (genetic) and extrinsic (environmental) factors. Because human populations differ morphologically in relation to size and shape, identification formulae should be customized to be population specific. The knowledge of the ethnic origins of an individual drastically narrows the search for missing persons that can ultimately result in victim identification. However, this is becoming increasingly challenging as individuals migrate to different populations and *standards* have been continuously appraised. The *standards* for classifying or differentiating closely related populations (e.g., "Hispanic") using both traditional and modern three-dimensional methods are currently being addressed by numerous researchers.

Recent studies have paid much attention to the problematic nature of using biologically meaningless terms such as "Hispanic", which ignore geographic heterogeneity throughout the New World. To this end, we present a comparative study of among-group variation for two samples from the Iberian Peninsula (Oloriz Regional 19th Century, F= 27, M = 27; Wamba Local 16-17th Century, F = 25, M= 26) and Terry Whites (F = 22, M = 22) using a combination of traditional linear metric methods and modern approaches from the geometric morphometrics. The sample sizes for the traditional craniometric study was slightly smaller for each sample as those with any missing values were not included in the analyses. For this study sixteen traditional craniometric measures were utilized in the analyses. A discriminant function analysis was conducted using the traditional craniometrics to allocate crania into groups using *crossvalidation*. The degree of differentiation between the groups was measured using Mahalanobis D^2. Although human levels of sexual dimorphism are low compared to other primate species, males and females appear skeletally very different. Because the degree and pattern of sexual dimorphism vary by population, which can further complicate the accurate assignment of ancestry and sex in different populations, the degree of sexual dimorphism was also evaluated. The degree of sexual dimorphism was assessed with an index of sexual dimorphism or ISD [(male mean/female mean)/1] X 100. The similarity or dissimilarity in the degree of sexual dimorphism was evaluated using a nonparametric Spearman rank correlation coefficients. Fourteen standard craniofacial Type 1 and Type 2 landmarks were used in the geometric morphometric part of the analysis. The among-group variation of the coordinate data was examined using multiple pairwise comparisons with Bonferroni correction.

Both the traditional and morphometric cranial analyses detected significant differences among the samples (*p-values* > 0.001). Interestingly, 19th Century Spanish males were closer to Terry White males, but both Spanish female samples were closer to each other than they were to the Terry females. The average ISD for all measurements is slightly higher for the Wamba Local 16-17th Spanish sample suggesting that they are somewhat more sexually dimorphic. The intraspecific rank correlations among the ISDs for all craniometric variables detected a moderate difference in the pattern of sexual dimorphism between the two Spanish samples (*r=0.55*) possibly indicating secular changes in sex dimorphism within the Iberian Peninsula. The varying levels of dimorphism among populations could affect the classification accuracy when attempting to assign an "unknown" to a particular reference group and further skew results for sex estimation when applying different *standards* across populations. These results obviate the importance of investigating regional or geographic morphological variations and further underscore the importance of calibrating methods to reflect the biology of the local population.

Population Affinity, Sex Dimorphism, Spain

H84 Cranial Histomorphology: Species Identification and Age Estimation

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After attending this presentation, attendees will understand the histological characteristics of neurocranial elements and the usefulness of these elements in species recognition and estimation of age-at-death.

This presentation will impact the forensic community by providing a methodology for identifying and aging fragmentary cranial remains at the microscopic level.

Recent bone histological research on anthropological materials has focused on the postcranial skeleton and specifically, the pelvic and pectoral limb bones. The microscopic characteristics of these long bones have been utilized to ascertain the human or non-human status and to estimate age. However, few studies have undertaken a characterization of flat bones and it is not uncommon in the forensic setting to discover a skull or fragmented neurocranial elements.

This histological research addresses several questions using human and non-human frontal, occipital, and parietal bones to discern the microstructure and to interpret inter-bone and inter-species difference. This study follows up previous research by Cool and coworkers (1995) and Clarke (1987) as it re-examines the utility of using vault bones to ascertain age-at-death. Current histological age estimating methods utilize the Kerley (1965) method relying on diaphyseal mid-shafts. Kerley's method did not consider environmental and mechanical stress factors when it was created. Clarke (1987) considered the parietal and Cool et al, (1995) examined the occipital. Our research re-evaluates these questions and includes the frontal bone to ascertain the most accurate age estimation bone.

Human cranial samples were secured at autopsy from known age, sex and ancestry victims from the University of Tennessee Regional Forensic Center. Nonhuman crania were sampled from specimens in the Zooarchaeological Collection in the Department of Anthropology at the University of Tennessee including animals from four different families: white-tailed deer (O*docoileus virginianus*), goat (Capra hircus), pig (*Sus scrofa), and* dog (*Canis familiaris*).

Bone cores were removed from identical regions of the frontal, parietal and occipital of each specimen. Thin sections were prepared using routine petrographic methods and examined under light microscopy to view histological characteristics. Human samples were neither significant to individual nor to bone. Basic structures analyzed in humans include primary and secondary osteons, secondary osteon fragments and lamellar bone. Plexiform bone characterized the nonhuman specimens along with some primary and secondary osteons. The presence of plexiform bone taken in congruence with quantitative measurements of secondary osteon area and Haversian canal area were successful in differentiating all human from nonhuman samples. In human, fractional volumes of secondary osteons, secondary osteon fragments and lamellar bone were recorded for the frontal, parietals and occipital. These variables were statistically compared using SPSS and analyzed to obtain the best correlation to age-at-death.

This research considers cranial microstructure of human and nonhuman samples and indicates that certain histological structures can differentiate between humans and between and within non-human species. This study also discusses the applicability of using the frontal, parietal and occipital bones to estimate age-at-death in humans.

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Histology, Age Estimation, Neurocranium

H85 Are Cranial Morphological Traits Population Specific? A Reevaluation of Traditional Sex Estimation Methodology

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After attending this presentation, attendees will understand re-evaluation of traditional morphological cranial sex estimation methods in reference to specific population groups.

This presentation will impact the forensic community by helping to improve the standards upon which anthropologists rely for construction of the biological profile. Continual testing and alteration of these methods to reflect modern populations is essential to ensure the highest possible accuracy.

Visual analysis for sex estimation using the cranium and mandible as outlined by Buikstra and Ubelaker (1994) involves examination of five morphological traits on an ordinal scale, ranking from definite male to definite female. This system is well known, and has been commonly used by the forensic community for many years. Krogman tested the accuracy of this particular method by utilizing this particular suite of morphological traits in an attempt to identify the sex of 750 individuals from the Hamann-Todd collection (Krogman and Iscan, 1986). Although this collection included males and females of European and African ancestry, it was biased towards males of European ancestry. Even though Krogman returned a 92% accuracy rate from examining the skull alone, because of the bias towards European males, the actual accuracy of this system may be lower for a more diverse sample. Stewart (1979) also tested this method, examining 100 male and female individuals of African-American descent from the Terry collection. While he noted that his accuracy was only 77% for this population, he attributed the lower success rate to the fact that the sample was heavily male biased.

The aim of this study is to demonstrate that expression of cranial morphological traits are population specific, and therefore methods incorporating these traits may not be appropriate for all ancestral populations. For example, female individuals of African or African-American descent have been noted to display cranial traits that tend to mislead observers when assessing sex. Mastoid processes are typically larger in females of African descent than females of European descent. When using the standard scale to determine sex, larger mastoids are considered strongly indicative of a male individual. This example demonstrates that techniques that do not account for differences among populations may be inappropriate determinants of sex.

In order to test our hypothesis, a sex estimation analysis of adult male and female individuals of African-American ancestry from the William Bass Donated Collection was completed. Each of the five morphological traits were visually examined and rated according to the scale set down by Buikstra and Ubelaker. The resulting estimation was then compared to the individual's actual known sex.

In order to evaluate the accuracy of using mastoid processes alone as determinants of sex, metric estimation was also completed. Measurements of mastoid length and mastoid breadth were obtained from the Forensic Anthropology Data Bank. These measurements were used to compute mastoid area separately in males and females of both European and African ancestry. Subsequently the measurements of each sex were compared across the populations to investigate any differences between the two groups. A t-test was used to determine if any significant differences do exist.

Our results indicated that traditional morphological indicators of sex can reflect populational variation. Certain traits including the mastoid process, supraorbital margin and supraorbital ridge were expressed differently between the two ancestral groups. When the scale found in Buikstra and Ubelaker (1994) was applied to the populations without regard to ancestral differences, our accuracy rating was 79%. When the populations were separated and the Buikstra and Ubelaker scale was adjusted for ancestral differences, our accuracy rating increased to 88%. Further, mastoid measurements indicated that significant differences do exist between individuals of European ancestry and individuals of African or African-American ancestry.

The results here suggest that cranial morphological traits are not only sex specific, but population specific, as well. Since sex determination accuracy increased when population specific scales were used, it is recommended that the method be revised to state that it is best applied to individuals of European descent and alternative scales be developed for other ancestries.

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Cranial Morphology, Visual Sex Estimation, Population Study

H86 A Practical Method for Determining Sex From Human Chest Plate Radiographs

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Upon completion of this poster presentation, participants will be better informed of the accuracy of past published sex determination methods as applied to human chest plates from a modern forensic sample. Participants will also become conscious of which sexual traits are most reliable from the chest plate region and will be presented with a new practical method for accurate sex determination.

The presentation of this research will impact the forensic community by providing the necessary evaluation and associated statistics of proposed sex determination methods from the human chest plate, which is essential for Daubert compliances. The presentation also presents new practical methods which are accurate and lack complex, extensive procedures, so that they may be applied either radiographically in the medical examiner setting, or osteologically to the skeletal elements of the chest plate, for preliminary or supplemental sex determination.

Highly decomposed or altered human remains often prevent quick assessment of the victim's biological profile at autopsy. When their preservation or integrity do not allow for a diagnosis from soft tissues, the remains require further processing for osteological examination by a forensic anthropologist which adds extra time to the identification process, especially when aggressive maceration methods are avoided. Within this framework, radiographic examination of different anatomical areas can provide a useful tool for obtaining reliable, yet quick assessments of factors such as age, sex or ancestry, and serves to guide the initial stages of a forensic investigation, before processing and comprehensive osteological analysis can be completed.

The present study explores the presence of sexual dimorphism in the anterior thorax region, and its potential for sex diagnosis from anterior chest plate radiographs. Although the skull and pelvis provide the most reliable indicators of sex in human skeletal remains, these areas may be absent or damaged. Additionally, anterior thoracic radiographs are easily taken during autopsy, as the chest plate is routinely removed during autopsy, and presents less orientation problems than other regions. Furthermore, both metric and morphological sex differences in the anterior thoracic region (including observations based on autopsy radiographs) are well documented in the literature. Among them, the degree and pattern of ossification of costal cartilage, morphological changes to the sternal ends of the ribs, and relative size and morphologies of the sternum are described as providing reliable sex estimates.

Although these sexual markers have been noted since the 1980's, they are scarcely used in forensic practice. A lack of proper associated probability estimates essential for *Daubert* compliance, such as percentages of correct classification and posterior probabilities, as well as the scaling problems derived from radiographic recordation, can likely be counted among the top causes of this neglect. The present study addresses these problems by: (1) testing the accuracy, in terms of percentages of correct classification, of existing sex determination methods based on radiographic examination of the sternal area, and of the individual traits employed in these methods, (2) exploring alternative methods to correct for radiographic scale, and (3) estimating the probabilities attached to the newly created alternative methods.

Special attention is paid to costochondral ossification patterns and sternum morphology in this study. With respect to the former, typically only the sternal ribs are available to the forensic anthropologist (and lacking the associated costal cartilage). Given that most of the morphological changes to the sternal rib ends are a direct result of the costal cartilage ossification, a better understanding of sexual differences in cartilage ossification, as observed radiographically, can provide a useful insight into the traits considered in the osteological method.

Sternum morphology is likewise highly dimorphic, and relatively easy to record from radiographs, given the density, placement and orientation of the sternum. If the scaling (distortion) problems can be eliminated, the radiographic observations could be easily extrapolated to defleshed bones.

The study sample consisted of 105 chest plate radiographs of adult males and females, taken at autopsy. The radiographs were digitized and the appropriate metric and non-metric variables (including landmark data) recorded. A sex diagnostic was then obtained for each radiograph through various existing methods, and the corresponding percentages of correct classification estimated. Multivariate predictive equations for sex determination, and the corresponding probability estimates, were obtained through canonical variate analysis, for both sternal linear measurements and partial warps from landmark configurations. The process of rotation, translation and scaling attached to the landmark method serves to effectively remove scale effects, rendering size-free shape variables. Bivariate analysis through linear regression and analysis of covariance (ANCOVA) was applied to the data in order to explore the feasibility of using either ratios or residual analysis to correct for scaling effects, as well as to explore the general allometry of the potential sexual differences detected.

Finally, non-metric analysis of individual stages and trait combinations was applied to assess the potential of costal cartilage ossification as a reliable sex marker. Results suggest that radiographic examination of anterior thoracic radiographs shows a high potential for sex estimation, at least in those individuals showing configurations close to their group centroids.

Sex Determination, Sternum, Costal Cartilage

H87 A Test of an Age-at-Death Method Using the First Rib

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Attendees of the presentation will understand that the first rib has potential as an additional tool in the age-at-death toolkit available to anthropologists.

This presentation will impact the forensic community by demonstrating that forensic anthropologists working domestically and on human rights issues in locations outside of the United States can improve their efforts by refining methods used to estimate age-at-death. Results from this research indicate that the first rib can be used to estimate age-at-death as an isolated element or as a component in a multifactorial approach.

The purpose of this study was to determine whether a method developed by DiGangi *et al.*[1] for estimating age-at-death from the first rib is an effective age-at-death method. The method was based on a revision of Kunos *et al*[2] and originally was developed using a Balkan population as the reference population. There are a number of issues involved with applying age-at-death methodologies developed using one reference population to another population of differing ethnic background and age structure.[3] Among these is the concern that different populations age at slightly different rates and in different ways, and that this leads to the possibility of bias when applying age-at-death methods to populations on which the method was not developed.[3] These questions become especially critical when accurately aging a skeleton has medico-legal significance, whether it is small-scale, as with an isolated forensic case, or large-scale, as with human rights investigations. Numerous researchers have reported on the significance of developing population-specific standards in human rights contexts (e.g., [4], among others). These anthropologists have demonstrated that identification in human rights cases is improved when localized standards are developed.

While the fourth rib has been used for some time in age-at-death estimation, Kunos and coworkers[2] indicate several limitations with the element. Oftentimes, the fourth rib is misidentified in unarticulated skeletons or damage to the sternal aspect precludes its use as an age indicator. Moreover, Kunos *et al.* indicate methods that rely solely on morphological changes of the costal face do not utilize other aspects of the rib that change throughout life, particularly the head and tubercle. These authors argue that the first rib is unambiguously identifiable in addition to its prolonged span of remodeling into the eighth decade and beyond. In addition, the fact that this method incorporates only two observations should make it simpler to learn and apply than other available methodologies that incorporate multiple observations.

In order to determine if the first rib aging method developed using a Balkan reference population could be effectively used as an age-at-death method in the United States, the first ribs from known-aged males from the William M. Bass Donated Skeletal Collection were scored using the technique developed by DiGangi *et al.* Specifically, texture of both the rib head and tubercle facet were scored categorically. Categorical scores were then transformed to age-at-death estimates in the manner of DiGangi *et al.*

A total of 114 individuals were scored, including right and left sides, when available. Ages at death for the test sample ranged from 19 to 96 years for males (with a mean age of 57.7 years). In addition, both authors scored 50 individuals for the purpose of inter-observer testing. The correlation between best age and real age was tested for both left and right sides. Correlation coefficients were .490 and .687, respectively. Such results indicate while asymmetry is present between sides, the method developed by DiGangi and colleagues does capture age-related change. Moreover, 56% of the target sample was accurately aged within ±10 years of real age. These results indicate that the method developed DiGangi *et al.* can help with age at death estimation in forensic contexts and can be incorporated into multifactorial age-at-death assessment.

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Forensic Anthropology, Age-at-Death, First Rib

H88 Classification of Frontal Sinus Patterns in Koreans by Three-Dimensional Reconstruction Using Computed Tomography

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Attendes of ths presentation will understand that the frontal sinus from computed tomography data might be helpful as an identification of unknown individuals of Korean in forensic studies.

The impact of this presentation on the forensic community will demonstrate the usefulness of frontal sinus as the identification and a distinction among populations and the simply classified method by three-dimensional reconstruction.

The frontal sinus from computed tomography data might be helpful as an identification of unknown individuals of Korean in forensic studies.

This presentation has presented the usefulness of frontal sinus as the identification and a distinction among populations and the simply classified method by three-dimensional reconstruction.

The use of frontal sinus in identifying human skeletal remains is now an increasingly applied and accepted technique in forensic anthropology. The frontal sinus begins to develop at the age of five and six and does not change after the age 20 years except fracture or diseases. Computed tomography is becoming increasingly available and replacing gradually the radiographs rapidly. The aim of this study is described to define a simple and useful system for identification of an unknown person by three-dimensional reconstruction of frontal sinus in Korean and compared with other populations.

The material was the Digital Korean as human model database (http://digitalman.kisti.re.kr) at Department of Anatomy·Catholic Instituted for Applied Anatomy, College of Medicine, The Catholic University of Korea. The frontal sinus was classified based on four basic features: present sinuses, outline of upper border, partial septum, posterior extension, and measured twelve items included volume, width, and depth. The bilateral asymmetry index modified by Yoshino et al. (1987) and bilateral dimension are used as a classification in this study.

The most common type of frontal sinus due to four features was present sinuses at both, absent partial septum, smooth shape of outline of upper border, and absent posterior extension at both sexes. In bilateral dimension by volume, middle size (10 cm^3 < volume < 100 cm^3) was the most common in both sexes and sides but large size (100 cm^3 < volume <200 cm^3) was the most common in males' left side. The bilateral asymmetry index was used in two methods, one was used in volume (3D image) and the other was in width (2D image). In males, extreme asymmetry type (20%) was the most common under volume, and moderate asymmetry type (30%) was the most

common under width. In females, the most common type was symmetry; 17% in volume and 35% in width. Analysis of variance showed that total volume, maximum height of both sinuses, and depth of right and left sinuses were significantly associated ($P<0.05$) with sex. In generally, the frontal sinus of male is larger than female and the left sinus is larger than right. The frequency of bilateral absence of frontal sinus is used to compare with other populations. The bilateral absence ratio of Koreans (this study), 5.8% in males and 3.9% in females, was lower than other populations; Eskimo was over 25%, Japanese was over 10%.

In three-dimensional reconstruction, the frontal sinus is showed with complete shape and in detail at a look so it doesn't need many slices for identification unlike two-dimensional images. To make use of Reichs's (1993) method, the digit code was listed 14-, 21-, or 28-digit code number for each case. In this study, the digit code is listed just 7-digit code number for each case and 7-digit code is different in each case. This study suggests that three-dimensional images of the frontal sinus can be helpful in identifying and distinguishing individual skeletal remains from other populations.

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Frontal Sinus, 3-D Reconstruction, Korean

H89 Demographic Expression of the Frontal Sinuses

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This research invovles the evaluation of a rarely accessible radiographic juvenile sample. The study drives at further understanding the biological processes involved in the formation of the frontal sinuses, producing a better understanding of those factors which may shape or disrupt development.

This study will impact the medical, anthropological, and legal communities in its evaluation of the growth and development of the frontal sinuses. Also, through the elucidation of its morphological expressions, valuable patterns emerge in relation to age, sex, and ancestry groups.

The high morphological variability of the paranasal sinuses is a well recognized fact within the anthropological literature. This variability combines with a high morphological complexity to produce a structure that is virtually individual-specific. These characteristics, and the relatively frequent availability of ante-mortem radiographs of the area, has led most forensic research on frontal sinuses to focus on their utility for individual identification, mainly aimed at defining the level of precision with which a positive identification can be conducted by comparison of ante- and post-mortem frontal radiographs.

An adaptive value is also frequently attributed to frontal sinuses in the paleontological literature, especially as a potential adaptation to cold environments in some fossil hominid species. Still, a review of the literature reveals a marked scarcity of references focusing on the study of potential inter-populational differences in frontal sinus morphology.

The reason for this neglect is likely related to the same morphological complexity that confers frontal sinuses their value for forensic identification. Their structure may be easily seen as too fickle and idiosyncratic to provide any information about the biological background of the individual. The difficulty to describe mathematically the intricate frontal sinus morphology, and the scaling problems derived from radiographic recording, may as well lead to consider that, even if inter-populational differences were present, their testing and observation would be impeded by the random noise associated to the recording and scaling processes. Consequently, the analysis of inter-group differences in frontal sinuses may appear as too costly to represent an attractive line of research, especially when inter-populational differences may be regarded as a secondary, unimportant issue for positive identification purposes.

These assumptions are not necessarily true. Even when the morphological complexity of frontal sinuses may have prevented a more thorough analysis in the past, sound computing and statistical techniques are nowadays available for accurate recording and scaling of the sinus outline. As a matter of fact, the soundness and applicability of these techniques to the analysis of frontal sinuses are well established, precisely as a consequence of their utility for positive identification studies.

On the other hand, the perception of inter-populational variability as a secondary issue for identification purposes is also fundamentally flawed, as the probabilities associated with individual comparisons are not independent of those related to differential demographic expression, when group differences are present. Therefore, the development and validation of positive identification techniques cannot assume by default the absence of inter-group differences, and difference testing is required.

The present study analyzes the presence of inter-populational differences in a modern radiographic sample collected at the Erie County, Medical Examiners Office, Buffalo, New York, and from forensic casework conducted at Mercyhurst College. The sample comprises juvenile, adolescent, and adult crania of both sexes and with different ancestries. The radiographs were digitized and the outlines of the frontal sinuses traced and recorded. Data transformation and variable reduction were performed through Elliptic Fourier Analysis (EFA), and Principal Component Analysis (PCA). The presence of group differences in sinus morphology and symmetry were analyzed through multivariate ANOVA models, with the principal components as dependent variables and group and sex as grouping factors. Differences in sinus outline complexity were similarly evaluated in terms of fractal dimensions. Discriminant Function Analysis was employed to test the forensic relevance of the observed group differences, in terms of percentages of correct classification. Age differences were assessed through a cross-cut allometric analysis of outline complexity with age.

Results suggest that both individual and group differences in sinus shape may be correlated with sinus size and expansion and, due to their effect size, they are not relevant for positive identification purposes. On this respect, the proposed methodology appears as a promising tool to shed additional light upon the developmental processes shaping the frontal sinus, both between and within different demographic groups, through its application to longitudinal data.

Frontal Sinus, Sex, Ancestry

H90 Sex Determination of Talus in Korean Using Discrimination Function Analysis

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This presentation suggest that the talus could be helpful for sex determination in forensic anthropologic field, as the dimension of the talus is highly dimorphic between male and female in Korean and the discrimination function analysis classify sex with high accuracies.

The talus of Korean is useful for sex determination in either case of complete or fragmentary state as the discrimination function equations obtained from nine measurements are specific for sex determination of Korean with high accuracy.

The determination of the sex is essential in human identification, as it make the matching possibility decreased by half. The sex of the unknown individual is determined mainly by non-metric method observing the anatomical elements with sexual difference on bones. This method is depending on the presence or absence of these elements. Although the elements are as complete as possible to obtain accurate results, incomplete or fragmentary bones are more often excavated in forensic cases. Then, it is needed to devise analytical methods considering fragmentation. Statistical analysis using metric method provides more reliable and quantifiable estimation than non-metric method.

Talus, one of the tarsal bones, is useful bone for human identification that is preserved more intact during the recovery of human skeletons comparing with long bones as its hardness and is readily distinguished even in fragmentary state as its characteristic morphology. Besides the merits of the talus in excavation, several statistical studies on the talus of the population groups excluding East Asian populations suggested that the discrimination function using metric data of this bone is able to classify sex with high accuracy. Therefore, it is the aim of this study to investigate the sex discriminating potential of the metric data from the talus in Korean, one of East Asian populations, and compare with other analysis on White and Black population.

The descriptive and discrimination function analysis were performed on the data acquired from the nine measurements, referred by Steele (1976) and Bidmos et al. (2003), taken from 165 tali (118 male, 47 female) in Yonsei University of Korea. The talus of Korean is highly dimorphic between male and female as there were significant differences in all measurements ($P < 0.01$). The discrimination function equations were generated by univariate, bivariate and step-wise method. In the equations obtained from one variable, the equation using talar width had the highest accuracy of sex classification in 86.7% and the range of accuracy of each equation was 72.7% to 86.7%. The range of accuracy of the equations using two variables was 80.0% to 87.9% and the equation from talar width and height of head classified sex with the highest accuracy in 87.9%. The analysis by step-wise method selected the best 2 out of the 9 measurements: talar width and talar height. The accuracy of the equation by step-wise method was 86.1%. The reason why the step-wise analysis select talar width and talar height instead of talar width and height of head which were the variables of the equation with the highest accuracy in bivariate analysis might be that Wilk's lambda in talar width and talar height was higher.

In comparison with other population groups studied by Steele (1976), Bidmos et al. (2003, 2004), the talus of Korean had generally similar dimension of White and Black population except for South African Black with smaller dimension than Korean. In the discrimination functions, the variables with the accuracies over 80.0% are different from each population and the variables selected by step-wise method are also different. These results show that the variables with high accuracy in this study are specific for sex determination of Korean.

Any equation calculated from one or two variables among nine measurements in this study provides high accuracy (72.7% ~ 87.9%). It is concluded that the talus of Korean is useful for sex determination in either case of complete or fragmentary state.

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Talus, Sex Determination, Korean

H91 Morphometrics of the Korean Thyroid Cartilage for Determination of Sex

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After attending this presentation, the attendee will understand the results of a physical anthropological data of Korean thyroid cartilages applied for determination of sex of Koreans.

This presentation will impact the forensic community by demonstrating the usefulness of thyroid cartilage for sex determination in Korean and another method for sex determination using morphometric analysis of thyroid cartilage.

Each time a forensic anthropologist investigates the morphological characteristics of an unidentified victim who is badly decomposed or found in dried bones, many unknown questions are to be answered.[1] Among them, the answers to biological profile such as ethnicity, sex, age and statue are basic step to identify the victim. The biological profile could be estimated based on the knowledge of physical anthropology which is mainly collected by metric and non-metric characteristics of bones. However, studies about the soft tissue such as cartilage are fewer. The thyroid cartilage is located just below the hyoid bone and is the biggest cartilage in laryngeal cartilage. Similar to other cartilages and bones, thyroid cartilage is known to enlarge its size as the puberty onwards. Its sagittal diameter is nearly doubled during this process. Cho[2] reported the study concerning 22 items of measurement of the Korean laryngeal cartilage in both sexes, but difference between sexes after statistic procedures was negligible. The purpose of this study is to identify the sex based on the morphological analysis of the thyroid cartilage of Koreans.

The thyroid cartilages were separated from the larynx and dissected from the surrounding connective tissue. Specimens were surveyed with digimatic caliper (Mitutuyo Co., Japan) in 110 specimens of the thyroid cartilages including 69 males and 41 females. In order to measure the angle of cartilage, each specimen was photographed (COOLPIX995, Nikon, Japan) with its anterior, both lateral and superior surface maintaining its anatomical position. Thirty items were measured including 20 surveyed items such as width of thyroid cartilage and ten measured items such as angle of superior horn. After the measurements, the statistic procedures were performed using SPSS software (Version 13.0, Chicago, IL).

The measurement value of distance between superior horns did not show difference between sexes, but other 29 items of measurement did show difference between sexes after the statistic procedures. Male subjects exhibited larger values mainly related with the size of thyroid cartilage such as width, height and length of thyroid cartilage and height of lamina than female subjects ($p<0.01$). On the other hand female subjects exhibited larger values related with the shape of thyroid cartilage such as angle of upper margin of lamina, angle of lamina in lateral view and angle of superior thyroidal notch than male subjects ($p<0.01$). Results of discriminant functions indicate that measurements related with the size of thyroid cartilage are significant factor when considering determination of sex for Koreans. Accuracy for Rt. and Lt. length of thyroid cartilage shows 100%, 99.1%, and Rt. and Lt. height of lamina shows 97.2%, 97.2% respectively. Furthermore, these measurements are convenient to measure at the fields.

This research indicates the thyroid cartilage is useful in determining the sex for Koreans whose age is over twenty. From the results of discriminat functions, it could be suggested that the demarking point as follows: (1) if each side length of thyroid cartilage exhibit larger value than 33.2 mm, then male, or (2) if each side height lamina exhibit larger value than 24.8 mm, then male. A further investigation is now conducting to verify its utility at the autopsy.

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Thyroid Cartilage, Sex Determination, Koreans

H92 Sexual Dimorphism of the Humerus in Contemporary Cretans

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The goal of this research is to facilitate the determination of sex which constitutes a very important aspect of a forensic investigation, by providing a simple and easy sex determination technique using the humerus.

A specific standard for sex estimation for a modern Cretan population is attempted here. Establishing this standard will impact the forensic science community by assisting the Greek and neighbouring Balkan countries when human skeletal remains are recovered from forensic settings.

The present study is aiming to facilitate the determination of sex which constitutes a very important aspect of a forensic investigation, by providing a simple and easy sex determination technique using the humerus. When decomposed, skeletonised bodies or body parts of unknown identity are recovered, a forensic anthropologist is considered expert in determining sex from skeletal remains using a variety of techniques in order to make the ultimate decision. In medico-legal routine though such experts are not always available, especially in Greece where there are no forensic anthropologists.

Therefore this study is an attempt to develop a sex identification technique that can be easily applied to a decomposed body. The measurements chosen are easy to be taken after when the remains are all decomposed or skeletonised. Taking under consideration the population aspect of sexual dimorphism of the skeleton, the present study aims to create a sex identification technique using osteometric standards applied to a contemporary Cretan sample.

The skeletal material for this study is selected from the cemeteries of St. Konstantinos and Pateles, Heraklion, Crete, Greece. The bones are gathered, cleaned and placed in boxes and stored in an ossuary. Unless living members of a deceased person can afford to keep them in the tomb with a "rental" fee it is to be destroyed. Authors were given permission to analyze a limited number of unearthed remains in order to carry out a population based investigation. The study population consists of individuals who lived between the end of the 19th century and the beginning of the 20th and buried in Crete. Sex is available for all individuals while age at death and cause of death for only part of it. A total of 84 male and 84 female left humerii are measured according to standard osteometric techniques. Mean age for males is 68, 57 +/- 13.52 (N=61) and for females 72, 98 +/-16, 90 (N=58). The following measurements were taken: maximum humeral length (mean: 321.3 mm in males; 293.4 mm in females), vertical humeral head diameter (mean: 46.38mm in males, 41.19mm in females), midshaft maximum diameter (mean: 22.55mm in males, 20.11mm in females), midshaft minimum diameter(mean: 18.53mm in males, 15.58mm in females), midshaft circumference(mean: 65.93mm in males, 58.12mm in females), humeral epicondylar width (mean: 61.66mm in males, 54.40mm in females).

The differences between the means in males and females were significant $p<0.0005$) with the exception of age at death which resulted insignificant. About 92.3% of cases were correctly classified when all measurements were applied jointly. Stepwise discriminant function analysis selected only four dimensions (maximum humeral length, vertical humeral head diameter, midshaft minimum diameter and humeral epicondylar width) producing an accuracy rate of 92.9%. Assuming different fragmentary patterns multiple functions were generated giving an accuracy rate from 83.3 to 89.9%. The most effective single dimensions as determined by direct discriminant analysis were vertical head diameter (89.9%) followed by minimum midshaft diameter (86.3%).

Classification accuracy is higher when compared to similar studies of Chinese and Japanese but lower when compared to German, Portugal and Guatemalan populations (Carretero et al. 1995; Iscan et al. 1998; Mall et al. 2001; Frutos 2005). Interestingly humerus demonstrates higher sexual dimorphism than skull (88.20%) and femur (91.1%) in the same population.

The recovery of fragmentary and pathological skeletal remains, in forensic investigations, requires easy and rapid techniques for biological profiling and reconstruction of the scene history. There is no doubt that population differences affect sexual dimorphism reflected in the humeral dimensions. Thus a specific standard for sex estimation for a modern Cretan population is attempted here. This standard is expected to be applicable for Greeks and neighbouring Balkan countries in which human skeletal remains are recovered from forensic settings. Simple measurements accessed during autopsy can provide an immediate and accurate prediction of sex, thus contributing significantly to positive identification in forensic cases.

Forensic Anthropology, Humerus, Sex Identification

H93 Evaluating Methods of Age Estimation of Fetal/Neonate Remains From Radiographs Using a Diverse Autopsy Sample

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After attending this presentation, attendees will understand the validity of methodology used to estimate gestational age in human fetal and neonate remains.

This presentation will impact the forensic community by testing methods that estimate the age of human fetal remains and raising issues that may affect the validity of such methodologies.

The purpose of this presentation is to evaluate methods of estimating the age of fetal and neonate remains from radiographs and skeletal remains. Estimating the age of unknown remains can be an important step in establishing the identity of a fetus or infant as well as determining viability in homicides or clandestine disposals of remains. Previous studies have established a relatively linear relationship between gestational age and body size of a fetus. As a result, methods have generated linear regression equations that predict the age of an individual from the length of long bones. Although several methods exist, they have never been adequately evaluated nor tested on diverse populations.

Method: Measurements were taken of both humerii, femora, and tibiae (when possible) by the first author from x-rays of 137 identified fetuses and young infants radiographed at autopsy from 1995-2006 at the New Mexico Office of the Medical Investigator. The sample included 20 Native Americans, 4 African Americans, 58 White Hispanics, and 55 White non-Hispanics with approximately equal sex distribution. Age represented the number of completed weeks of gestation for fetuses and the total number of weeks gestation plus neonate survival time for infants. The range for this sample was 14-49 weeks. Each radiograph was assessed for proper positioning and long bones were measured to the nearest .005mm. The first and second author remeasured a subset of 30 individuals for intra- and interobserver error tests using pairwise t-tests and the technical error of measurement (TEM). The magnification factor was calculated by radiographing skeletonized fetal remains and dividing the length of bone in the x-ray image by the length of the dry bone. The larger of the two sides was used for further

analyses and the sexes and population groups pooled. Three published standards were tested. Method 1 generates a predictive regression equation from radiograph measurements of a single long bone;[1] Method 2 produces a predictive regression equation from radiograph measurements of the length of a long bone used to first estimate the body length (crown-heel length, CHL) of the individual;[2] and Method 3 utilizes a table for gross measurements of each long bone.[3] Age estimated by CHL was assessed from the most common clinically referenced source.[4]

Results: The intra- (p-value = .2355, TEM = .2826) and interobserver (p-value = .1579, TEM = .4610) errors are relatively insignificant, suggesting that the measurements are replicable. Overall, Method 1 performed the best, correctly predicting the age of 72.4% of individuals from the humerus, 75.2% from the femur, and 66.9% from the tibia. Method 2 correctly predicted the age of 64.7% of individuals from the humerus, 71.9% from the femur, and 62.1% from the tibia. Method 3 accurately aged 63.8% of individuals from the humerus, 70.2% from the femur, and 55.3% from the tibia.

Discussion: The two methods predicting age directly from long bone measurements performed better for all three bones than the method predicting age from the estimate of the total length of the body. With the exception of the femur for Method 3, each technique consistently underestimated the ages of misclassified individuals. Neither of the two radiographic methods (Methods 1 and 2) had corrected for the magnification factor. Interestingly, when the correction for magnification factor is removed, the results improve slightly for these two methods. The practical significance of adjusting for the magnification factor and possible explanations for these results will be discussed.

Conclusion: Before a method can be widely accepted in forensic contexts, its internal and external validity must be rigorously evaluated. While the results of the prior studies suggest that the methods achieved adequate internal validity (i.e. were accurate when applied to the population from which they were developed), the results of this study indicate all three methods have poor external validity (i.e. perform poorly and cannot be generalized to other populations). Caution is warranted when using these standards to diverse populations. Additional testing is needed, as are standards that reflect greater population variation.

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Fetal Osteology, Age Estimation, Radiography

H94 The Utility of the Samworth and Gowland Age-at-Death "Look-Up" Tables in Forensic Anthropology

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The goal of this study is presenting to the forensic anthropological community the forensic application of three new bioarchaeological age-at-death estimation methods recently developed by Samworth and Gowland (2007), stressing their utility and applicability in forensic settings.

This presentation will impact both forensic practice and future research, by demonstrating that the new methods, which were developed f bioarchaeological intent, are in fact applicable and useful in forensic settings, and that the new statistics used in creating these age-at-death "look-up" tables are worth further consideration and study within the field, as well as for paleodemographical purposes.

Accurate age-at-death estimates are crucial to the forensic anthropologist when constructing a biological profile aimed at narrowing a missing persons list, to allow for timely and efficient identification of an unknown victim. To this goal, new methods are continuously constructed from known samples, while existing methods keep being updated, adapted and tested for their forensic use on contemporary populations. Validation of these newly developed methods for forensic purposes, in the spirit of the Daubert criteria, requires testing them on at least one independent sample of known individuals. From the paleoanthropological or bioarchaeological points of view, method validation on independent samples serves to obtain the corresponding associated probabilities, aiding in decision-making and comparison with other methods, as well as to assess their applicability to samples and populations different from those from they were obtained.

The present contribution evaluates the forensic utility of three new age-at-death estimation techniques recently proposed by Samworth and Gowland (2007). These techniques are based on: (1) the pubic symphysis, (2) the auricular surface of the ilium, and (3) a multifactorial combination of these methods. Forensic utility and their applicability to American populations, will be tested through their application to three contemporary forensic samples.

A particularly attractive feature of these three new procedures is that they are based on two well established ageing methods, widely known and regularly used within the forensic community. These techniques are the Brooks and Suchey (1990) pubic symphysis method, and the Lovejoy *et al.* (1985) auricular surface method. The Samworth and Gowland (2007) procedure provides individual corrected 68% and 90% confidence intervals for each of these methods, in the shape of user-friendly "look-up" tables. Even more interestingly, similar tools and statistics are provided for the combination of both methods (referred to as *combined method* hereafter).

These new procedures were developed with a focus on paleodemography, and Samworth and Gowland (2007) warn about their heavy reliance on the aprioristic knowledge of the precise age-at-death distributions of the samples under study, which may cause them to be highly population- or even sample-specific. If this hypothesis were true, the sensitivity of the method to deviations from the distribution of the original study sample would limit importantly their immediate utility in North American forensic contexts. This would require the anew estimation of all confidence intervals, in order to adapt them to the North American population, and would impede their application to individuals of mixed, unknown, or uncertain ancestry.

In the present study, the hypothesis of high sample-specificity is tested on three known samples of males and females of multiple, but predominantly European American descents: ((n=188) from the Bass Collection (University of Tennessee, Knoxville, TN); (n=66) from the Hamann-Todd Collection (Cleveland Museum of Natural History, OH) and (n=83) from the Forensic Data Bank (Jantz and Moore-Jansen 2000)).

Results indicate that, in the samples under study, the Samworth and Gowland estimates from the pubic symphysis and auricular surface actually perform slightly better than the previous methods from which they were developed. Similarly, the combined method performs better in these samples than most attempts at multifactoria age-at-death estimation (Martrille *et al.* 2007, Saunders *et al.* 1992 and Passalacqua and Cabo 2007). Interestingly, the combined method does not appear to further enhance neither the precision (bias/inaccuracy) nor the accuracy (percent correct classification) of the single pubic symphysis age-at-death estimate. On the contrary, it would in fact appear that the addition of the auricular surface estimate to the pubic symphysis estimate actually decreases the utility of the method. In conclusion, these new methods seem to be more robust to distribution deviations than originally proposed by Samworth and Gowland (2007). They are therefore suitable for immediate and reliable forensic usage in the United States and worth further research for their use in North American forensic contexts.

Age-at-Death Estimation, Forensic Anthropology, Validation Study

H95 Metric Sex Determination From the Mandible

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The goal of this presentation is to examine patterns of metric sexual dimorphism within the mandible, and to provide a simple, accurate, and reliable means of sex determination.

This presentation will impact the forensic community by providing an updated method to determine biological sex from unknown human skeletal remains using a contemporary sample.

Assessing the biological sex of an individual is one of the first steps that the forensic anthropologist is faced with when constructing a biological profile. The designation of sex is of utmost importance because other aspects of the biological profile, such as stature, age and ancestry, rely on an *a priori* knowledge of the individual's sex. It is widely known that the pelvis is the most accurate estimator of sex, followed by the cranium. However, these elements are not always present for analysis due to incomplete recovery or taphonomic events. Additionally, even if the elements are present, many of the diagnostic aspects of the bones are often destroyed due to animal scavenging or weathering processes. As such, other skeletal elements must be evaluated for their usefulness in differentiating between the sexes.

The mandible is one of the densest bones of the skeleton and therefore is one of the elements most likely to survive in an archaeological or forensic setting. While several metric and non-metric traits of the mandible are often cited as accurate indicators of sex, many of these values and traits have not been rigorously tested. A poster given at the 59th annual meeting of the American Academy of Forensic Sciences presented the results of a study on the utility of the mandibular angle (degree of rami inclination) and its corresponding, oft-cited 125° sectioning point for sex determination of unknown individuals. Contrary to what is often taught in classrooms and presented in introductory textbooks, this study showed that the mandibular angle is neither an accurate nor reliable indicator of sex (Zambrano et al., 2007). The current study seeks to elaborate on last year's conclusions by finding an alternate metric means to quickly and accurately determine sex using the mandible.

The study sample is composed of mandibular metric data from forensic cases compiled by two separate laboratories. The Florida data are derived from contemporary individuals from Florida and surrounding states processed at the C.A. Pound Human Identification Laboratory at the University of Florida (n = 171). The Forensic Data Bank sample is composed of cases analyzed and submitted to the University of Tennessee by forensic anthropologists from across the country (n = 490). A random sample of 150 individuals was held out of the combined forensic dataset for use as a test data set.

Nine linear mandibular measurements (Moore-Jansen et al. 1994) from the remaining combined forensic sample (n = 511) were analyzed using stepwise linear discriminant function analysis, in an attempt to identify which dimension(s) of the mandible provided the greatest discrimination between the sexes. Among the nine measurements, bigonial breadth, ramus height, and chin height were chosen, based on partial R-square values, as the variables producing the greatest separation between sex groups. A linear discriminant function was created using the aforementioned measurements. Re-substitution and cross-validation results accurately sexed the mandible 82 – 87% of the time. Verification of the ability of the three variable function to discriminate was further tested on the hold-out test data and found to accurately sex individuals in 82% of the cases.

These results are consistent with previous linear discriminant function studies of the mandible such as Giles (1964) with an accuracy of 85% and Steyn and Iscan (1998) with an accuracy of 82%. However, the current study has a much larger sample size than the previous two studies and is comprised of contemporary US forensic cases of mixed ancestry. As such, the study and test samples are more similar to those that are encountered in routine forensic casework. Over the years, sex estimation using the mandible has proven difficult. This study provides an alternate means to accurately and quickly determine the sex of an individual using three mandibular measurements.

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Mandible, Sex Determination, Linear Discriminant Function

H96 Microscopic Age Estimation From the Anterior Cortex of the Femus in Korean Adults

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The objective of this study is to ascertain the usefulness of microscopic age estimation method based upon Korean adults using modified measuring methods from the femur with four histomorphometric variables, such as the most anterior cortical width, osteon population density, and average size of osteon and Haversian canal.

This presentation will impact the forensic community by suggesting the possibility for microscopic age estimation method based upon Korean adults. Tthis study is a first attempt for microscopic age estimation method using the femur in Koreans, so it will be contribute to growth of concern for forensic anthropology of forensic sciences in different countries as well as Korea.

The objective of this study is to ascertain the usefulness of microscopic age estimation method based upon Korean adults using modified measuring methods from the femur with four histomorphometric variables, such as the most anterior cortical width, osteon population density, and average size of osteon and Haversian canal.

In studies on microscopic age estimation methods applied to the femur, variety of measuring fields and histomorphometric variables has been suggested. As considering the conditions of skeletal remains excavated from archaeological sites or forensic situations, utilitarian methods with small sampling site against complete cross-section and a few variables for efficiently quantifying the remodeling history of the bone were needed to develop. The objective of this pilot study is to ascertain the usefulness of microscopic age estimation method using modified measuring methods from the femur based upon Korean adults. The bone specimens of anterior femoral midshaft were removed from 19 Korean cadavers (10 males and 9 females) in wedge form that one of the saw cuts was kept perpendicular to the long axis of the shaft and depth of cut was limited to anterior half. The age range for the sample is 41 to 82 years with a mean and standard deviation of 62.4

and 12.1 years, respectively. Thick sections of 1-mm were cut from the perpendicular plane of the wedged femoral specimens using a diamond wheel. Then thin sections (less than 100 um thick) per individual 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 most anterior cortical width, osteon population density, and average size of osteon and Haversian canal were measured using an Olympus BX-51 light microscope with simple polarizing attachment and image analysis solutions (Image-pro Plus 4.5.1, Media Cybernetics, Inc., Silver Spring, MD, USA) at a magnification of ´100. Statistical regression analysis was performed using age at death as dependent variable. An analysis of covariance found no statistically significant differences in all variables between sexes. In all cases, the strongest associations with age for the pooled sexes were osteon population density and average osteon size (r^2 = 0.654 and 0.554, respectively). For multiple regression method, osteon population density and average osteon size were selected as independent variable and its r^2 and standard error of estimate were 0.746 and 6.460, respectively. These preliminary results indicate that five measuring points and two of four histomorphometric variables can be used to reliably estimate age at death in Korean adults.

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Age, Femur, Histomorphology

H97 Sternal Rib Histomorphometry: A Test of the Age Estimation Method of Stout, et al. (1994)

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After attending this presentation, attendees will understand the application of histological age estimation method for the sternal rib, and become aware of the effects of biological ancestry, and diagenesis on its accuracy.

This presentation will impact the forensic community by providing valuable information regarding the application and limitations of the sternal rib method for histological age at death estimation.

Stout et al. (1994) offer an age estimation method that employs cortical bone histomorphometry of the sternal end of the rib. The published age predicting formulas are derived from the original sample of fourth ribs of European ancestry used by Iscan et al. (1984, 1985) to develop their sternal rib phase method for age estimation. The purpose of this paper is to report the results of the application of this method to estimate age at death for an independent sample of ribs derived from a 20th Century, Midwestern, African American cemetery. Comparison of estimated ages and reported ages at death found that the Stout et al. (1994) sternal rib age predicting formula was not accurate when applied to this independent sample. Mean differences between reported and estimated ages at death among several observers ranged between -2.5 to -17.7 years, with standard errors of 6.2 and 9.9 respectively. Several factors may account for these results. First, Cho et al (2002, 2006) have reported population differences in bone remodeling rates for the mid-shaft rib. The resulting disparity between predicted and reported ages at death, therefore, may be due to population differences in age associated bone remodeling rates that are reflected in sternal rib histomorphometrics. Observed differences between reported and estimated ages, however, did not exhibit a clear pattern. The added effects of various degrees of diagenesis on sampling and the performance of histological age estimation are also discussed.

Sternal Rib, Histomorphometry, Age

H98 Accuracy of Regression Formulae for Racing and Sexing the Cranial Base in a Forensic Collection

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The goal of this presentation is to share results of a study that tested two researcher's regression formulae for race and sex determination using the cranial base when applied to a modern forensic collection.

This presentation will impact the forensic community by presenting results of a study that tests the accuracy of formulae for determining race and sex of the cranial base on a modern forensic collection.

This presentation examines the applicability of Holland's race determination (1986) and Wescott's sex determination (1996) regression formulae when applied to a modern forensic collection that is housed at Louisiana State University's Forensic Anthropology and Computer Enhancement Service (FACES) Laboratory. Testing was conducted on 77 complete skulls that had been positively identified, or, if unidentified, skulls that clearly exhibited no admixture features. The 77 skulls consisted of 48 males and 29 females. Of the 77 skulls, 41 were identified as white and 36 were identified as black.

In 1986, Holland analyzed 100 black and white crania from the Terry Collection and created five regression equations for race determination based on eight measurements from the cranial base with an accuracy rate ranging from 70 to 86%. In a separate control test involving 20 different skulls from the Terry Collection, Holland had a 75 to 90% accuracy rate. The interpretation of certain landmark locations on the cranial base led us to exclude some formulae that included these landmarks. Therefore, for testing and determining race from the cranial base, we used Holland's regression formula #4 that involved the following four measurements: 1) the length of the occipital condyle defined as the maximum length of the left condyle as measured along its long axis from the ends of the articular surface; 2) the width of the occipital condyle defined as the maximum width of the left condyle as measured from the articular edges along a line perpendicular to the length; 3) the length of the foramen magnum defined as the maximum length of the foramen magnum as measured from basion to opisthion along the mid-sagittal plane, and 4) the width of the foramen magnum defined as the maximum width of the foramen magnum as measured perpendicular to the mid-sagittal plane. Holland's #4 regression formula had an overall 70 to 75% accuracy rate. The 77 modern forensic collection skulls were measured and Holland's #4 regression formula was applied. An accuracy of 57% was obtained.

In 1996, Wescott analyzed 308 combined crania from the Hamann-Todd and Terry Collections and created five regression equations for sex determination based on five measurements from the cranial base with an accuracy rate ranging from 72.1 to 80%. In a separate control test involving 83 different crania from the Hamann-Todd and Terry Collections, Wescott had a 63.6 to 90% accuracy rate. For testing and determining sex from the cranial base, we used Wescott's regression formula #5 that involved the following five measurements: (1) maximum condyle length defined as the maximum edge to edge length of the articular surface of the occipital condyle measured along its long axis, (2) maximum condyle breadth defined as the greatest edge to edge breadth of the articular surface of the occipital condyle measured perpendicular to the long axis, (3) basion to hormion length defined as the length of the basilar process measured from basion to hormion,. (4) foramen magnum length defined as the length from endo-basion to opisthion, and (5) foramen magnum breadth defined as the maximum breadth of the foramen magnum measured perpendicular to the length. In Wescott's research, his #5 regression formula had an overall 73.2 to 90% accuracy rate. Of the 77 modern forensic collection skulls, 10 were eliminated due to anterior damage to the basilar process. Therefore, 67 skulls were measured and Wescott's #5 regression formula was applied. An accuracy of 68% was obtained.

As suggested by both Holland and Wescott, these formulae may be applied when a skull has been damaged and only certain portions of it remain. Additional testing on larger forensic collections may improve the accuracy rate of these formulae, further enhancing their applicability on forensic cases.

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Race Determination, Sex Determination, Cranial Base

H99 Deconstructing or Perpetuating Race: The Status of Race in Forensic Anthropology

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After attending this presentation, attendees will gain an understanding and increased awareness of the trends relating to the acceptance of the concept of race portrayed in textbooks and Journal of Forensic Sciences articles in the field of forensic anthropology over the past 35 to 45 years.

This presentation will impact the forensic community and humanity by demonstrating the important role that the social construct of race has played in this scientific field. Through the literature presented, trends in the acceptance and non-acceptance of race will be examined and exemplified to give insight as to how the discrete categories of race are used today and have been used since 1960.

Physical characteristics and human variation, as often studied by forensic anthropologists, have resulted in defining differences between people as "race." The misconceptions that arose with such an explanation of physical differences have augmented the tremulous and malevolent past of the concept of race.

The goal of this study is to examine the views of race that have been presented in the forensic anthropology literature and to extrapolate any trends from the opinions expressed by the authors. While the pattern of the acceptance of race in physical anthropology is never clearly defined, others have reported a decline in non-forensics journals. A similar decline in the acceptance of the existence of biological race as a valid description in forensic anthropology may be expected, although due to the utility of "race" in skeletal analysis, this trend is apt to be more gradual and not as pervasive.

This study aimed to identify sections of forensic anthropology and/or human osteology textbooks and *Journal of Forensic Sciences* articles primarily concerned with race or human variation. Thirty-four textbooks published between 1962 and 2007 were examined, and 26 *Journal of Forensic Sciences* articles were selected from between 1972 and 2007. The author's view presented in each of these texts was then classified as: (1) races do not exist, (2) races do exist, (3) author noncommittal, (4) race not mentioned, and (5) race accepted, but the author's view was not explicitly stated.

Results from the textbooks and the articles indicate a gradual decline in the acceptance of race in the field of forensic anthropology over the past 35 to 45 years. Changes in the authors' views were noted in both the manner in which race was discussed and the terminology used to describe such human variation. While there was no one span of years identified as a time of drastic change in regard to race, terminology employed by the authors demonstrated a shift to terms other than "race" as early as 1988 in textbooks and as late as 1995 in the journal articles. Overall, throughout the time period examined, there was an increase in "races do not exist," and decreases in both "races do exist" and "race accepted."

In conclusion, these results suggest that that a gradual transition is occurring between the view of races existing to the view of races not existing. Forensic anthropology is a subset of physical anthropology but perhaps even more intertwined with the concept of race, because forensic anthropologists continue to struggle with appropriate terms for communicating with law enforcement personnel and the public.

Race, Trends, Terminology

H100 A Test of the FORDISC Sex Discriminant Function on a Korean Cranial Sample

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The objective of this presentation is to apply the software to a population excluded in the reference sample and to determine if the database from which FORDISC is based should include more specific modern reference groups.

This presentation will impact the forensic community by further contributing to our understanding of human biological variation and applying the software to a South Korean population where forensic anthropology is a relatively new discipline.

Sex estimation of human skeletal remains is one of the key analyses in forensic anthropology. Forensic anthropologists have been relying on discriminant function analysis as one of the powerful statistical tools in estimating individual characteristics in skeletal remains. FORDISC is a user-friendly computer software that is designed to assist in the estimation of sex and ancestry by employing discriminant function analysis. The reference groups used to create the program is based on the Forensic Data Bank (FDB) at the University of Tennessee-Knoxville, and includes the following populations: American black males and females, American Indian males and females, American white males and females, Chinese males, Hispanic males, Japanese males and females, and Vietnamese males. Due to human biological variation, the osteological methodologies developed from the reference groups may not necessarily apply to another population. However, due to the biological and cultural affinity among East Asian populations, FORDISC sex discriminant function may be applicable to modern Koreans. Thus, FORDISC 2.0 was tested on a pilot sample of modern South Korean crania for which sex was known through DNA, dental, and/or other identification methods.

Thirty-one ethnic Korean individuals in this study represent forensic cases from various regions of the South Korean peninsula that were submitted by local law enforcement agencies to the National Institute of Scientific Investigation (NISI) in Seoul. A tooth or a small bone sample was removed and sent to the DNA Analysis Division at NISI for analysis. The amelogenin locus was used in sex determination through the Polymerase Chain Reaction (PCR) and electrophoresis of PCR products. The DNA output was submitted as XY for males and XX for females. At the Forensic Medicine Division, up to 24 cranial and ten mandibular measurements were collected as specified in the standard osteological data collection procedure (Moore-Jansen et al. 1994). Measurements from the individual cases were entered into the FORDISC program. To run the sex discriminant function, we excluded the XRB measurement, or maximum ramus breadth, in all individuals as the inclusion of XRB dramatically reduced the group samples and the analysis was not possible.

FORDISC correctly classified the sex in 26 individuals (83.9%). Of the five that were misclassified, two individuals had cranial measurements which placed them close to the sectioning point or the overlapping region. Three of the five individuals were females and misclassified as males and two males were misclassified as females. It was expected that the software program would be applicable to modern Koreans due to their close affinity to the Chinese and Japanese populations, which are included in the FORDISC reference groups. However, the software should be tested on a larger Korean sample, and although ethnic Koreans in South Korea are relatively homogeneous, the need for FORDISC in Korea may be necessary due to the recent influx of immigrants from many regions of the world. As the authors of FORDISC intend, the FDB will continue to expand on the number of cases with definite sex and ethnicity and incorporate them into the database. Therefore, it is recommended that forensic anthropologists continue to employ multiple metric and non-metric methodologies when estimating sex and other individual characteristics.

FORDISC, Discriminant Function, Korea

H101 Sexual Dimorphism in the Juvenile Skeleton

Kyra Elizabeth Stull, BA, Mercyhurst College, 501 East 38th Street, Erie, PA 16546*

The research will introduce a study based on fetal development and sexual differentiation as well as sexual dimorphism among juvenile skeletons during the first year of life.

The primary purpose of the current study is to investigate sexual dimorphism among juvenile skeletons through radiographic analysis. The metric results will impact both sex determination as well as age determination of juvenile remains.

Reliable sex estimation can be attained from different skeletal elements in adult individuals. The secondary sexual characteristics in which adult sexing techniques are typically based are linked to the pubertal hormonal surge. The resulting skeletal size and shape differences are therefore absent in immature individuals. Consequently, it is often assumed that accurate sex estimation based on metric characteristics or morphological traits is not attainable before puberty.

Still, from early embryological stages to the first year of life, humans experience a sexual hormonal surge as intense as that linked to pubertal sexual differentiation. Embryologic development is identical in both sexes until 8 weeks after conception, when the indifferent gonad develops. Testicular differentiation of the male is then triggered and regulated by the Sry gene, located on the Y chromosome. By week 12 the differentiation is largely complete, with characteristic male and female structures developed. In total, the most critical period for sexual differentiation seems to span from the 8th to the 24th week, but testosterone levels in males remain elevated for the first year of life, peaking around 3 to 4 months after birth. This postnatal period is known as the *neonatal surge*, where hormonal levels are equivalent to those in the second stage at puberty, the *pubertal surge*, when the secondary sexual characteristics develop.

It is therefore reasonable to assume that the hormonal changes experienced during the neonatal surge could result in a substantial amount of sexual dimorphism in the infant skeleton, which would allow for the development of reliable metric sexing techniques for this period.

The present study explores the presence of metric sexual differences in the juvenile skeleton. The study focuses on long bone dimensions, as a potential size dimorphism would also affect age estimates obtained from long bone measurements. The study sample consists of a set of radiographs assembled from the Erie County Medical Examiners Office, Buffalo, New York, as well as from forensic cases from Mercyhurst College. The radiographs involve juvenile individuals of known age, sex, and ancestry. The presence of sexual dimorphism in growth patterns and allometric relationships between different long bone dimensions was tested through ANCOVA (Analysis of Covariance) models. When applicable, the accuracy and reliability of the obtained sex markers were assessed through cross-validated percent correct classification estimates.

The obtained results impact both sex determination, and current standard age determination from long bone dimensions in infants.

Juvenile Sex Determination, Sexual Differences, Sexual Dimorphsim

H102 Coming Unglued: The Use of Acrylic Resin Adhesives in Forensic Reconstruction

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After viewing this presentation, attendees will gain a greater appreciation for the use of polymer resin adhesives as an alternative to cellulose nitrate adhesives, such as Duco® cement, for reconstructing fragmented skeletal remains.

This presentation will impact the forensic community by demonstrating the advantages of using a non-destructive adhesive with reversible properties for reconstructing fragmented and/or burned skeletal remains.

Forensic anthropologists are often confronted with fragmented remains that require reconstruction. Adhesives are commonly used to refit bone fragments to aid in trauma analysis, identification of burn patterns on thermally-altered remains, the establishment of the MNI, and in the construction of the biological profile. Reconstruction is often a means to an end, thus, little attention has been focused on the long-term impact of different adhesives on bone. The use of a high-quality adhesive with reversible properties is beneficial in forensic reconstruction for a myriad of reasons. For example, if fragments are incorrectly refitted, the choice of adhesive will determine whether or not the process can be reversed, and also the degree to which fracture margins are chemically altered. This has medico-legal implications, as cases may need to be re-examined in the future by other specialists using new methods.

Acryloid B-72 (Paraloid B-72) is a common type of acrylic polymer resin used by practicing conservators for reconstructing archaeological materials. Chemically, it is a methacrylate ethylacrylate copolymer that can be used as both a consolidant and an adhesive by varying the amount of a solvent, such as acetone or ethanol. Acryloid B-72 is converted into an adhesive by allowing the solvent to evaporate over a period of hours, leaving the adhesive behind. By adding solvent, the adhesive can be reconstituted to varying degrees of thickness. The process can be easily reversed by applying acetone to the area where bone fragments are conjoined. Museum conservators currently favor acrylic-based adhesives due to their high stability, transparency, mechanical resistance, and reversibility (Koob 1986). The same features that have made acrylic-based adhesives attractive to the conservation community can also be used by those working in forensic anthropology. The resistance of Acryloid B-72 to brittleness, cracking and yellowing, while still providing strength and hardness make it ideal for use in forensic reconstruction. Conjoined fragments can later be separated by applying acetone to the fracture margins. This is critical if fragments are not reconstructed correctly the first time, or if there is a later need to examine fracture margins microscopically.

Acrylic resins are generally better alternatives to cellulose nitrate adhesives such as Duco® cement. Cellulose nitrate is a non-synthetic polynitrate ester of polysaccharide cellulose (Selwitz 1988). Unlike acrylic-based adhesives, cellulose nitrate resins have been found to be unstable over time, and often shrink, become brittle, and turn yellow in color. The chains of polymers in cellulose nitrate resins will also eventually crosslink, making the adhesive irreversible. Moreover, if cellulose nitrate becomes brittle, it may also pull bone away from the conjoined bone fragments, causing permanent damage to the fracture margins. As a result, the conservation community no longer recommends cellulose nitrate for use adhesive joins and repairs. Yet, the use of Duco® persists in archaeology and forensic anthropology for reconstructing fragmented remains. Cellulose nitrate maintains popularity due to its low cost, accessibility, familiarity, and rapid drying time (Johnson 1994).

To better understand the effects on bone of using acrylic versus cellulose nitrate adhesives, chemical cross-linkage and damage to bone fragment margins were examined microscopically. Non-human bones were mechanically broken and rejoined using acrylic adhesive and cellulose nitrate resin. Acetone was later applied to the bone surface margins to reverse the adhesives. Using microscopic images, the degree of damage to fracture margins treated with acrylic versus cellulose nitrate adhesives was compared, as well differences in the degree of reversibility.

This study was conducted to provide the forensic community with a greater appreciation for the suitability of acrylic adhesives in reconstructing fragmented skeletal remains, especially in cases that may be subject to future examination. While acrylic adhesives may not be ideal in all conditions (e.g., wet bone, temperatures over 40º Celsius), they are better suited for forensic purposes than cellulose nitrate adhesives, due to their minimal alteration of fracture margins, and their greater strength, stability, and long-term reversibility.

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Adhesives, Forensic Reconstruction, Fragmentation

H103 Biomechanics of Blunt Ballistic Impacts to the Head and Fracture Specific Injury Criteria Development

David Raymond, MS, Greg Crawford, MS, Chris Van Ee, PhD; and Cynthia Bir, PhD, Wayne State University, 818 West Hancock, Detroit, MI 48201*

After attending this presentation, attendees will be presented with a unique set of data regarding the biomechanics behind depressed comminuted skull fractures and blunt ballistic impact to the head. Engineering parameters responsible for the response and tolerance of the skull to blunt a ballistic impacts will be discussed with focus on the development of a new injury criteria for use in forensic case work.

This presentation will affect the forensic community by offering leading-edge scientific data set on skull fracture from blunt ballistic impact and of the depressed, comminuted fracture type. Investigators will gain insight into biomechanics of skull fracture and the development of unique injury criteria for application in forensic reconstruction of skull trauma.

Forensic applications of injury biomechanics is a unique and emerging field. Forensic biomechanics deals with reconstructing events that led to a documented injury. Skull fractures are forensic evidence that may be related to direct contact to the head by an external object and can assist in reconstruction of the impact conditions leading to the trauma. Circumstances leading to skull trauma may not always be known due to the lack of witnesses, inability of the patient to recall or articulate the events that led to the trauma or patient death. A forensic biomechanist may be brought in to work with a forensic pathologist or a forensic anthropologist to relate the mechanics involved with causing particular types of skull fractures. He/she may perform evaluations of various impact scenarios using biomechanical surrogates and injury criteria to assess the likelihood of producing fractures that match the physical evidence. Unfortunately, the current injury criteria and biomechanical surrogates developed by automotive safety researchers fall short of providing necessary information for the reconstruction of specific fracture types. Head injury criteria and biomechanical surrogates are currently needed for fracture-specific risk assessment. The primary goal of this research was the advancement of fracture-specific head injury criterion for the assessment of blunt ballistic lateral head impacts.

Experimental impact testing was performed on eight (8) isolated, unembalmed postmortem human subjects. Specimens were impacted laterally in the region of the squamosal temporal bone with a 38 mm diameter rigid impactor, launched via a ballistic air cannon. Specimens were instrumented with a nine-accelerometer array to document global head response. Local bone response was measured by three Rosette-style strain gages attached to the outer cortical layer surrounding the impact site. Soft tissue was left intact at the impact site. Impact force was calculated from a 20,000 g accelerometer mounted to the rear aspect of the impactor. High speed video captured the impact at 10,000 frames per second. Post-test CTs were obtained along with detailed autopsies documenting resulting fracture patterns. Fracture criteria were explored through logistic regression analysis of measured parameters and compared with previously developed head injury criteria. Goodness of fit was evaluated by the chi-squared statistic, p-value and Nagelkerke R^2. Significance levels were set at $p < 0.05$.

Sixteen impacts were performed resulting in fractures to eight specimens with an average peak force of 5,079 ± 1572 N. Fractures were primarily depressed comminuted in nature. Acceleration from the array indicate that the skull does not respond as a rigid object under these loading conditions which limits the ability to utilize the nine-accelerometer array for estimating center-of-gravity acceleration. Deformation-based measures should be investigated further in future experimental studies.

Logistic regression results indicate that strain-based measures were statistically significant predictors of fracture followed by acceleration of the head ($P < 0.05$). While impact force demonstrated increase risk of fracture with increasing force, this was not a statistically significant predictor of fracture ($P=0.054$).

Technical limitations currently exist for developing strain or deformation-based criterion for use with biomechanical surrogates. Current biomechanical models are not equipped to measure skull deformation or strain. These measures are currently most effectively measured through finite element models. The basic biomechanical data from this study will first and foremost serve as validation for advancement of finite element models of the head to the blunt ballistic impact environment. Additional efforts can then be put forward into development of an advanced fracture-prediction model. The current results indicate that effort should begin with strain-based criterion for blunt ballistic temporo-parietal skull fracture.

Biomechanics, Skull Fracture, Ballistic Impacts

H104 Detection of Gunshot Residue (GSR) on Bone: Potential for Bullet Direction and Range Estimation

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After attending this presentation, attendees will appreciate the potential of using Scanning Electron Microscopy (SEM) with Energy Dispersive X-Ray Analysis (EDXA) to confirm both visually and by elemental composition, the presence of gunshot residue (GSR) on bone with the additional prospect of direction and range estimation.

This presentation will impact the forensic community by presenting findings that may potentially lead to the development of techniques to estimate the distance of shooter to victim by the presence of GSR on bone.

The purpose of this study was to determine if gunshot residue could be detected on bone at varying distances by visual means using Scanning Electron Microscopy as well as by elemental composition using Energy Dispersive X-Ray Analysis. Six pork ribs were shot at distances of one through six feet at one foot increments using American Eagle .45 caliber, 230 grain, full metal jacket bullets. Each rib, with the meat intact, was placed inside a plastic Ziploc® bag and shot with the bullet penetrating the plastic, approximately one inch of muscle tissue, and the bone from external to internal surface. After each rib was shot the meat was removed using scissors and the periosteum was forcibly stripped from the bone. The ribs were placed in paper bags and put into an incubator to dry at 40 degrees Celsius (approx. 104 degrees Fahrenheit) for five days. The ribs needed to be completely dry so that vacuum could be achieved in the SEM without contaminating the instrument. After the ribs were dried they were removed and allowed to cool. The ribs were not coated with conducting material, such as gold or carbon as is common practice, in an attempt to be as non-destructive as possible.

The fracture pattern associated with each rib was examined in order to verify the entrance side of the bone. For ease of placement of the rib into the specimen holder, the exit side of the rib was defined as the side of the bone directly opposite to the determined entrance side. The ribs were then positioned in the specimen holder so that the analysis could be performed on either the entrance or exit side of the bone and then placed in the specimen chamber of the Hitachi VP-SEM S-3400N for analysis.

Visual analysis was performed as close to the fracture site as possible at 20kV and a working distance of 10mm. An area of high concentration of gunshot residue was identified and micrographs were taken of the site. The initial micrograph taken at 130X magnification was used to count the number of GSR particles present in a 400µm diameter circle. This initial micrograph

was chosen due to the nature of the GSR particles as they tend to melt after a prolonged period under the electron beam. Elemental analysis was performed using the Oxford INCA Energy 200 Dispersive X-Ray Analyzer over the area of high concentration of GSR particles at 270X magnification, which was chosen due to the GSR particles melting part of the way through the analysis if performed at a higher magnification. Elements of interest that were identified were Lead, Antimony, Barium and Molybdenum which are known components of GSR.

Results indicate that this is a feasible means to identify the presence of gunshot residue on bone both visually and elementally using SEM/EDXA from distances ranging from one to six feet. There is potential for visually differentiating between the entrance and exit sides of the bone as the gunshot residue appears to distribute differently on each side. Additionally, this technique may hold potential for the development of an objective method for estimating firearm to target distance as the number and diameter of GSR particles counted in this study tended to decrease with distance. Since the forceful removal of the periosteum did not seem to interfere with the adherence of these particles to the bone, further testing is planned to determine the affects of decomposition on GSR on bone.

Gunshot Residue, Terminal Ballistics, Gunshot Trauma

H105 Determination of Low Velocity Bullet Trajectory in Long Bones: An Experimental Investigation

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After attending this presentation, colleagues will understand the different methods previously employed to determine direction of fire in the skull, and the importance of experimental study to determine if the method can be translated to postcranial long bones. They will understand the main components of factors that can be employed to determine direction of fire: beveling, entrance and exit wound morphology, and fracture sequencing. They will also see that from experimental investigation, it was determined that the most efficient method for determining direction of fire includes all three factors, as each on its own is insufficient.

This presentation will allow the forensic community to learn of a method for determining direction of fire developed from experimental study as opposed to case study. This will in turn give forensic practitioners another method to reconstruct the events of a crime, differentiate between homicide and suicide and confirm or contradict a witness statement.

Handguns are by far the most common weapon used in violent crimes in the United States (Federal Bureau of Investigations, 2005). Determination of the direction of fire can be used to evaluate witness statements, to differentiate between manners of death (e.g., homicide versus suicide), and to reconstruct events in mass homicides to enable authorities to prosecute guilty parties. Soft tissue markers used by pathologists may not be available if the remains are skeletal.

The publications regarding the estimation of bullet direction in the cranium have been of two main types: determination of entrance and exit wounds by interpretation of defect beveling (Quatrehomme and Iscan, 1998), and analysis of fracture sequence (Sexton, 1979; Dixon, 1984; Smith, et al. 1987). Publications on bullet trajectory in postcranial bones are available (Berryman and Gunther 2000; Langley 2007), but tend to be case studies without controlled factors. Therefore, an experiment was designed to produce gunshot wounds from known directions in the humeri of domestic pigs (*Sus scofa)*. The hypothesis was that the methods used for the cranium would be useful, but may need to be refined due to the very different bone morphology in postcranial long bones.

Twenty humeri from recently deceased articulated pigs were shot with a .357 Magnum full metal jacketed bullet in the midshaft: three from anterior to posterior, three from posterior to anterior, three from medial to lateral, and three from lateral to medial. The remaining eight humeri were shot from directions unknown to the researcher in order to permit a blind study of any method developed from the wounds of known direction. It was found that the humerus of the domestic pig was difficult to shoot when still articulated, and therefore 12 more humeri, clear of flesh but still very wet, were shot at a later date with the same bullet type and from the same distance. After determining that there were no significant differences in the fracture patterns between the fleshed and de-fleshed wet bones of the two shooting periods, the sample contained 22 humeri. Five bones were not used as they were missing a significant number of fragments, were hit tangentially or not hit in the shaft. All five experimental bones that were hit had damage only in the proximal epiphysis; therefore, 12 bones of known direction were present in the final sample.

Beveling was defined as the amount of exfoliation of the bone surface divided by the cortex breadth in order to eliminate any effect this factor may have on beveling. There was significantly more internal beveling of entrance wounds than exits, and more external beveling on exit wounds than entrances. There were, however, two exit wounds that exhibited some amount of internal beveling, supporting earlier conclusions that lack of internal beveling is not a consistent indicator of an exit wound (Quatrehomme and Iscan, 1997, 1998). As expected, the size of the exit defect was significantly larger than the entrance defect. Entrance defects tended to be circular or ovoid in shape, and exit defects tended to have less defined edges and a more rectangular shape. However, none of these patterns were present in the entire sample.

The humeri in this study tended to fracture in a double butterfly pattern, with primary radiating fractures emanating from the superior and inferior aspect of the entrance and exit. When fractures were sequenced, eight of twelve bones had radiating fractures from exit wounds that were halted by those from entrance wounds. In two bones, all fracture lines were ambiguous, and in two bones fractures from the exit halted fractures from the entrance, contradicting the sequencing theory.

It was concluded that each analysis outlined above was not a consistent indicator of directionality on its own, but a method that included all of them (beveling, entrance and exit defect size and shape, and fracture sequencing) would be more effective. In the absence of the blind experimental group, this comprehensive method was taught to five forensic anthropology colleagues with no special background in gunshot trauma. Four colleagues correctly identified all twelve trajectories, and one colleague correctly identified 11 out of 12 trajectories. However, further research in this area is indicated, as a larger sample size would greatly benefit this study.

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Gunshot, Postcranial, Trajectory

H106 Fragmentation Patterns of Victims From a Fatal Aviation Accident

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After attending this presentation, attendees will gain an understanding of how fragmentation patterns of the victims can assist in the analysis and investigation of plane crashes and the events prior to the crash. This study will evaluate if there exists a fragmentation pattern of victims in high velocity impact plane crashes as well as a relationship between the assumed seat locations of the victims and the extent of their injuries.

This presentation will impact the forensic science community by demonstrating the ways in which the examination of the fragmentation patterns of human remains can add to the investigation of plane crashes as well as the recovery of human from the scene. In addition, it explores how this information can aid physical anthropologists during the triage of human remains from an aviation accident.

On November 12, 2001, American Airlines Flight 587, a regularly scheduled passenger plane bound for Santo Domingo, Dominican Republic, crashed in a residential area in Belle Harbor, New York, shortly after take-off from JFK International Airport. All 260 people aboard the flight, including the pilot, co-pilot, seven crewmembers and 251 passengers, were killed. In addition, five people on the ground were killed. This presentation assesses the injury and fragmentation patterns of Flight 587 victims in correlation with their seat location on the plane. Previous studies of injuries of plane crash passengers focused on determining whether the injuries were preventable and, if so, suggested safety features to reduce airline crash related casualties. In view of the Flight 587 passengers having no chance of survival, the objective of this study is to evaluate if there exists a fragmentation pattern of victims in high velocity impact plane crashes as well as a relationship between the assumed seat locations of the victims and the extent of their injuries. After attending this presentation, attendees will gain an understanding of how fragmentation patterns of the victims can assist in the analysis and investigation of plane crashes and the events prior to the crash.

In total, 2,058 body fragments were recovered. To date, 1,750 bodies and body fragments are identified and 308 remain unidentified. There were 112 nearly complete bodies recovered, including the five on the ground, 163 partial bodies, and 1784 fragments. Autopsies were conducted on 251 of the mostly whole and partial remains by Medical Examiners from the Office of Chief Medical Examiner, New York City. The autopsy reports of the victims include detailed information about the nature and extent of injuries. The descriptions of smaller fragments are less detailed but they include information regarding the body part, its size, and the extent of any burning. As in other disasters, the inclusion of physical anthropologists is pivotal in recognizing and accurately describing the fragments so as to obtain more detailed information to use in conjunction with Medical Examiner reports. Using these reports, the injuries of each victim are classified by location (head/neck, face, thorax, abdomen, extremities, and external) and their severity is scored following a revision of the Abbreviated Injury Scale system. The injury scores and the number of fragments that have been identified for each victim are examined in conjunction with the location of the victim's seat.

Preliminary results of Flight 587 show that 35 nearly complete bodies from victims seated in the front half of the plane were recovered compared to 70 from the back half of the plane, consistent with a nosedive crash. In addition, 75% of autopsied victims had avulsed brains and crushed skulls with lower limbs as the most frequently amputated body area suggesting considerable forward motion at high velocity; the last recorded airspeed of Flight 587 was approximately 288 miles per hour. Although witness reports suggest that the plane was banking to the left prior to crashing, 1,207 body remains of victims seated on left side of the plane were identified while only 433 remains from victims seated on the right side of the plane were identified. These results imply the remains of victims seated on the left suffered less postmortem damage facilitating both recovery and identification. Some witness reports also recalled a fire in the middle of the plane prior to crashing, however no autopsied victims, except those on the ground, had soot in the airways.

The fragmentation pattern from this flight, which crashed shortly after take-off and in a nosedive with no prior explosion, can be compared to other flights to find similarities and differences in patterns. For example, TWA Flight 800 was also a high impact crash with no survivors however, Flight 800 exploded in mid-air prior to crashing into the Atlantic Ocean. Unlike Flight 587, the TWA 800 investigators found no correlation between severity of injury and structural damage or seat location and no predominant injury to the upper or lower extremities consistent with an explosion (Vosswinkel and Brathwaite 1999). In addition, understanding how bodies fragment during a high velocity impact may aid anthropologists in disasters to re-associate remains during triage while sorting through commingled and fragmented remains.

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Aircraft Crash, Fragmentation Patterns, Multiple Fatality Incident

H107 Effect of Loading Environment on the Healing of Long Bone Fractures

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The educational goal of this presentation will examines the timing of the healing sequence in long bones, without the aid of modern medicine, and investigates the effects of loading on the appearance of healing stages.

This presentation will impact the forensic science community by examining the effects of various factors on the appearance of healing stages, practitioners will be better able to determine the timing of a particular traumatic event in cases of abuse and in the identification of postmortem remains.

There have been several studies done to create a timeline for the healing of fractures using a variety of technologies. With the exception of a study on crania, these have focused primarily on long bones. Though these studies roughly agree on the timing of important stages in the healing process, none has addressed the observed difference between weight-bearing and non-weight-bearing bones, especially during the critical callus formation stage. Previous work used a variety of long bones to increase the available sample size from clinical settings. By using a historical population and focusing on two analogous bones, this study uses an increased level of variable control to determine if this difference exists without the benefit of modern medicine and if it is significant.

The Civil War Collection at the National Museum of Health and Medicine was used for both its size and documentation. Only femora and humeri were utilized from this collection as they were analogous but in different loading environments and only those caused by shot fractures, treated by the removal of the affected bone, and with the necessary documentation were included. This limited the sample size to 130 humeri and 62 femora. All the included fractures were comminuted. The healing stage of each specimen was noted and separate timelines created for the femur and the humerus. Those were then compared to find any differences between them.

Initial callus formation was seen at approximately 44 days (6 weeks) for the femur and 62 days (9 weeks) for the humerus. Callus formation was complete by 145 days (~5 months) for the humerus, with an outlier at 219 days still forming a callus. Femora did not complete callus formation for 328 days (~11 months), with a severe case not completing formation in 525 days. It should be noted that the fractures included in this study were severe with little attempt at resetting the bone. This callus initially appears lumpy and disorganized in appearance but will remodel to a smooth callus in about 9-10 months for a humerus, however a femur requires more than a year to reach this stage. The length of the callus formation stage between these two bones is significant with $\rho = 0.028$ while the timing of these stages overall is not statistically significant, though there is a trend for the humerus to start later. With the use of modern medicine, callus formation begins at 7-10 days and ends in 6-8 weeks on average.

The differences seen in healing time and the length of stages between femora and humeri is likely due to differences in mechanical environment, a femur bears weight while a humerus does not. Though these timelines are rough, they illustrate that mechanical environment has a large affect on healing behavior. The large discrepancy between these timelines and those seen in modern medicine are likely due to a variety of causes including the severity of these injuries and lack of treatment, the prevalence of disease, and the unlikely survival of evidence for the early stages of callus formation. The use of historic populations to control for confounding variables, such as type of injury and treatment, can offer greater resolution of the factors affecting healing rates than clinical studies alone.

Biomechanics, Fracture, Healing

H108 Cranial Bone Trauma: Misleading Injuries

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Attendees of this presentation will learn from bone similar patterns of injuries how to distinguish among different weapons used in criminal cases.

This presentation will impact the forensic science community by showing how interdisciplinarity (forensic pathology-forensic anthropology) can be useful in solving homicide complex cases, even in bodies fairly well preserved.

Forensic pathologists and anthropologists are obligated to recognise traumatic patterns in soft tissue and bone. Additionally, these patterns may be analysed for potential weapons that could produce similar trauma. The cranium is commonly the area to be examined and researched in anticipation of obtaining the most information concerning the death of a victim. However, cranial injuries may take on such a capricious forms that less experienced personnel may find diagnosis difficult at best. The authors present two cases of complex skull fractures, similar in fracture pattern. Case A was a possible point of impact on the right side of skull, with radiating and concentric fractures, suggesting a gunshot wound. The other Case B, displays a quite different pattern: the body of the mandible exhibits a butterfly fracture with numerous fractures radiating across the entire cranial vault. There are numerous indicators that this is likely blunt trauma of the head.

Case A was a complete and fairly well preserved body (the head skeletonized) whose autopsy revealed neither a traumatic injury nor a natural cause of death. While the skull was suspiciously consistent of a homicide by a gunshot wound, blunt force trauma was the real cause of death. Close examination of the internal skull demonstrated internal bending of concentric fractures, as opposed to concentric heaving fractures expected with ballistic trauma. No signs of pellets or gunshot holes were found. The skull was complete, although the biomechanics of the blunt force trauma made it difficult to juxtapose all the bone fragments in the reconstruction. Mixed with the skull, the remains sent for analysis also included an almost complete skeleton of a dog.

Case B is a putrefied/saponified male found floating in a septic well, the head severely injured apparently by a blunt trauma. Police suspected a homicide and a disposed body. Observation of soft tissues and radiographs quickly dispelled criminal behavior and indicated suicide. The 12 gauge double barrel shotgun found at the bottom of the drained well, confirmed this hypothesis. Anthropological examination of skeletal trauma, particularly in the skull, often ignores internal bone surfaces. Initial examination of Case B, is an excellent example of how middle cranial fossa damage and pellet impact sites on the endocranially surface were missed. Suicide with a smaller gauge shotgun put into the mouth initially produced no signs of lead nor any entrance plug in the bone as one would expect with a gunshot wound. The biomechanics of the described fractures are discussed with emphasis on compression/tension bending of the mandible fracture, or "Kolusaiyn" fractures according to some authors, often observed in gunshot wounds to the head.

Each case presents clear examples of the potential of multidisciplinary examination of bone trauma (forensic anthropology and pathology) even in fresh corpses, in order to achieve cause of death, weapon involved, and eventually, manner of death.

Bone Trauma, Shotgun Wound, Blunt Trauma

H109 Recognizing Patterned Fire and Heat Damage to Bone

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The goal of this presentation is to investigate patterned thermal destruction of bone, particularly when applied to medicolegal analyses of victims of fire. A focused, systematic approach to burn bone analysis is proposed through the observation of definitive bone-altering characteristics indicating whether the consumption of human tissues in fire is normal or abnormal.

This presentation will impact the forensic community by elucidating thermal destruction patterns through the analysis of specific burning process signatures observed on bone while considering extrinsic properties of the fire constant.

Burned bone research is well represented in the anthropological literature yet there is little technical consensus in the procedural analysis of specific types of residual skeletal trauma. This disparity appears rooted in the varied approaches in burned bone analyses and suggests that the forensic anthropology community requires additional research and samples to achieve reliable pattern recognition. It is the intention of this presentation to identify certain heavily researched burn variables and suggest that they may be recognized as constants in an all-encompassing fire. Designation of these variables as constant influences of heat and fire on a decedent may allow burning process signatures to become decipherable.

By considering temperature, atmosphere, and duration as constants, thermal bone destruction becomes recognizable and patterned. These signatures include shielding soft tissues and body position, color change as the bone is subjected to heat-induced chemical changes, and finally heat shrinkage fractures in bone (Symes et al. 2008). If these features are documented on cases of burned remains, researchers are no longer restricted by the "constants of fire." With this theoretical basis established, researchers can understand normal burn patterns as a whole and how each bone is consumed in a fire. For the purposes of this presentation, bone fractures, as a fire process signature, are demonstrated.

While at least seven burned bone fracture types have been defined in the literature, this research has found one fracture pattern particularly diagnostic. The curved transverse fracture, sometimes labeled a "thumbnail fracture," has been recognized and debated for decades in the literature by anthropologists. The research will demonstrate that curved transverse fractures not only indicate fleshed body consumption, but these also specify the direction of destruction on that element. By understanding the direction of bone destruction on major elements, the pattern of destruction of the individual can be documented and evaluated for normalcy.

Curved transverse fractures are a reflection of a pattern that is well documented in victims consumed by fire – the pugilistic posture. The pugilistic posture is initiated by contraction of muscle fibers due to heat destruction as flexors generally override the extensors. This posture is retained until structures are destroyed and no muscle fibers cross joints to influence limb position. Curved transverse fractures on long bones are simply a reflection of this muscle destruction and contraction.

Heat altered muscle shrinkage action is discontinuous in nature. While the tension on muscle fibers is constant, their movements are not. The discontinuous nature is facilitated by increasing tension on the muscles and subsequent destruction of muscle and bone around the heavily burned attachment sites. As stretched muscle bundles eventually break free of attachments, muscle tension is temporarily relieved until heat once again produces more shrinkage. While at rest, muscle bundles create a line that will demarcate the next curved transverse fracture. As major muscles intermittently shrink up the shafts of bone, the residual curved transverse fractures inadvertently document direction of bone destruction specifically at that point on that element.

In presenting this research, the authors simplify the complex and overwhelming destructive results associated with remains recovered from fire scenes. By illustrating a single burning process signature, curved transverse fractures, this presentation focuses on just one of three major variables that assist in the recognition of typical fire destruction of a fleshed body. As these data become increasingly recognizable, the process of thermal bone destruction is found to be patterned, predictable, and eventually useful in recognizing atypical behavior associated with victims of fire.

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Burned Bone, Skeletal Trauma, Burn Fracture Pattern

H110 Missing in Amazonian Jungle: A Case Study of Suspected Dismemberment

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After attending this presentation attendees will understand the differences that exist between cut marks caused by bladed instrument and power saw in a case of homicidal dismemberment.

This presentation will impact the forensic community by showing the benefits of an experimental approach using an animal model when examining forensic cases of suspected dismemberment under technological constraints.

The aim of this presentation is to illustrate a practical approach in the analysis and interpretation of bone trauma related to a possible case of dismemberment.

Intentional separation of body fragments is well documented in forensic literature. Generally, injuries related with dismemberment are caused by cutting, chopping and chiseling. Biomechanical properties of bone are essential for the analysis and interpretation of cut marks as the bone response will differ according to location, frequency and causative agent. Dismemberment patterns are of particular importance as the actions and instruments used are a clear expression of the perpetrator intentions and therefore the manner of death can be established.

This case study present the results of a forensic examination performed on three sets of disarticulated and incomplete human remains found in Amazonian jungle. A few months before this finding, two European tourists went missing in this area. Anthropological analysis for identification and the clothing associated with the decomposed remains were consistent with the antemortem data of the two missing persons. Body parts sustained a number of cut marks situated on different aspect of the skeleton. Despite intensive searches including a canine team, the recovery of victim's remains was not complete (one of the two is only represented by lower half part of body). The location (Amazonian jungle) and the perpetrators actions (dismemberment and dispersion of body parts in river) were effective. DNA analysis was performed and confirmed reassembly of body parts and identification of the two victims.

Each cut mark was fully described with location, number, type (e.g., false start) and measures (e.g., width, length and depth) following standard anthropological protocols. An experimental study was conducted by the author on pig bones and pieces of wood to examine and compare wound and witness marks produced by different instruments in order to corroborate causative agents and evaluate the manner of death. Despite incompleteness of the remains and a lack of laboratory facilities, a reconstruction of the possible sequence of traumatic events based on results of forensic examination and an experimental study provide evidence for a first attempt of dismembering at the level of knee joint of one of the victim with a long and heavy blade (possibly a machete) follow by a successful separation of body parts (trunk, legs…) using a power saw that have caused most of the damage present on both victim's remains. The cause of death was ascertained for one of the two victims showing a penetrating injury through the right scapula inflected by a sharp bladed instrument. Due to its location the injury was considered as lethal.

This case study constitutes for the forensic community a complement of the researches on bone trauma related to dismemberment activity trough an anthropological and practical approach based on an experimental comparison of cut marks with a basic microscope, looking at a variety of weapons and mechanism of injury.

Dismemberment, Bone Trauma, Forensic Anthropology

H111 An Epidemiological Study of Trauma in U.S. Casualties of the Korean War

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After attending this presentation, attendees will better understand the relationship between paleopathological diagnosis of skeletal trauma and historical epidemiology. Attendees will learn the value of this approach as a tool for predicting and recognizing patterns of combat-related trauma.

This presentation will impact the forensic community by illuminating the relationships between paleopathology and epidemiology and their utility in the forensic identification process.

Data on antemortem and perimortem trauma was collected between 1996 and 2007 from more than 70 skeletons of U.S. casualties of the Korean War. While the CIL does not conduct analyses of perimortem trauma for medicolegal purposes—no judgments of cause or manner of death are associated with CIL identifications—skeletally visible antemortem traumata can be compared with individual biographical records, and perimortem traumata can be compared to historically documented circumstances of death.

These data were compared with three related data sets. The first set includes the records on file at JPAC for skeletons from putative U.S. casualties processed by the Central Identification Laboratory in Kokura, Japan, in 1953 and subsequently buried as Unknowns in the National Memorial Cemetery of the Pacific ("the Punchbowl"), Honolulu. Both perimortem and antemortem trauma were recorded during anthropological analyses of these remains. The second set is the electronic database CARIS (Centralized Remains Information System), maintained by JPAC, which contains biological profiles for all unresolved (and a few resolved) casualties of the Korean War, as well as other conflicts, including records of antemortem trauma. The third set includes the data tabulations of perimortem trauma in two separate studies of combat casualties in the Korean War.

Deaths in the Korean War, as in other conflicts, can be divided between those that occurred on the battlefield and those that occurred elsewhere. Logically, the causes of death may be expected to differ between these venues. For this reason, the JPAC-CIL sample consists primarily of those skeletons excavated in or around battlefield locations during the Joint Recovery Operations (JROs) conducted in the Democratic People's Republic of Korea from 1996 to 2005. These are supplemented by multiple skeletons originally 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. These particular skeletons are also believed to derive from battlefield contexts. Those turned over to the U.S. by North Korean authorities between 1990 and 1994, many of which were alleged to come from Prisoner-of-War holding locations, will not be considered, nor will those recovered from sites in South Korea. Similarly, the historic epidemiological data on locations of wounds comes from those who were Killed in Action (KIA) as well as those who were Wounded in Action (WIA) and subsequently Died of Wounds (DOW). Whenever possible, the KIA numbers, which should be most directly comparable to the battlefield skeletal data, will be considered, although some remains from JROs have subsequently been identified as individuals known to have been treated for their wounds at an aid station.

In current death investigations, forensic anthropologists are often called upon to address the circumstances of death, although not generally the cause or means, and as a result, the discipline has developed numerous techniques for reconstructing perimortem traumata. These techniques are generally applied to each skeleton as an individual case, with limited epidemiological applications (c.f., Baraybar 2007). For homicide victims, far more comprehensive and accurate epidemiological data can be provided by pathologists than by anthropologists. In historic and prehistoric contexts, bioarchaeologists may also address the circumstances of death for isolated individuals, but their general concern is paleoepidemiological, particularly for populations that lack significant demographic documentation. The sample considered here provides an opportunity to test whether a population-level study of trauma from an archaeologically derived skeletal sample is actually representative of what is historically documented about that population.

Paleopathology, MIA, Combat

H112 The Utility of the Identification Unit Concept in the Medical Examiner Setting

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This presentation will demonstrate the formation, standard operating procedures, and immediate value of a specialized medical examiner identification unit staffed with anthropologists. Attendees will be given a comprehensive description of the innovative process that has led to success in difficult identifications of unidentified decedents for both current and cold cases at the Harris County Medical Examiner's Office.

The development of a specialized Identification Unit staffed by anthropologists in the medical examiner office setting will impact the forensic science community by demonstrating a novel and creative solution to the problems associated with identification of unknown individuals.

Recent progress on the identification of three remaining decedents from the Houston "Mass Murders" of 1973 will be highlighted.

The Harris County Medical Examiner's Identification Unit (ID Unit) ensures all avenues available to identify an unknown decedent are pursued and all unclaimed decedents receive an appropriate and timely final disposition. The responsibility of the ID Unit is threefold: (1) to construct and disseminate complete unknown decedent descriptions, obtain all postmortem records, and submit biological samples for the purpose of identification, (2) to maintain and regularly audit case files of unidentified decedents for application of new technologies when appropriate, and (3) to process unclaimed decedents for final disposition. The ID Unit uses autopsy findings and anthropologic analysis to construct the biological profile of unknown decedents and disseminates the information to law enforcement, the media, and several websites. Biological samples are collected and submitted to the University of North Texas to be entered into CODISMP. Full skeletal radiographs and dental radiographs are taken and compared to possible matches as necessary. Cold cases of unidentified remains are audited for completeness and accuracy. In cooperation with the Harris County Community and Economic Development Department, unclaimed decedents and families in need of assistance for funeral arrangements are referred to Harris County Bereavement Services.

Each member of the ID Unit takes the major responsibility for a set of related tasks beyond anthropologic analysis, although all are cross-trained in ID Unit responsibilities. The collaboration of anthropologists and a full-time Identification Specialist at the HCME has provided the initiative, experience and staff time to move forward on difficult identifications of both current and decades-old cases, as well as provide for final disposition of those decedents without resources. As a direct result of this new program, three decedents from 1980s' cases have recently been identified and the next of kin notified. Significant progress has also been made on the identifications of three adolescent male decedents received by the HCME 35 years ago as alleged victims of a serial murderer. On August 8, 1973, seventeen year-old Elmer Wayne Henley fatally shot 33 year-old Dean Corll. The law enforcement investigation of this shooting led to the discovery of 27 adolescent male homicide victims and the eventual life imprisonments of Henley and an 18 year-old named David Brooks. Corll and 26 of the victims were brought to the Harris County Morgue (previous incarnation of the HCME) for autopsy, sending the office into disaster response mode. The majority of the victims (21) were identified within three months of autopsy and two more were identified in 1985 and 1994, respectively. The three remaining decedents are receiving special attention from the HCME ID Unit that includes a clay facial reconstruction project in collaboration with the FACES Laboratory at Louisiana State University.

Successes with these types of cold cases and the continuing improvement in all aspects of the identification and final disposition of difficult current cases demonstrates the value of the ID Unit to the mission of the HCME.

Unidentified, Anthropology, Corll/Henley

H113 Evidentiary Standards for Forensic Anthropology

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After attending this presentation, the participant will understand the importance of establishing standards within the field of forensic anthropology and the role of a Scientific Working Group.

This presentation will impact the forensic science community by emphasizing the importance of judicial representations of scientific evidence. As issues of professional standards and error rates continue to be addressed in the courts, it is imperative that the field of Forensic Anthropology be proactive by developing professional standards for our discipline. One measure to create and maintain professional standards is through Scientific Working Groups (SWG).

Since the 1993 *Daubert* ruling, many forensic disciplines including anthropology have been forced to critically evaluate the techniques and methods used in their examinations. Disciplines like forensic anthropology may be problematic in the eyes of the courts since they employ a combination of traditional scientific methodologies and less rigorous observational methodologies, as well as case study evaluations. Critical questions and admissibility criteria of expert testimony have been established over the past two decades through three United States Supreme Court decisions. The decisions put forth from *Daubert v Merrell Dow Pharmaceuticals Inc,*.[1] *General Electric Co v Joiner,*[2] and *Kumho Tire Co v Carmichael*[3] were intended to ensure the reliability and usefulness of the scientific or technical testimony admitted as evidence.[4] As a result, several recent papers have advocated more earnest consideration of the *Daubert* guidelines when conducting research and preparing testimony in forensic anthropology. This

has likely contributed to the increased awareness and interest in quantifying, critically assessing, and re-evaluating some of the techniques most often used by forensic anthropologists. The issues of professional standards and error rates, however, have been less often and less aggressively addressed. This paper aims to more specifically identify areas where the field of forensic anthropology may improve regarding these issues, and encourage discourse among anthropologists to establish and employ standards in our field.

The three court decisions, referred to as the trilogy,[4] outline the importance of judicial gate-keeping and emphasize the need for judges and legislators to set the standards for admitting testimony. It is recognized, however, that the standards for admissibility of expert testimony as determined by the courts are tethered to the standards of professional practice. Moreover, the *Daubert* opinion emphasizes that the courts should focus on principles and methodologies that underlie the evidence, not necessarily the conclusions they generate. At present there are no standards for the application of forensic anthropology methodologies including body recovery and skeletal analysis, and every organization has their own guidelines and standards their practitioners must follow. Some organizations such as JPAC and the FBI are accredited by the American Society of Crime Laboratory Directors (ASCLD), but ASCLD does not specifically recognize anthropology as an independently accredit-able discipline. The American Board of Forensic Anthropology was created to examine and certify forensic anthropologists and set standards for their individual proficiency, but this organization does not (nor does any other organization) provide protocols to ensure consistency and reliability in the application of forensic anthropological methodologies.

An additional area that the authors acknowledge as in need of improvement is validation. While anthropologists have taken it upon themselves to validate and improve methods within the field, validation studies are often problematic due to the tendency of researchers to modify or adapt the techniques rather than test the methods as originally presented. The court ultimately decides the question of appropriate validation, but forensic anthropology as a discipline must set standards for a theoretical and empirical validation process to guide researchers and assist the courts. It is also important to understand that the point of developing methods under the rubric of evidentiary examination is not to completely quantify the field, and that subjectivity does not necessarily equal unreliability. Many forensic disciplines, including identification sciences like anthropology, involve some degree of subjectivity. It is therefore imperative to minimize the risk of error through proper training, quality assurance, validation, accreditation, and certification.

Creating and maintaining professional standards is performed in many disciplines by Scientific Working Groups (SWG). A SWG consists of a group of experts in a particular scientific discipline that meets periodically to formulate and review standards (for both examination protocols and validation testing) applied in their respective fields, and standards set by SWGs are increasingly recognized and considered by courts. It is the recommendation of the authors to construct a Forensic Anthropology SWG to develop professional standards for our discipline. As the courts continue to raise the bar regarding professional standards, forensic anthropology must be committed to providing analyses that are of the highest quality and reliability, and the authors believe that creating and adhering to recognized standards will facilitate achieving this objective.

***Daubert*, Scientific Working Group (SWG), Standards**

H114 An Electronic Data Management Tool for the Search for Missing Persons and Forensic Human Identification: The ICRC AM/PM DB

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Attendees will gain awareness of a new software application to manage data related to the search of missing persons and forensic human identification. They will understand the main functions of this software and the impact its implementation can have on efforts to recover and identify the remains of victims of armed conflict.

This presentation will impact the forensic community by presenting a new software application which aims to facilitate and help standardize forensic investigations into the whereabouts of those missing as a result of armed conflict or internal violence.

Efficient management of data is essential for the quality of any forensic investigation; data standardization and centralization are especially important in larger operations which involve a variety of different actors. Experience has shown that in the absence of a readily available and universally applicable system, organisations working in the search for missing persons are often faced with the need for developing their own forms and tools, with limited capacity to take into account the experience accumulated elsewhere, and often with neither the time nor means to develop actually functional tools. Many existing systems are either not freely available and/or not designed to deal with often extensive but unspecific data managed in investigations into the fate of missing persons especially in conflict related and less developed contexts.

Thus, responding to a need identified by experts during the consultative process that was part of the ICRCs major initiative on Missing Persons launched in 2002, the ICRC committed itself to produce a set of data management tools to support forensic practitioners and others involved in the investigations into the whereabouts of missing persons.

These tools are based on the concrete recommendations developed through a number of different workshops and studies, involving academic institutions, experts and representatives of governmental, intergovernmental and non-governmental organizations from around the world. They are based on the accumulated experience of those working in the search of missing persons and identification of human remains over the last decades.

This set of tools consists of Standard Reporting Forms on AMD and PMD to give guidance and serve as a means for standardizing and maximizing the quality of the data collection process, and of a software application for the management and analysis of the collected data, to support archiving, standardization, reporting, searching, analysis and matching of data.

This tool was designed to be multilingual, flexible and configurable but user-friendly at the same time, with a strong and easy to use search engine and good provisions for data security.

The AM/PM DB comprises modules on:

- ante-mortem data, including detailed circumstances of disappearance which may lead to the discovery and identification of remains;
- recovery/field data, including data on preliminary investigations and detailed archaeological information;
- postmortem examinations, including pathology, anthropology and odontology;
- hypotheses of identity and the identification process;
- events related to disappearances or findings of human remains.

Each module can manage multiple original interviews, witness statements or postmortem examinations respectively and their consolidated information. All main entities have sections for tracking of artefacts, any kinds of documents and samples. Personal roles and contact information can be managed contextually. Furthermore, the system provides a detailed operational journal and chain of custody form.

Some special software functions are: built in methods and formulas for automatic calculations of anthropological estimations on sex, age, stature, laterality and ancestry; an automatic calculation for the MNI of commingled remains; the possibility for reassociating bones or body parts while preserving the original information; and an automated matching function, which matches all Missing Persons and Human Remains under investigation in a given context according to a number of selectable criteria designed to help reaching and then tracking hypotheses of identity, especially in operations with a large number of cases.

The tool works in a network or as a standalone system with an automatic synchronization function and is compatible with other IT tools such as the Interpol DVI and GIS software. Distribution is free.

The global challenge of investigations into the whereabouts of the missing is a humanitarian priority, which requires special tools and methods for optimizing the applicability and use of existing local and international investigative capacity. Responding to this need with this tool, the ICRC hopes to contribute to its pledge to support the forensic identification of missing persons.

Forensic Human Identification, Missing Persons, Database

H115 Elliptic Fourier Analysis of Vertebral Outlines for Victim Identification

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The presentation demonstrates a new quantitative method for obtaining a victim identification from radiographic comparison. It examines the variability of the transverse process and its utility for this task. A discussion of the applicability of the method for other postcranial elements is also provided.

This presentation will impact the forensic science community by proposing methodology provides percent correct classifications and ID probabilities appropriate for current *Daubert* compliant standards. Results suggest that EFA of the transverse process can be particularly useful to reduce large lists of potential victims, such as in mass disasters or human rights cases. Furthermore, this methodology easily allows for the direct addition of other skeletal structures to obtain even higher associated probabilities, impacting both current practice and future research.

The comparison of antemortem radiographs with postmortem radiographs or photographs is one of the most common approaches to positive identification of skeletal remains. Traditionally, the method focuses mainly on cranial and mandibular elements, such as cranial sinuses and sutures, or dental elements, including the morphology and location of dental amalgams. This is related to the high variability of the outlines of these structures, which confers them a unique individual specificity allowing reliable ID assessments, even when performed just visually. Additionally, cranial and dental radiographs are among the most commonly registered antemortem records.

Postcranial elements present some disadvantages in this respect. Many different postcranial elements exhibit a structural complexity and variability similar to those of cranial and dental structures, but their morphology is assumed to be less stable through time due to mechanical loadings and Wolff's law. The predominance of dynamic articulations also increases error rates and variability related to radiographic perspective in postcranial elements.

Within this framework, the transverse processes of the lumbar vertebrae appear as an optimal postcranial alternative for positive identification: their morphology remains relatively unchanged throughout adulthood and, unlike the spinous process or vertebral body, they very rarely experience degenerative osteoarthritic alterations over time. Additionally, antemortem radiographs of the lower back are reasonably common (primarily related to slipped vertebral discs), and pathologies and trauma observed in antemortem radiographs seldom affect the transverse processes.

Still, positive identification attempts based on this region are typically visual, lacking any assessment of the populational frequencies of the features considered and, therefore, any associated probabilities. This contradicts the *Daubert* criteria for admissibility of scientific evidence in a United States court.

The problem is common to most radiographic ID methods. Unlike fingerprints or DNA analyses, which rely on easily quantifiable discrete traits or base sequences, radiographic methods (with the exception of those relying on the presence or absence of dental elements or supernumerary bone structures) are mainly based on the matching of continuous outlines. Apart from the problematic definition of quantifiable landmarks, these types of structures are also affected by perspective variations between the ante- and postmortem records. The development of geometric morphometric methods during the last two decades, has created a new source for the identification and analysis of new structures that can provide *Daubert*-compliant identity assessments.

The present study applies one of these techniques, Elliptic Fourier Analysis (EFA), to develop a new method and assess the utility of vertebral transverse processes for positive identification from antemortem radiographs. Parting from an approach similar to that of Angi Christensen (2003, 2004, 2005), antemortem and postmortem sets of records are simulated for a sample of 85 second lumbar vertebrae. Slight perspective differences between "antemortem" and "postmortem" radiographs were introduced to approximate the conditions expected in real forensic settings. Outlines of all left transverse processes were then produced, and transformed into Euclidean distances between all possible pairs of transverse processes after EFA and principal components analysis (PCA).

The modification of Christensen's methodology, through the introduction of PCA, serves to modify the variable space to produce orthogonal variables. The Euclidean distances are more appropriate in the new orthogonal space (becoming equivalent to weighted estimates, such as Mahalanobis distances, in non-orthogonal spaces), providing a more accurate description of overall shape differences. The stepwise estimation based on the percent of common variance explained, inherent to the PCA method, also serves to weigh the relative contribution of each harmonic to the characterization of the individual outlines. Finally, the examination of the principal components, representing meaningful shape differences, serves for a more revealing interpretation of the results, as well as to detect data input and recordation errors.

Confidence intervals for the distance between matching pairs were then produced, and this criterion used to assess the possibility of two records representing the same individual. The results show that this methodology provides percent correct classifications and ID probabilities appropriate for current forensic standards, even when large lists of potential victims are considered. Furthermore, this methodology easily allows for the direct addition of other skeletal structures to obtain even higher associated probabilities.

Geometric Morphometrics, Identification, Transverse Process

H116 Left Hanging in Mandeville: Multiple Approaches in Search of a Positive Identification

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The goal of this presentation is to illustrate how multiple lines of investigation can be used to develop an identification in cases where decomposed remains of unknown decedents are found. Particularly in cases of indigent or transient individuals, few leads may be available. In such cases, if no potential matches can be made with missing persons reports, alternative strategies such as facial reproduction, press conferences, and DNA analysis may be necessary.

This presentation will impact the forensic community by illustrating the importance of multidisciplinary collaboration in the identification of unknown skeletal remains.

This presentation highlights a case from Louisiana which presented few leads and little hope for a successful identification. In 2006, a boy riding an ATV through a wooded area found what appeared to be a human skull and other bones underneath a large tree. Still hanging from a branch above was a largely skeletonized trunk and limbs, wearing jeans and a shirt. The boy returned home and notified the St. Tammany Parish Sheriff's Office, which sent officers to the scene, along with death investigators from the St. Tammany Parish Coroner's Office. The remains in the tree were found to be hanging from a nylon rope with a simple slip knot encircling the neck area, suggesting that the death may have been a suicide. The scene was photographed and described, and the human remains and clothing were collected.

Staff from the coroner's office brought the human remains and clothing to Tulane University's Forensic Anthropology Laboratory on April 12, 2006, requesting assistance with developing a biological profile of the individual and an estimate of time since death. Analysis by Verano and Titelbaum indicated that the remains were those of an edentulate white male approximately 45-55 years of age, of relatively short stature (est. 5'5"). Time since death was estimated as between eight months to a year, based on multiple criteria, including the position of the body (suspended) during decomposition, as well as evidence that the tree had been damaged by Hurricane Katrina (August 29, 2005), resulting in two distinct clusters of skeletal remains on the ground. Although the skeleton was mostly complete, it was noted that some bones were missing, and offered to assist with another search of the scene. The second search produced another sixteen skeletal elements, including four vertebrae, eleven hand and foot bones, and a fragment of costal cartilage. Some of the bones found on the ground showed carnivore gnawing, and some elements that were not found in either search, including the hyoid bone, may have been scattered or destroyed by carnivores.

A search of missing persons records by the St. Tammany Parish Sheriff's Office produced some preliminary leads, but all were excluded based on a lack of correspondence in age, stature, or antemortem injuries. Given the lack of progress in identification, a bone sample was sent to the FBI DNA Laboratory for possible matching with data in the National Missing Person DNA Database, and the Coroner requested that we do a facial reproduction. A three-dimensional facial reproduction was done by Pierson, and was presented in a local press conference in October, 2006. Following the press conference the sheriff's office received numerous phone calls, including one strong lead towards identifying the individual. A landlord reported that he had rented a trailer to a man matching the description of the decedent, and that he subsequently had left without notice and had not been seen again. With this information, investigators located a possible relative in another state who agreed to provide a DNA sample for comparison.

A bone sample from the decedent and a buccal swab from the possible relative were submitted to the FBI DNA Laboratory in Quantico, Virginia, for analysis and comparison. Mitochondrial DNA comparison revealed a match between the two samples, although unfortunately, the sequence identified was not a particularly rare one (observed in 8.65% of Caucasians in the FBI database). Nuclear DNA analysis is now being done in an attempt to provide a more secure identification, although based on their investigation, the St. Tammany Parish Sheriff's Office is convinced they now have a secure presumptive identification.

Human Identification, Facial Reproduction, DNA Analysis

H117 The eBay® Mummy: A Case of a Scottish Mummy From Maryland for Sale in Michigan

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After attending this presentation, attendees will be familiar with the characteristics of medical mummies, specifically those from the Burns Collection, and why the ability to recognize these mummies is important in medicolegal investigations.

This presentation will impact the forensic community by raising awareness about a little-known, but historically significant, collection of medical mummies, with the possibility of restoring lost or stolen samples to the collection. This case highlights the importance of communication between state, federal, and international agencies. Human remains of historical significance can travel surprisingly long distances and turn up in unexpected places. It is important for forensic anthropologists to be cognizant of this when presented with an unusual specimen.

In October 2006, a woman in Port Huron, Michigan, put a mummy up for sale on the internet auction site eBay®. The mummy was recovered by police and transported to the St. Claire County Medical Examiner's Office for examination. On October 16, the mummy was transported to the Michigan State University Forensic Anthropology Lab for further analysis. It was at this point that the mummy was recognized as being a member of the Burns Collection of medical mummies housed at the Maryland College of Medicine.

The Burns Collection originated in Glasgow, Scotland in the early 1800s. Allen Burns was a Scottish anatomist and talented dissector who prepared many preserved anatomical specimens. Upon his death in 1813, the collection went to his protégé, Andrew Russell, who shortly thereafter sold his share in the collection to Granville Sharpe Pattison. Pattison brought the collection to the U.S. and sold it to the Medical School in 1820. Since 1820 the collection, which may have originally numbered in the 100s, has suffered from neglect and theft.

The Burns Collection is a varied set of anatomical specimens, but all are preserved in a similar manner and most are dissected with a strong emphasis on the cardiovascular system. The specimens have a characteristic medium to dark brown coloring, often with injection of the arteries with a red substance. The dissection style is similar throughout the collection, with nerves, muscles, and ligaments being distracted from their original anatomical position to be separated from surrounding structures. Great care has been taken in the dissection of all of the specimens to show anatomical structures clearly and in great detail. Adult cadavers in the collection are cut up, whereas children often appear as complete specimens.

Radiographs of the specimen were used to evaluate age at death. CT scans were also helpful in this case because the radiopaque material used to inject the arteries prevented an unobstructed view of the bones and teeth. Age at death estimation was based primarily on dental development and eruption as assessed on radiographs and CT scans. This estimate was supplemented with epiphyseal closure data obtained from radiographs.

The eBay® mummy is a juvenile, aged 6-9 years at death. Sex and ancestry are undetermined. The mummy is very well preserved, although it has suffered some damage over time. The dissection focuses on the circulatory system in the trunk region, with the removal of all abdominal and pelvic organs. The heart was likely preserved in the thorax at one time, but has since been lost. The specimen shows a medium to dark brown coloration throughout. The arteries are injected with a solid, reddish, radiopaque substance.

The eBay® mummy presents the coloration, artery injection, and dissection style that are characteristic of the Burns Collection. There are several juvenile specimens in the Burns Collection that are very similar to the individual in question. There is little doubt this specimen was removed in the past from the Burns Collection.

Medical Mummy, Anatomical Specimen, Burns Collection

H118 Uncovering the Truth Behind the Killings: Predicting Patterns of Perimortem Trauma Using Skeletons Exhumed From Ex-Military Bases in Guatemala

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After attending this presentation, participants will learn about the types of perimortem trauma that were inflicted on the Guatemalan population in military bases during the armed conflict. They will become aware of the fact that all aspects of the population were affected and that the FAFG is using these patterns to predict trauma in future exhumations.

The Guatemalan Forensic Anthropology Foundation (FAFG) has to date worked on 847 cases totaling more than 5000 skeletons. Of these 847 cases, 12 have taken place within Guatemala's ex-military bases distributed throughout the country, comprising 386 skeletons. It is estimated that during Guatemala's armed conflict 200,000 people were killed, spanning all ages, and 50,000 were disappeared. Many of the disappeared were transferred to the military bases from other areas, and as a consequence the majority of skeletons exhumed from these bases are awaiting identification pending DNA testing. Despite the lack of identification, all of these skeletons have been analyzed and are being held in evidence by the FAFG.

The analysis of these remains revealed that the majority of skeletons exhumed from ex-military bases have evidence of perimortem trauma as well as signs of antemortem torture. Typical traumas observed in the skeletons from this type of exhumation are ballistic bone traumas to the cranium, blunt trauma to the thorax, knife-cut wounds to the cervical area, blunt-sharp trauma (machete wounds) to the cranium and thorax and decapitations. It is hypothesized that the type of trauma will vary depending on factors such as the type of grave, or the biological profile of the victims. It is the intention of this paper to search for and present patterns of trauma based on a number of selected independent variables. It is not the purpose of this paper to detail the antemortem torture, but to conduct a statistical analysis of the perimortem trauma observed in the skeletons, and as a result to be able to predict the type of trauma based on a single independent variable or a number of independent variables.

A statistical analysis will reveal if it is possible to predict the type of trauma from a number of independent factors including sex, age grouping, size of grave (number of skeletons), placement of bodies in the grave, presence of clothing, depth of grave, presence of ballistics, presence of rope-type artifacts, signs of antemortem torture, etc. It is expected that a pattern of perimortem trauma will emerge linking a type of lesion with a particular group or circumstance.

Five cases were selected consisting of skeletons with the cause of death well established. One of these cases is an ex-military base situated in the department of Chimaltenango, where 218 skeletons were recovered, consisting of 154 male adults, 40 female adults, 12 sub-adults and 12 elderly victims. These statistics show that the military campaign was not only directed at adult men of fighting age, but rather the population as a whole. Typically the types of perimortem trauma observed in the victims recovered from this ex-military base are gunshot wounds to the cranium, decapitations and various sharp-force traumas to the thorax and the anterior cervical region.

The results of the analysis will be used to inform the exhumations of military bases in the future and will serve as a part of the forensic report produced by the FAFG for the Prosecutors Office.

Perimortem Trauma, Ex-Military Base, Guatemala

H119 Unearthing Peru's Buried Secrets: La Cantuta Revisited

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The learning objectives of this presentation are to discuss the physical evidence of one of the most serious violations to Human Rights (HHRR) that took place in Peru during the regime of President Alberto Fujimori (1990-2000, and to present the results of the second examination of the human remains, 14 years after they were recovered using a multidisciplinary approach combining forensic anthropology and human genetics.

This presentation will impact the forensic community by showing the importance of forensic anthropological analysis in cases of human rights violations particularly those involving enforce disappearance and attempted destruction of the evidence through the analysis of a case in Peru.

Governments in the process of national judicial reform are tasked with investigating human rights (HHRR) abuse and extra-judicial executions of former regimes, often many years after the crimes occurred. The rule of law projects underway in Peru are in the process of locating and exhuming graves and performing postmortem examinations (sometimes even second autopsies) from past HHRR violations. Investigations into such cases not only have the challenges associated with "cold cases" but often must sort through evidence previously altered to cover–up crimes committed. The following presentation is a discussion of such a case in Peru, representing one of the most serious HHRR cases during the regime of President Alberto Fujimori (1990-2000).

In July 1993 authorities exhumed some boxes containing burnt human remains in a land fill in the outskirts of Lima. The location of the remains was tipped to the media by "COMACA" (Commanders, Majors and Captains) a dissident group within the military opposing the regime of President Alberto Fujimori and his spy chief Vladimiro Montesinos. According to the same information, the human remains belonged to nine students and a professor (two females and nine males) abducted a year earlier (17-18 July 1992) from the University of La Cantuta, East from Lima. At the time, the University of Lima had been under military control and the now known the students and the professor were abducted by a task force of the military under the direct command of *Montesinos* also known as the "Colina" group, who were responsible for several other major crimes (http://www.cverdad.org.pe/ifinal/pdf/TOMO%20VII/Casos%20IlustrativosUIE/2.22.%20LA%20CANTUTA.pdf).

At the time of the initial investigation, the Office of the Prosecutor concluded that the remains had been buried and then exhumed to be burnt and reburied in secondary graves. The identity of the remains was determined to belong to one of the missing students. Further a set of keys opened the locker of a second missing student. However there was no information regarding whether all ten victims were buried in that location, nor was the cause of death estimated for any of the remains. Following the passage of Laws (Law 26479 and 26492) passed in 1995 under the Fujimori regime, giving amnesty to all members of security forces and civilians accused of HHRR violations, such as those committed by the "Colina" group, the Inter-american Court of Human Rights ordered the Peruvian State to investigate the case properly and to locate and identify the human remains of the ten victims among other reparative measures (http://www.corteidh.or.cr/docs/casos/articulos/seriec_162_esp.pdf). Following this order by the Court, the Peruvian Forensic Anthropology Team (EPAF) was appointed by the Peruvian Judiciary to carry out the exhumation and analysis of the remains fourteen years after their initial discovery.

This presentation discusses the process and result of this investigation. It also emphasizes important issues and challenges of investigating HHRR cases under transitional judiciary reform and highlights critical methods for anthropologists working in similar contexts. The exhumation of the remains uncovered four heavy coffins containing the disarticulated and fragmented remains representing at least nine individuals. Most of the weight and

volume of the coffins were made only by refuse, probably collected during the initial operation. Only eight individuals were however related to the case, since the ninth individual was represented by a single distal phalanx of a child aged 8 to 10 years. The missing students and professor were between the ages of 18 and 48 years. At least three individuals had been exposed to fire at different temperatures (from combustion to calcination), showing typical changes associated with postmortem burning.

One individual was complete and sustained four gunshot wounds to the head, two of which were caused by a "double tap". Three other unrelated cranial fragments showed posterior gunshot wounds indicating a certain pattern concerning the manner of death of the victims (homicide). Methods for identification including STR DNA analysis are discussed.

Fifteen years after the fact, all remains of the missing students and professor have not been located. The results of the analysis corroborate testimonies of some of the perpetrators. It is clear however that a negligent recovery by the Peruvian police in 1993 contributed to add unrelated evidence (refuse and child's phalanx), but were not thorough enough as to find the remains of all victims. It is expected that in its forthcoming sentence, the Peruvian Court will order further investigations to determine the whereabouts of the victim's remains in order to repatriate them to their families.

Fujimori, Disappearance, Double-Tap

H120 How Easily Can We Derive Cause and Manner of Death on the Basis of Dry Bones? Lessons Derived From Coimbra Identified Skeletal Collections

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After attending this presentation, participants will be able to: (1) evaluate the potential of a reference skeletal collection to forensic anthropology, (2) evaluate the difficulty to derive cause and manner of death from dry bones, and (3) evaluate the danger of infering to much from dry bones.

This presentation will impact the forensic science community by increasing awareness of the importance of reference skeletal collections to forensic anthropology and of the need to be more accurate in cause and manner of death determination statements. The importance of a previous taphonomic interpretation is emphasized since postmortem cahnges can disguise perimortem trauma.

The Coimbra identified skeletal collection is a unique research resource available to forensic anthropology. The identification of each of the individuals permit the validation of a series of methods applied in forensic anthropology increasing thus their accuracy. The project presented here demonstrates attempts to increase the accuracy of cause and manner of death determinations on the basis of traumatic skeletal lesions. It is well know that those objectives of a forensic anthropology examination are particularly hard to be accomplished. Among the 505 identified individuals, death certificates indicate 31 died from violent causes between 1898 and 1932. All of these 31 skeletons were recently subjected to a thorough anthropological examination performed before reading individual records, i.e., without knowing, a priori, the exact cause of death. In a further stage, the conclusions of the anthropological exam were compared with the original cause of death stated on the individual record. Homicides, suicides, accidents, falls are some of the causes of death stated on the obituary records. Later, for those who had been autopsied, the autopsy report, completed in the 1920s, were analyzed and again, cause and manner of death were compared particularly in what traumatic injuries descriptions were concerned. Below we discuss the agreements and disagreements between the present day anthropological analysis and the autopsy reported for three interesting cases.

In one case, while the death was caused by a single gunshot to the thorax, the anthropologist, by means of the anthropological analysis, was unable to recognize cause of death because the injuries besides being subtle were hard to differentiate from postmortem changes.

In a second case, both the anthropological exam and the autopsy report produced a similar cause of death: blunt force trauma to the head. However, the fractures observed on the dry bone produced improved results than those reported by the pathologist. In dry bones it was possible to follow the fractures lines pattern in much accurate way.

Finally, in a third case, the anthropologist was not able to predict cause of death even though the death was a severe trauma on the vertebral column, solely on the basis of the skeleton due to taphonomic alterations disguising perimortem trauma. Indeed, taphonomic changes are a paramount factor in the interpretation of traumatic events on the basis of dry bones since they preclude more reliable interpretations.

These three cases exemplify the practicality, utility, and limitations of forensic anthropology contributions to cause and manner of death, where case one illustrates that bones do not represent the whole body. Case two demonstrates the advantages of examining the traumatized human skeleton in a dry state as opposed to fresh autopsy examinations. However, the dry bones in case three limited accurate analysis due to taphonomical influences and of the evidence. In all, this was a rare opportunity to enhance both the potentials and limits of dry bone to cause and manner of death assessments.

Trauma, Cause of Death, Bone

H121 Renewed Search, Recovery, and Identification Efforts Related to the September 11, 2001 Attacks of the World Trade Center

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This presentation will highlight several of the projects associated with the renewed search and recovery efforts occurring at Ground Zero and the surrounding area.

This presentation will impact the forensic science community by demonstrating the role of anthropology in this type of work will be stressed. In addition, the unique challenges posed by operating under hazmat conditions will be discussed.

Two thousand seven hundred-fifty people died in New York City from the World Trade Center attacks on September 11, 2001. As a result of two airplane crashes and the collapse of two sky-scrapers, the search and recovery efforts were extremely challenging and on a scale that was previously unmatched. Due to the magnitude of the incident and the forces involved, fragmentation of bodies was extensive. Initial recovery efforts were largely handled by the emergency service agencies in New York City. By the time the recovery ceased, nearly 20,000 human remains ranging in size from small bone fragments to nearly complete bodies had been recovered. These remains were sent to the Office of Chief Medical Examiner (OCME) in New York City for identification.

In April 2006, OCME initiated an on-site presence at the Deutsche Bank, a 40-story building at the southern edge of the World Trade Center site. The building was slated for deconstruction due to damage associated with the attacks. The OCME's role in this deconstruction project was triggered by an increased frequency in the number of small bone fragments encountered on the roof by laborers. Since the project site was considered to be contaminated (primarily with asbestos and heavy metals), the search and recovery operation had to be conducted under hazmat conditions utilizing appropriate personal protective equipment. Work was eventually completed on the rooftop and the interior, resulting in the recovery of several hundred small (generally < 1/8 inch) bone fragments from the rooftop alone.

In October 2006, human remains were again discovered. This time the remains were found at the World Trade Center site in an abandoned manhole by utility workers. These remains were immediately confirmed to be related to World Trade Center victims. This triggered an obvious interest in the likelihood that additional human remains could be encountered in other areas at and around Ground Zero. The Mayor's Office quickly called for the resumption of search and recovery activities and designated the Office of Chief Medical Examiner as the lead agency. Following an extensive review process involving numerous agencies, additional areas of concern were identified. These areas included other subterranean structures (e.g., sewers and manholes), additional building rooftops, and roadways.

The renewed efforts have resulted in the completed search of several building rooftops and hundreds of subterranean structures. Large-scale excavations have also been conducted, resulting in the removal of thousands of cubic yards of material that requires hand-screening. In order to handle this large amount of material, an elaborate screening facility was constructed specially for this project. By the end of this project it is anticipated that the budget will exceed $30 million.

The skills of forensic anthropology and archaeology are essential components for ensuring that the most comprehensive and accurate job possible is achieved during this recovery project. Archaeologists direct the excavations at and around the WTC site. Although heavy equipment is used to excavate, archaeologists direct the progress and implement the appropriate techniques to ensure that excavation depths are sufficient and appropriately documented. Understanding site formation processes and interpreting soil stratigraphy is crucial for undertaking this large-scale endeavor. Forensic anthropologists have the expertise in human osteology and are able to recognize even the smallest of bone fragments and to distinguish them from the non-human remains that are frequently encountered. OCME's Forensic Anthropology Unit carries the responsibility of ensuring the forensic integrity of the fieldwork, in addition to performing analyses of the potential human remains recovered during the project. Due in large part to this specialized work, the OCME as an agency recognized the critical role of anthropology and, as a result, the full-time anthropology staff has grown in size to eight people. During the height of the project, a crew of approximately 25 temporary, contract anthropologists also participated in various aspects of the daily operations, especially the hand-sifting work.

Through this renewed WTC recovery work, hundreds of additional human remains have been recovered. Most of these remains are small fragments, usually ranging in size from < 1/8 inch to several inches in size. Every fragment is submitted for DNA testing for identification purposes. Many of the remains have been linked to previously identified individuals, while others have resulted in the association of remains to individuals who were previously unidentified.

World Trade Center, Mass Disaster, Forensic Anthropology

H122 The Use of Material Culture to Establish the Ethnic Identity of Victims in Genocide Investigations: A Validation Study From the American Southwest

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After attending this presentation, attendees will understand the potential for using clothing and personal effects to accurately categorize victims of genocide or war crimes.

This presentation will impact the forensic community by providing an accurate, independent scientific method of establishing the ethnic identity of the victims of genocide, a crucial step in the successful prosecution of genocide and war crimes charges.

Successful prosecution of genocide requires that the victims constitute one of the four groups protected under international law: national, religious, ethnic or racial. Establishing victim social identity in prior tribunals has been largely presumptive, based on untested methodology, or relied on the positive identification of victims. This paper details a validation study of one untested method: the use of material culture in establishing ethnic identity. Classes of clothing and personal effects were scored for 3,430 individuals of known White Hispanic or White non-Hispanic ancestry from the autopsy records of the Office of the Medical Investigator in New Mexico from 2002 through 2005. Only positively identified decedents over age 18 who died unnatural, unexpected deaths (homicidal and accidental manners of death) were included in the study. Excluded were those who had experienced thermal damage resulting in the destruction of clothing or artifacts or whose clothing or personal effects were removed by hospital personnel or law enforcement prior to autopsy.

Personal effects were divided into three major categories: those providing evidence of nationality or personal identification (driver's licenses or government issued documents, currency); items indicating language (non-ID documents, jewelry, prescribed medications, books) and articles suggesting religious affiliation (jewelry, icons, documents such as prayer cards).

Data were entered into an Excel spreadsheet and statistical analyses were conducted using SAS version 9.1. Categorical variables were analyzed for univariate associations using chi-square or Fisher exact tests and continuous variables were compared using t-tests.

Following preliminary analysis, a second categorical system was introduced that evaluated the material evidence associated with each individual in terms of its potential to establish ethnic identity. Evidence was ranked according to its relative contribution. For example, evidence of language was considered more reliable in isolation than evidence of religious affiliation, currency or clothing styles. Multiple sources of information were considered preferable to isolated indicators. A total of 5 classes of identity potential were scored for the total sample:

1. Well-defined, multiple sources of identity. Criteria include at least one source of national identity and one indicator of language or religious affiliation.
2. Reasonable sources of identity. Criteria include either multiple sources of potential information (i.e. indicators of religious affiliation) OR a single credible source of identity (evidence of language or nationality).
3. Ambiguous evidence of identity. Clothing or personal effects were recovered but such evidence was not definitive (i.e. indicators of religion only).
4. No potential for identity. No material culture was associated with the decedent OR only a single, non-descriptive item (such as underwear) was present.
5. Investigator error. Evidence was noted as present at autopsy but was not described in sufficient detail to allow for categorization. Individuals in this category were removed from subsequent analysis.

A model was then developed to predict ethnic affiliation in unknown individuals. Based on the relative frequency of a trait within the two populations, the presence of the trait was considered neutral (no significant difference between populations), or as an indicator of either Hispanic or non-Hispanic ethnicity. Blinded, breakout subsets (n=100, 50 White Hispanic, 50 White non-Hispanic) were randomly selected and the ethnicity of the individual was estimated using the evidence available. A total of 400 individuals were tested representing the following subsets: general population (drawn from potential identity classes 1 through 4); potential identity class 1 (well-defined); potential identity class 2 (reasonable); potential identity class 3 (ambiguous).

Intraobserver error tests were conducted and kappa statistics were calculated to determine the reliability and reproducibility of trait scoring, classification of potential identity evidence and ethnicity prediction models. A random sample of 25 individuals was re-scored and the results were compared to prior data. Kappa statistics were interpreted using the classification proposed by Landis and Koch (1977).

Statistically significant differences (all p values were less than 0.0001) were seen in evidence of language, nationality and religious affiliation between the two groups, as well as clothing types and currency. Predictive models used to estimate ethnic affinity in the random, blind subsets produced an overall accuracy of 80.5% and estimates of 61 to 98% in specific subsets.

Failure to adequately establish victim group identity has resulted in overturned verdicts. In 2006, the International Criminal Tribunal for Rwanda was found to have erred in failing to take judicial notice of the ethnic identity of the victims. Prosecutors can no longer afford to presumptively address the victims' cultural identity in acts of genocide. This study indicates that material culture can provide reliable evidence of ethnic affinity in genocide investigations, providing forensic scientists with a means of accurately establishing victim social identity.

Forensic Science, Forensic Anthropology, International Human Rights Investigation

H123 A Population Approach to the Problem of the Missing and Unidentified With Emphasis on the Status of Migrant and Undocumented Workers

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The objectives of this paper are to discuss the problem of unidentified decedents and strategies at the local and state level to improve identification methods. Special attention is given to the role of families through this process and the importance of the information they provide. The purpose of the study is to use a population based approach to profile the missing, such as immigrants, migrants and un-documented workers to better serve these underrepresented groups. A demographic analysis of solved and unsolved cases from the American Southeast is presented.

This presentation will impact the forensic science community by. Using the American Southeast as an exemplar will serve as a model for others to employ. Further, framing the problem of the unidentified with research and outreach initiatives aimed towards population specific methods and protocols should improve the identification process.

Outcomes: Using the American Southeast as an exemplar will serve as a model for others to employ. Further, framing the problem of the unidentified with research and outreach initiatives aimed towards population specific methods and protocols should improve the identification process.

The FBI's National Crime Information Center (NCIC), Missing Person and Unidentified Person files (as of December 31, 2006) reports 110,484 recorded active missing person cases and 6,208 unidentified person cases, which is a 2.2% increase over reported cases from 2005. Within the Unidentified Person File, 73.81% (n=1,043) of cases are of unidentified, deceased individuals; 0.5 % (n=7) are unidentified catastrophe victims; and 25.69% (n=363) of cases include living but unidentified persons. However, experts estimate that there are approximately 40,000 to 50,000 unidentified sets of human remains in the United States, which highlights a significant problem in that only 1.24% of the unidentified remains are accounted for by the NCIC database. Local and State level databanks account for some of this discrepancy, offering a variety of alternative means to share information about the deceased in hope that a witness or family member will come forward and offer information. For example, the Florida Unidentified Decedents Database (FLUIDDB) has more than 500 open cases in the state of Florida alone.

The number of cases that remain unidentified is due in part to the low priority and attention given to "cold cases", the overall accuracy and applicability of identification methods ranging from the initial parameters of biological profiles to DNA analysis, the access families have to information and knowledge about Unidentified and Missing persons, and the willingness or ability of witnesses or family members to come forward. The pool of persons who go missing and subsequently become part of the unidentified population is predominately adult, male, under-represented minorities, foreign-born individuals, and people from at-risk groups (i.e. the elderly, mentally ill, or individuals with substance abuse). In particular, a growing obstacle to the identification of unidentified decedents (UIDs) is the increase of foreign-born immigrants, including migrant workers and un-documented persons in the United States. Increasingly, individuals of foreign born Nationality, is an important component in unidentified cases as there may not be access to information about who is missing, personal data about the decedent, nor family members available to aid the identification process.

The demographic structures of identified cases are compared with unidentified cases and the reported missing. The demographic profiles of individuals identified through the C.A. Pound Hunan Identification Laboratory at the University of Florida, the Forensic Data Bank maintained at The University of Tennessee and the Medical Examiner's Offices of Georgia and North Carolina are compared. The value of a population approach to individual estimation is demonstrated through demographic analysis and a comparative discussion of population variables of the Missing and Unidentified; as well as the databases and processes in place aimed towards human identification in the United States. Recommendations for policy and methodological changes are further discussed such as the application of population based research strategies that account for biological and cultural variation related to identification parameters; the development of bilingual searchable databases with anonymous information submittal capabilities; and the incorporation of biological information of the decedent along with possible biological traits and personal or cultural artifacts such as descriptions and photographs of personal effects, tattoos, and facial approximations into searchable web-based databases that facilitates the monumental task of identifying unidentified or unknown decedents in a way that is appropriate given the population in question.

Identification, Unidentified Decedents, Demography

H124 Establishing a Central Database for the Missing and Unidentified of Louisiana

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The goal of this presentation is to inform attendees of a state-sponsored database of information on all missing persons and unidentified remains cases in Louisiana.

This presentation will impact the forensic community by presenting information on the construction of a state database, how case information has been gathered, and the current status of case resolution. Such a database is meant to act as a central location for data on all missing persons and unidentified remains cases in a state. By creating a central location for data, the goal is to assist law enforcement in resolving cases that otherwise might remain unsolved.

The issue of unsolved missing persons and unidentified remains cases continues to be a problem in this country. Few states offer a centralized location for detailed information on missing persons and unidentified remains cases. Without a centralized information system in place, comparisons between cases that could potentially result in a positive identification may go unnoticed by the agencies involved. As agencies are forced to confront new cases that arise, the trail grows colder on cases that remain unsolved. When a cold case involves unidentified remains, these remains may end up on the back shelves in coroners' offices or they are buried or cremated before all possible identifying information has been collected. The authors propose that more unresolved cases could be solved if each state developed a central location for all the data available on all missing persons and unidentified remains cases reported in their state.

For almost thirty years the Louisiana State University Forensic Anthropology and Computer Enhancement Services Laboratory (LSU FACES Lab) has worked with both Louisiana agencies and agencies across the United States on unidentified remains cases. The lab has assisted in hundreds of successful identifications. However, there are cases on record at the LSU FACES Lab which still remain unidentified. In April, 2004, the LSU FACES Lab began a collaborative effort to address the issue of unresolved cases. Thanks to funding from the President's DNA Initiative, the LSU FACES Lab and the North Louisiana Criminalistics Laboratory established the Louisiana Identification Data Analysis (IDA) Project. The funding allowed for DNA testing on every unidentified homicide case on record at the LSU FACES Lab. The goal of the IDA Project was to develop DNA profiles to work in conjunction with the anthropological profiles established on each unidentified remains case.

In 2006, a bill was presented to the Louisiana State Legislature that would allow for the establishment of the Louisiana Repository for Unidentified and Missing Persons Information Program to be maintained by the LSU FACES Lab in conjunction with the North Louisiana Criminalistics Laboratory. The bill was signed into law and became Act 227 (http://www.legis.state.la.us). The law allowed for the development of a database on all missing persons and unidentified remains cases reported in the state of Louisiana. The database combines data on unidentified remains (i.e., DNA profiles, anthropological assessments, facial reconstructions, and other case specific information) and data on missing persons (i.e., biological information, dental records, family reference samples, and other case specific information). The state of Louisiana provides all funding for the database. Although a statewide database is paramount to assist in resolving unsolved local cases, it is also important that the information be available on a national level. DNA information on Louisiana's unidentified cases and family reference samples will be entered into the FBI's national CODIS database for comparison across state lines.

The Louisiana Repository for Unidentified and Missing Persons Information Program has already generated some success, much of which is due to the ability of the researchers to travel and actively seek case information. By taking an aggressive stance, rather than waiting for cases and samples to be submitted, the LSU FACES Lab has managed to establish additional contacts and collect more case information than otherwise would have been possible. As data continues to be collected across the state of Louisiana, the expectation is that more success stories will be generated from this project.

Missing Persons, Unidentified Remains, Louisiana

H125 Resolution of Cold Identity Cases: Resources, Methodology, and a Review of Some Success Stories

Dana Austin, PhD, and Paul E. Coffman, Tarrant County Medical Examiner District, 200 Feliks Gwozdz Place, Fort Worth, TX 76104-4919*

This paper will present the listener with an overview of many resources available for finding the identity of unidentified individuals. Successfully resolved cases will be presented as examples.

This paper will impact the forensic community by providing resource material and examples whereby the resources were successful.

This paper will present the listener with an overview of the methods used by the Tarrant County Medical Examiner District (TCME), located in Fort Worth, TX, to resolve cases of long-standing unidentified bodies. The attendee will be advised of multiple databases and resources for assistance in resolving their own unidentified cases. The TCME has been able to solve several cases recently with a positive identification and notification of family members, in most instances. The time period from death to positive identification ranges from 4 to 22 years. Methods used to make positive identification include matches from the Missing Persons DNA database, and fingerprint matches made by comparing morgue fingerprints to known fingerprints suggested by AFIS. In this paper, the successful cases are reviewed enabling us to learn how the identity was originally missed and what can be included in our standard protocols in order to lessen the likelihood of cases remaining unresolved.

As of July 2007, the Tarrant County Medical Examiner District had 76 cases of unknown identity dating back to 1982. The cases, 63 males and 13 females, are assigned to 18 different law enforcement agencies. Forty-six cases were ruled homicide or undetermined and 30 were ruled accident, suicide or natural. We have found that the manner of death has significant impact on the support we receive from the law enforcement agencies that are assigned these cases. Homicide cases necessarily allow for continued manpower from the police agency. Over one-third of the cases had circumstances that suggested that the decedent was homeless/vagrant at the time of their death.

A grant-funded part time position at the Tarrant County Medical Examiner district provided additional manpower to review the cases for solutions to identification and submission to national databases such as NCIC, Missing persons DNA databank, Unidentified Decedent Reporting System (UDRS) and the Mexican national identification system and DNA database, SIRLI (Sistema de Identificacion de Restos y Localizacion de Individuos). Within three weeks of the new hire we had our first successful resolution.

This paper will review successfully resolved cases with specific attention to reasons why the identification was not made initially and lessons learned after the identification was complete that may assist us in future casework. Resources that are available to medical examiners/ coroners and law enforcement will be presented so that others may have access to resources need to resolve their own unidentified cases.

Human Identification, NCIC, AFIS

H126 Identity Crisis: The Number and Quality of Unidentified Decedent Data and a New Solution

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The goal of this presentation is to discuss the extent of the problem of unidentified human remains, how forensic anthropologists can play a key role, and a working solution. Missing persons and unidentified remains continue to be a staggering problem for law enforcement, medical examiners and coroners' offices, forensic scientists, and the public as a whole.

Approximately 14,000 unidentified human decedents are on record at nearly 2,000 medical examiners and coroners' offices, but the number of unidentified decedents that are without records are unknown. Recent statistics suggest that each year an additional 1,000 deceased persons remain unidentified and so the number of unidentified human remains continues to climb and persists as a significant and constant national problem. This presentation will impact the forensic science community by significantly increasing insight into the caliber of the problem of unidentified human remains and an understanding of both the existing efforts for identification and the future implications of forensic anthropology's contribution to these efforts.

Currently, the FBI's National Crime Information Center (NCIC) reports approximately 6,200 unidentified persons files in its database. The NCIC plays an important role in missing and unidentified persons cases, but its limitations many times hinder both the utility and success of the database, its search criteria, and its results. However, many times it is the quality of the data or the lack of forensic expertise that prevents the success of identification. The progress and advancements in the forensic science field as a whole has exceeded the capabilities of the NCIC. An in depth investigation into the quantity and quality of the data in the NCIC will be presented.

Traditionally, forensic anthropologists only examine skeletal remains and, while many unidentified cases are skeletal or in a state of advanced decomposition, forensic anthropologists have become increasingly utilized as consultants for fleshed bodies as well. Whatever the circumstance, the

ultimate goal for any forensic anthropologist is identification. As the popularity of forensic anthropology increases, so does the knowledge that the field exists and can make significant contributions to the problem of unidentified remains.

There are several resources available to law enforcement agencies, medical examiners and coroners' offices, and other forensic science experts including the NCIC, CODIS(mp), ViCAP, and IAFIS. An initial effort to address the overwhelming number of unidentified human remains was the utilization of DNA. The CODIS(mp) or National Missing Person DNA Database was created in 2000. At the Center for Human Identification (CHI) at the University of North Texas Health Science Center, DNA testing is being performed on skeletal remains, missing persons' families, and direct reference samples free of charge. Anthropological examinations on unidentified human remains are also performed there; all in an effort to identify the unknown.

The newest resource for unidentified remains is the Victims Information Catalog, Tracking, and IMaging System (VICTIMS) Identification Project. This system is Internet based and, for the first time, creates a comprehensive database with the capabilities to hold all of the information about an unidentified decedent. This information is available in varying degrees to law enforcement, medical examiners and coroners' offices, and the public. The success of this database lies in the hands of the forensic science experts who examine and provide information about an unidentified person. An extension of the VICTIMS Identification Project is a referral service where law enforcement agencies and medical examiners and coroners' offices seeking forensic expertise can search for local experts in a nearby area. The last aspect of the VICTIMS Identification Project is an Evidence Preservation and Processing (EPP) facility, which will enable the examination and preservation of physical remains of unidentified decedents, as well as support anthropological research.

Unidentified Human Remains, Forensic Anthropology, VICTIMS Identification Project

H127 Comparison of Two Methods of Age Determination Using Histomorphology: Periosteal vs. Endosteal Surface Equations

Andrea Clowes, BA, Michigan State University, 16789 Chandler Road, #1422A, East Lansing, MI 48823*

After attending this presentation, attendees will gain a greater understanding on the applicability of estimating age through the histomorphological evaluation of bone, and more specifically, the relevance of endosteal and periosteal surfaces in such analysis.

This presentation will impact the forensic community by employing a simple histological method of determining age at death that many do not realize exists. The estimation of adult age at death typically relies on standard techniques that use the pubic and rib bones. When these bones are not present, estimating age at death can prove to be challenging. In fact, forensic cases involving unidentified individuals whose remains are not fully present, fragmented, and/or otherwise damaged can prove impossible to positively identify. Forensic techniques of bone histology, the microstructural analysis of tissue, are known to be good aging techniques. This is important because establishing the age at death in a human remains case is a critical component in positive identification. By narrowing the age range, identification becomes more likely.

Two histological aging methods were tested: (1) The Hauser Method (Hauser, R, D Barres, M Durigon, and L Derobert, 1980. Identification par l'histomorphometrie du femur et du tibia, *Acta medicinae legalis et socialis.* 30:91-97), and (2) the Kerley-Ubelaker Method (1978). By directly comparing the two methods, the applicability of the equations of Hauser et al. will be showcased next to those already well established by Kerley-Ubelaker. The ease of use and repeatability of the Hauser method provides an attractive alternative to those more complicated. This method will prove to be of great use in the determination of age in damaged bone.

Since its original presentation, the Kerley-Ubelaker technique has become a standard histological method for the determination of age in forensic anthropology (Kerley, 1965; Ahlqvist and Damsten, 1969; Kerley and Ubelaker, 1978; Stout and Gehlert, 1980; Robling and Stout, 2000). Though considered one of the more accurate, Kerley-Ubelaker's method is less than ideal in circumstances in which the periosteal surface of the bone (the outer fibrous layer) has been worn away due to erosion, chemical substances, burning of the remains or other processes. This research tests the system developed by Hauser et al. utilizing endosteal and periosteal bone and compares the results with those of the Kerley-Ubelaker updated method which utilizes the outer perisoteal layer (Kerley, 1965; Kerley and Ubelaker, 1978; Hauser et al, 1980).

There are two main strengths to the Hauser method: the application of the endosteal surface of bone for age analysis (to avoid difficulty in circumstances in which the periosteal surface is damaged), and the ease of use of the method itself. When analyzing Hauser, the diameter of the circular field was decreased to 1.16mm (area 1.06 mm^2). Two areas of each bone (periosteal and endosteal) were utilized for separate equations. As such, they were treated as separate methods. The full analysis is dependant only upon the counting of present Haversian canals which are either present or are not.

The Kerley-Ubelaker method is based on the identification of osteons, osteon fragments, and measurement of the percentage of present lamellar bone. An osteon includes those Haversian systems that are equal to or greater than 80% complete while fragments are defined as less than 80% completeness. The field size is circular with a diameter of 1.62 mm (area of 2.06 mm^2). A circular image of 1.62 mm was placed over a calibrated image captured through the Sigma Scan Pro 5.0 program.

This research validates the Hauser method of aging unknown individuals as well as provides an additional option when severe fragmentation eliminates other histological methods, such as Kerley-Ubelaker. The Hauser method, specifically the equation which utilizes the endocortical surface, provides an accurate method for estimating age, which opens the door for future research on the medullary cavity of bone.

Histology, Age Determination, Endosteal

H128 Osteon Area Measurements - A Validation Study

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After attending this presentation, attendees will become familiar with this method for osteon area measurements. This presentation will also identify the need for the validation of this measurement technique as the purpose of this study is to analyze the error rate produced within and between observers for the measurement of osteon area.

This presentation will impact the forensic science community in validating the use of osteon area measurements in forensic work as a reliable method of osteon size estimation as well as a method that is able to be replicated with a high degree of consistency. This research also identifies the need for experience and practice with this measurement technique, as with any other type of scientific measurement technique.

This research determines the inter-observer and intra-observer error rate of researchers with varying levels of experience measuring the area, circumference and diameter of human osteons. The independent variables are individual level of experience, while the dependent variables include consistency among and between individuals with novice, intermediate and advanced experience in this technique.

Four researchers, with varying levels of experience with the technique (termed novice, intermediate and advanced) were asked to measure the area, circumference and diameter for the same 361 osteons(contained in multiple captured images), using Image Pro Plus 4.5 microscopy software. The two novice researchers each had only a 20 minute instruction to the method. The intermediate researcher had more than 10 hours of experience measuring the osteon area using this Image Pro Plus 4.5 software. The advanced researcher had over two years experience measuring osteon area using the Image Pro software and image capture system. Each researcher was asked to measure the area and greatest diameter of the same group of osteons in each image. Some of the groups of osteons were measured by each researcher various times throughout each measurement session to test the inter-observer error rate of each researcher. This allowed the researchers to measure the same osteons several different times within the same day to determine their consistency in measurement. Histomorphometric data was collected using a Leica DM 2500 transmitted light microscope equipped with 10x wide field oculars, 5x, 10x, 20x UPLanFL objectives, and a Leica DFC480 R2 color firewire digital camera. Each of the images was captured at 10x ocular lens and 10x objective lens. The area data was exported to an Excel spreadsheet, where all area and diameter measurements were compared within and between researchers. The data was compared using the SAS statistical package. The data suggests that the level of experience the researchers have with the technique and the equipment plays an important role in the accuracy of their measurements. It seems that the more familiar the novice researchers got with measuring the osteons the more consistent their measurements were when measuring the same osteons over again.

Osteon Area, Intra-Oberver Error, Inter-Observer Error

H129 Osteon Area and Circularity: A Method for the Assessment for Human and Non-Human Fragmentary Remains

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After attending this presentation, attendees can expect to learn the method for the measurement of osteon area and the assessment of circularity of osteons based upon digital measurements taken from human remains, and how these measurements can help with the assessment of fragmentary remains.

This presentation will impact the forensic science community by demonstrating a method that allows for the assessment of whether remains are human or non-human when osseous fragments are too small for other methods of gross or genetic identification. This can benefit the forensic community by adding to the methodology available for the identification of highly fragmentary osseous remains as found in mass disasters, military conflicts or other situations which result in the fragmentation of individuals.

The impetus for this research is the lack of current methods within the forensic studies which can accurately assess human from non human remains when the remains are highly fragmentary in nature. Although many researchers have attempted to use histological methods to analyze these types of remains, there is still no conclusive way to determine whether a fragment of bone is human or non-human in nature when circular osteons are present at the microscopic level. This study, by using a large sample of osteons from all of the long bones of the human body, will identify an osteon area measurement range for humans based upon a modern sample. In addition to the osteon area measurements, this study also looks at the overall shape of human osteons and compares that to the shape of non-human osteons for use as an additional method to distinguish between human and non-human fragments of long bones.

To accomplish this, three thin sections were selected from each of the following long bones from 5 different individuals: humerus, radius, ulna, femur, tibia, and fibula. These thin sections represented a midshaft, proximal, and distal portion of each long bone shaft to account for osteonal size and density differences throughout the shaft of each long bone. A minimum of 30 osteons were measured from each thin section of bone using the Image Pro Plus 4.5 digital microscopic measurement program. A total of over 3400 osteons were measured from the aforementioned sections of the long bones. Of the measured osteons, all had digital area measurements recorded. Additionally, the circumference and maximum diameter were taken for over 2300 of the 3400 osteons. All of the recorded measurements were exported to an Excel spread sheet. From there, the areas, circumferences and diameters were subjected to various statistics, including the range of areas within and between skeletal elements and determination of circularity based upon the equations used for a circle (). This research shows that the overall majority of human osteons are not circular in shape, but rather elliptical in nature, while non-human osteons tend to be very circular. The osteon area range for humans based upon this sample can help eliminate non-human osteons that fall outside of this area range.

Osteon Area, Osteon Circularity, Human vs. Non-Human Histology

I1 Criminal Responsibility in Juveniles: Less Guilty by Reason of Adolescence?

Christopher Thompson, MD, 10850 Wilshire Boulevard, Suite 850, Los Angeles, CA 90024*

The goals of this presentation are to explain the concepts of criminal responsibility, culpability, penal proportionality, insanity, and mitigation; to explore the evolution and implementation of the concept of criminal responsibility in the juvenile justice system; and to discuss the impact of developmental immaturity on juveniles' criminal responsibility and culpability.

This presentation will impact the forensic community by exploring these and other issues.

Over the past twenty years, there has been a fundamental change in the way juvenile defendants are viewed by and subsequently have interacted with the legal system. In the late 1980s, there was a marked increase in the rate of crimes committed by juveniles, particularly homicide. Over time this led to a change in the public perception of minors involved in the juvenile justice system. These youths began to be seen as budding psychopaths who needed adult punishment rather than troubled children in need of rehabilitation. Many minors were subsequently sentenced to long prison terms is adult criminal court.

However, incarcerating individuals for lengthy periods imposes a tremendous cost on society, both directly (e.g., cost to house inmate) and indirectly (e.g., institutionalization, loss of employment opportunities because of 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. 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 (i.e., adolescent-limited anti-social behavior)?

Hopefully future research can lead to more just legal outcomes for minors, help protect the general public and preserve the dignity and integrity of the legal process.

In response to an increase in juvenile violent crime in the late 1980s, most jurisdictions in the United States have adopted a more punitive stance toward juvenile offenders. Juveniles face increasing sanctions in juvenile court and are being transferred to adult criminal court in greater numbers, where they face serious penalties.

Unfortunately, policymakers often failed to consider that certain characteristics of juveniles (e.g., psychosocial/developmental immaturity) may affect their culpability, not to mention their adjudicative competence. Additionally, minors likely to become involved in the juvenile justice system have additional characteristics (e.g., higher rates of mental illness and substance abuse, lower IQs) that might further mitigate their criminal responsibility.

Research has supported the notion that adolescents' psychosocial immaturity significantly affects their criminal decision-making. Neuroimaging has proved a powerful tool in helping elucidate a potential neuroanatomical basis for poor decision-making in adolescents. Because adolescents are likely somewhat less culpable than adults for similar criminal acts and because most individuals limit their anti-social behavior to adolescence, the wisdom of indiscriminately giving minors (or even young adults) long prison sentences, which exact a large individual and societal cost, is questionable.

Criminal Responsibility, Developmental Immaturity, Mental Illness in Juvenile Justice Population

I2 Using Legislation to Change *Tarasoff* Problems in California

Robert Weinstock, MD, 10966 Rochester Avenue, #4C, Los Angeles, CA 90024; Gabor Vari, MD, Department of Psychiatry, University of California at, Los Angeles, CA 90024; Gregory B. Leong, MD, Center for Forensic Services, Western State Hospital, 9601 Steilacoom Boulevard, South West, Tacoma, WA 98498-7213; and J. Arturo Silva, MD, PO Box 20928, San Jose, CA 95160*

After attending this presentation, attendees will become familiar with the new *Tarasoff* developments in California and how problematic court decisions can be remedied by legislation.

This presentation will impact the forensic community by presenting changes in the law achieved through legislation.

There are significant developments regarding *Tarasoff* situations. California courts had interpreted the original immunity statute to have created a new duty to warn that could be satisfied only by warning. The former Judicial Council jury instructions and the Ewing vs. Northridge Hospital Medical Center 16 Cal Rptr. 3d 591 (Cal. Ct. App. 2004) decision had led to a finding of automatic liability if a serious threat by a patient to an identifiable victim was communicated to the therapist by the patient or a close family member, the therapist did not warn, and something untoward occurred. Expert testimony was not necessary. The California Association of Marriage and Family Therapists along with the California Psychiatric Association (CPA) were instrumental in getting new legislation passed with the support of a consortium of stakeholders. California Civil Code Section 43.92 now reads:

a) There shall be no monetary liability on the part of, and no cause of action shall arise against, any person who is a psychotherapist as defined in Section 1010 of the Evidence Code in failing to warn of and protect from a patient's threatened violent behavior or failing to predict and warn of and protect from a patient's violent behavior except where the patient has communicated to the psychotherapist a serious threat of physical violence against a reasonably identifiable victim or victims.

b) There shall be no monetary liability on the part of, and no cause of action shall arise against, a psychotherapist who, under the limited circumstances specified above, discharges his or her duty to warn and protect by making reasonable efforts to communicate the threat to the victim or victims and to a law enforcement agency.

The earlier ambiguous phrase "shall be discharged by warning" is eliminated from the statute. Those words were interpreted to require warning and not as intended that warning was sufficient. The revised statute was meant to clarify that immunity is provided by warning, but not that it was the only way to discharge the duty. The legislation was intended as a remedy for the problematic judicial decisions.

Generally, therapists will still want to warn. If not harmful, it is a way to get immunity from liability. There could be liability if it is argued successfully that warning would have protected the victim and it was negligent to choose an alternative means of protection. However, there are some situations in which warning will exacerbate the danger, and a responsible therapist may want to choose an alternative protective action such as hospitalization to enable further assessment and intervention. Such examples will be presented. The new legislation was intended to allow therapists to choose such an option without automatic liability if something happens for such a reasonable choice. Also, it requires only probable cause to hospitalize a patient. A therapist may want to leave it to the inpatient psychiatrist to assess the threat better and make a determination about whether to warn and/or take other measures to protect a potential victim.

Although warning the potential victim and the police provides immunity from *Tarasoff* liability, the situation is not like child abuse reporting. In child abuse reporting there is immunity from liability for false harmful reports. However, in *Tarasoff* situations there remains possible liability for the consequences of an irresponsible warning such as causing a patient to lose his/her job for a mere expression of anger about a boss that could readily have been determined not to be a serious threat. Thoughtless warnings may not necessarily be the best way to escape all liability. For political reasons the proponents of the bill were forced to allow some ambiguity into the stature. Dr. Weinstock went to the California Judicial Council to develop jury instructions consistent with the intent of the legislation so that therapists can choose the most appropriate protective action.

New proposed Judicial Council *Tarasoff* Jury Instructions: Consistent with the intent of the revised statute to provide both flexibility and (if warnings are made) immunity, the Judicial Council recently adopted jury instructions that would accomplish what the proponents of the bill wanted. CACI 503 B states warning is an affirmative defense that can result in immunity from liability and is read first if claimed by a therapist. It would state that the therapist is not responsible for the plaintiff's injury or the death of the deceased if the therapist proves that he/she made reasonable efforts to communicate the threat to the plaintiff/decedent and to a law enforcement agency.

If it is not claimed or found that such warnings were made, the therapist can be liable under *Tarasoff* for failure to make reasonable efforts to protect the intended victim from the patient's threat as described in jury instruction CACI 503A. If a therapist forgoes the safe harbor immunity by not warning, the therapist can be found liable if reasonable actions are not taken to protect the potential victim.

The marriage and family therapists and the CPA asked the Judicial Council to develop jury instructions such as these. If they are finalized, they will allow flexibility to do the most responsible protective thing without automatic liability if that does not include warning both the victim and the police. It is gratifying that the legislature, the Governor, and now the Judicial Council have understood and have been receptive to our concerns.

The new legislation did not changed the finding in Ewing vs. Goldstein 15 Cal Rptr. 3d 864 (Cal. Ct. Appt. 2004) that if a serious threat of physical violence is received by the therapist from a member of the patient's immediate family and shared for the purpose of facilitating and furthering the patient's treatment, the fact that the family member is not technically a patient is not crucial to the statute's purpose. If the threat in the therapist's opinion was not credible and communicated for an ulterior purpose (like in a divorce or custody dispute), it would not be to further treatment and should not lead to a duty. If an immediate family member does communicate a credible serious threat, therapists reasonably should take protective measures, including the possible option of immunity by warning both the potential victim and the police.

Proper documentation of your thinking that clarifies the reasons for your choices can be essential. It is important for practitioners to know what liability risks they are taking in these situations, on order to make an informed choice. This successful effort demonstrates the ability to correct court decisions through legislation when misguided decisions actually increase the danger to the public.

***Tarasoff*, Legislation, California**

I3 An Isaac Ray Award Lecture: Ethical Codes in the Forensic Sciences What Makes Them Right?

Richard Rosner, MD, Forensic Psychiatry Clinic, 100 Centre Street, Room 500, New York, NY 10013*

The goal of this presentation is to foster awareness in the desirability of grounding for ethical codes, either in the form of explanations or in the form of justifications and to encourage consideration of the foundations or lack of foundations for ethical codes in the forensic sciences.

This presentation will impact the forensic science community by assisting the audience to distinguish between the rules of normative ethics, on the one hand, and the meta-ethical explanations and justifications for those rules. The audience will learn that the meta-ethical explanations and justifications for normative ethical rules are essential to consideration of ethical problems not yet addressed by existing ethical codes.

The American Psychiatric Association (APA) and the American Academy of Psychiatry and the Law (AAPL) jointly sponsor the Isaac Ray Award for distinguished contributions to forensic psychiatry or psychiatric jurisprudence. The award recipient is required to deliver a scholarly paper in a national forum within one year of receipt of the award. In May 2007, the APA and AAPL bestowed the Isaac Ray Award on Richard Rosner, MD. This presentation is the scholarly paper required by the terms of the award. While professional ethical codes (including those in the forensic sciences) provide guidelines for ethical conduct, they usually do not provide either explanations or justifications for those guidelines. This paper will explore and evaluate some of the leading explanations and justifications that have been offered in support of ethical codes.

Two of the explanations of ethical codes are historical tradition and subjectivism. Historical tradition suggests that the values that have been inherited from the past should be retained for the present and future, regardless of the absence of convincing arguments in their support.

Subjectivism suggests that ethical values are merely expressions of our subjective feelings, that they are inherently unsupported by rational grounds.

Among the justifications of ethical codes are Divine Command Theory, Natural Law, Consequentialism, Deontology, and Feminist Ethics. Divine Command Theory suggests that ethical codes are based on God's commands: whatever God commands us to do is right. Natural Law suggests that God has endowed human beings with the rational ability to determine what is right: whatever is supported by the best reasons is right. Consequentialism suggests that whatever act leads to the best outcome for the most people is right: the greatest good for the greatest number is right. Deontology suggests that factors other than the outcome of our actions determine what is right; the most famous example is Immanuel Kant's categorical imperative. Feminist Ethics suggests that because men have devised the major justifications of ethical codes, those ethical codes are inherently flawed and new justifications based upon feminist values must be developed. This paper will consider some of the arguments in favor and in opposition to these explanations and justifications for ethics, with specific attention to professional ethical codes.

Ethics, Philosophical Explanations and Justifications, Isaac Ray Award Lecture

I4 First Do No Harm; Forensic Psychiatric Examinations, Reports, and Testimony

Robert Sadoff, MD, University of Pennsylvania, Suite 326 The Pavillion, 261 Old York, Jenkintown, PA 19046*

Upon completion of presentation, the participant will: (1) have developed methods of minimizing harm to examinees during forensic psychiatric examinations, and (2) be able to testify in forensic cases as objectively as possible with testimony given on evidence based resources.

This presentation will impact the forensic science community by demonstrating how the practice of forensic psychiatry can be exciting, rewarding, and fulfilling; however, there are also a number of pitfalls that the practitioner may encounter. Forensic psychiatric evaluations are not benign and without risk. Conflicts between different guiding principles are commonplace in forensic psychiatry, where the concept of *parens patriae* is often at odds with considerations regarding public safety.

Dr. Robert Sadoff is a clinical professor of psychiatry, director at the Center for Studies in Social-Legal Psychiatry, and director of the Forensic Psychiatry Clinic at the University of Pennsylvania School of Medicine. He is board certified in psychiatry, forensic psychiatry, and legal medicine, and has added qualifications in forensic psychiatry with the American Board of Psychiatry and Neurology. In 40 years, Dr. Sadoff has examined more than 10,000 individuals charged with crimes. He has testified in numerous criminal and civil trials, both in state and federal courts. Author of six books and 90 professional articles, Dr. Sadoff has lectured in nearly every state and many foreign countries.

Dr. Sadoff will review, in this presentation, methods of minimizing harm that may be inevitable in forensic examinations, reports and testimony.

Forensic Psychiatry, Ethics, Nonmaleficence

I5 Suicide Risk Assessment: An Evidence Based Approach

Robert I. Simon, MD, Georgetown University School of Medicine-Psychiatry and Law, 8008 Horseshoe Lane, Potomac, MD 20854*

After attending this presentation, the participant will be able to understand the implications of suicide to forensic and treating psychiatrists, the basics of suicide risk assessment, including special population issues, and expert risk management strategies.

Suicide is the single most common cause of malpractice claims against psychiatrists, it is also the top-reported Joint Commission on Accreditation of Healthcare Organizations sentinel event in all hospitals around the country. This presentation will impact the forensic science community by demonstrating how a psychiatrist can best reduce the malpractice risk from patient suicide in a straightforward manner—practice evidence-based psychiatry.

Lawyers make short work of "clinical experience" testimony by defendants and expert witnesses in suicide malpractice cases. Clinical experience, unaided by evidence-based research, can be idiosyncratic, insufficient, uninformed, or just plain wrong when applied to complex, fact-specific suicide cases. Both in the clinical setting and in providing expert witness testimony, clinical experience can be colored by tradition, myths, and conservatism.

Every practitioner's clinical experience is necessarily limited, yet it may be proffered as the standard of care or even as "best practices." The question arises: is clinical experience, unaided by evidence-based research, the practice of the average or reasonable, prudent clinician or is evidence-based suicide risk assessment the standard of care? The answer is neither. Most clinicians combine clinical experience with evidence-based research. Substandard suicide risk assessments often rely on clinical experience alone. Expert opinions on the extremes of best practices or unaided clinical experience will be challenged by opposing counsel as not within the legally defined care and treatment ordinarily employed by the average or reasonable, prudent practitioner under same or similar circumstances. No single source or authority, however, defines the standard of care in suicide risk assessment.

Psychiatrists are expected to possess core competencies in suicide risk assessment and in evidence-based psychiatry. Acquiring these skills is a current requirement of residency training. Suicide risk assessment identifies acute, high risk suicide factors and available protective factors that inform the treatment and management of suicidal patients. Clinical experience alone is usually insufficient to support a competent suicide risk assessment.

Suicide, Risk Assessment, Forensic Psychiatry

I6 Practical Approaches to Risk Assessment and Report Writing in Sexual Offenders: Information Review, Integration and Interpretation

Dean M. De Crisce, MD; Merrill Main, PhD*, Evan Feibusch, MD*; and Jason Cohen, MD*, Ann Klein Forensic Center-Special Treatment Unit, 8 Production Way, Avenel, NJ 07001*

At the end of this panel presentation, the attendees will understand the components of a sex offender evaluation, have some practical guidelines on report writing and the use of the Static-99, and understand the current state of treatment in commitment centers for 'sexually violent predators.'

Psychiatric involvement with sexual offenders is a rapidly growing field. Sexually violent predator laws have been increasingly enacted throughout the United States and frequently utilize psychiatric and psychological expertise to guide legal decision-making. This presentation will impact the forensic science community by demonstrating how the process of evaluation of sexual offenders usually requires the determination of a necessity for involuntary civil commitment, often defined by statutory criteria.

Evaluators must combine a thorough review of the discovery material, such as police investigations and prior treatment records, with a mental status examination, the use of actuarial instruments and knowledge of the increasing literature on sexual reoffense to conclude a determination of dangerousness. Static risk factors must be weighed against mitigating factors such as treatment effect, age, and the coexistence of personality disorders and paraphilias.

The process of a thorough evaluation, in essence, is comprised of three phases: Information gathering, such as document review and a mental status examination; information integration involving the organization of information in a useful manner to provide for a consistent approach to evaluation; and information interpretation, in which all factors in a particular case are compared against known contributors to reoffense risk. This can be an intensive and lengthy process.

In this presentation, Dr. Main, Clinical Director of New Jersey's Special Treatment Unit, a commitment center for "sexually violent predators" will review the history of the creation of commitment centers for these offenders and the current state of treatment in such facilities. Dr. Feibusch will review methods of gathering and reviewing both clinical and discovery material, including the mental status exam in the performance of these evaluations. Dr. De Crisce will discuss useful approaches to organize and categorize the information gained during the review and examination, including the use of the Static-99 to place offenders within an actuarial risk category, and report writing. Finally, Dr. Cohen will discuss general guidelines on the determination of risk of reoffense, providing practical approaches to report writing and conclusion.

Forensic Psychiatry, Sex Offender, Risk Assessment

I7 Stalking as an Element of Paraphilic Rape and Sexual Sadism

Karen Rosenbaum, MD, 244 East 77th Street, Apartment 23, New York, NY 10022; Mohan Nair, MD*, PO Box 849, Seal Beach, CA 90740; Amy Phenix, PhD*, PO Box 325, Cambria, CA 93428; and Neena Sachinvala, MD*, Sepulvada VA Medical Center, 16111 Plummer Street Building 10, North Hills, CA 91343*

After attending this presentation, attendees will be able to understand how stalking is linked to paraphilic (preferential) rape and sexual sadism.

This presentation will impact the forensic science community by assisting in the identification of potential rape offenders.

Stalking is "a course of conduct directed at a specific person that involved repeated physical or visual proximity, nonconsensual communication, or verbal, written or implied threats." Stalking is a combination of information gathering, rehearsal in fantasy, and intrusion through covert observation stalking is often associated with sex offenses. It has been described as instrumental i.e., that stalking, like other elements of criminal scripts simply represent the routinization of criminal decision making for obtaining the desired result of raping the victim.

This paper demonstrates that predatory stalking may be part of the script of paraphilic rape. Paraphilic disorders are characterized by "recurrent, intense, sexually arousing fantasies, sexual urges, or behaviors generally involving: nonhuman objects, the suffering or humiliation of oneself or one's partner, or children or other nonconsenting persons (DSM-IV-TR 2000). Paraphilic rape is a controversial disorder However, research indicates that among individuals who rape, there is a subcatagory who have intense repetitive urges to commit rape from an early age. At the core of paraphilic rape is the recognition by the offender during the assault that his actions are nonconsensual. The recognition can happen in several ways: examples include the rapist's attention to the victim's reactions, his perpetrating against a stranger, or the use of weapons or a rape kit.

The rapes show a repetitive pattern of actions, as if they are scripts. Behavioral signs of ongoing rape fantasies may be seen in patterns of setting the victim up, initiating the attack, making comments during the assault, having the victim do or say particular things or perform certain acts in a certain order during the assault. These stalkers may derive a sense of power as well as sexual excitement through tracking their victims and anticipating and rehearsing their planned sexual attack. The stalker's intent is not to alert the victim prior to the fantasized or planned attack. Stalking behaviors may not reveal the more sexually deviant intent behind it. The act of stalking can be an element of foreplay for these individuals, often as sexually exciting as the act of rape itself or even more so. The paraphilic rapist becomes stimulated by the fear and terror that he can instill in the woman through stalking. A number of case studies will be presented.

Stalking may be merely a way to seek out vulnerable victims. However, in some cases, the stalking behavior may be an element of parpahilic rape and sexual sadism. This may help to identify some offenders before they commit further act of rape.

Stalking, Paraphilia, Sexual Sadism

I8 Scientific Interviewing of a Fraud Suspect

David A. Lounsbury, PhD, Florida Gulf Coast University, Criminal Forensic Studies, 10501 FGCU Boulevard, South, Fort Myers, FL 33965*

The goal of this presentation is to disclose the scientific method for interviewing a fraud suspect using forensic interrogation techniques and to show the benefit of using a scientific method over traditional methods of interrogation.

This presentation will impact the forensic science community by stimulating persons having to deal with fraud crimes towards learning scientific interrogation. Using the forensic approach to interviewing will result in more clearance of fraud crimes through more effective interviews and confessions.

Attendees of this session will understand and be aware of the personality type that commits various types of frauds against the general public victim. The attendees will be exposed to the scientific approach that best results in obtaining a truthful confession from the fraudster.

The fraud offender is a typical anti-social or non-emotional offender whose entire outlook is egocentric in nature. The key to a successful interview/interrogation of this personality is a combination of themes based on logic and perceived benefit on the part of the offender.

The scientific interviewer/interrogator must not cause the interview process to become a contest. The anti-social personality of the fraud offender is such that he or she will constantly seek to fool authority. Much of the emotional satisfaction gleaned by the offender comes from being able to deceive opponents in a battle of wits. The interviewer must learn to restrain themselves from falling prey to such a contest. The ego of the interviewer must be totally subdued. The general rule of interviewing applies in that the perception of the suspect about the interviewer is more important than the interviewer's confidence or self-perspective. The suspect must believe the interviewer is sincere and empathetic to their (suspect's) plight.

The interview setting must be completely controlled by the interviewer. No interruptions or unnecessary witnesses should be present. The interviewer should know as much about the suspect and demographic of the victims selected as possible prior to conducting the interview. Knowing the history of the offender is critical in determining the types of fraud he or she has perpetrated in the past and the likelihood of a specific method of fraud used by the offender. The victim demographics help the interviewer form a theme blaming the victims for their own victimization.

The interrogation portion will initialize following the interview component of the process. During the interview the interviewer will determine whether or not the person being interviewed is guilty of the fraud offense being investigated. This is not guilt or innocence as determined by a court but rather a mechanism to determine if an interrogation is merited.

The scientific interrogation process relies on observations of normative behavior and deviations on the part of the offender. Because of the acting ability of the fraud offender, the observations of behavioral change are often more subtle than other type of offenders. The interviewer must have a full view of the suspect from head to toe. Distractions in the interview room must be minimized. The observations of the reactions by the suspect for deviations of normative behavior will include language choice, language or voice stresses, and kinesic body reactions. Kinesic body reactions are broken down into micro or minor movements such as facial tics as well as macro movements like arm gestures or posture changes.

Actions and verbalizations designed to show empathy on the part of the interviewer must be subtle. The fraud offender suspects everyone of thinking like they do. In their paranoia, they often recognize tactics that might work on a more emotional offender. This might appear to be patronizing to them and counterproductive to the successful interview. The fraud offender does not do well with a positive confrontation which is a tactic normally utilized by scientific interviewers between the interview and interrogation process. It calls for a revelation that the investigation has concluded that the suspect had indeed committed the offense being investigated. While this tactic is effective for many types of offenders it is a detriment when interviewing a fraud offender.

The goal of the scientific interviewer is to get the truth. The fraud offender will tell enough of the truth to get them into the best possible position from a legal standpoint. The interviewer must draw details from the fraud offender as they will not be volunteered under most circumstances. Once the confession is obtained and recorded the interviewer must never relay a victorious attitude. The offender may have to be re-interviewed and it would interfere with the possibility of a second successful interview.

Interview, Fraud, Interrogation

I9 MAOA and SLC6A4 Genotyping and Testimony at Criminal Trials

William Bernet, MD, Vanderbilt Psychiatric Hospital, 1601 23rd Avenue, South, Suite 3050, Nashville, TN 37212*

After attending this presentation, attendees will learn how testimony regarding behavioral genomics and gene x environment interactions may be appropriate at criminal trials.

This presentation will impact the forensic science community by increasing the awareness within the forensic community of recent research regarding behavioral genomics and its application to criminal trials.

Should testimony regarding behavioral genomics be presented at criminal trials? Philosophers, physicians, and mental health professionals have thought for hundreds of years that human behavior is driven by some combination of nature (heredity, family history, genetics, genomics), nurture (parental upbringing, influence of peers, good and bad life experiences), and free will. There are three ways in which a specific individual's genetic make-up may be relevant to his or her behavior: *(1) The person's genotype may exactly designate a psychiatric or medical diagnosis that clearly explains the person's abnormal behavior.* An example is Huntington's disease, an autosomal dominant neurodegenerative disorder that causes psychosis, dementia, and sometimes violent behavior. In this circumstance, the genotype determines the diagnosis and there is a distinct causal relationship between the genotype and the behavior. *(2) The person's genotype may support a psychiatric diagnosis that has been made on clinical grounds.* For example, a person who is homozygous for the short allele of the *SLC6A4* (serotonin transporter) gene is more likely to become depressed and suicidal after stressful situations than a person who is homozygous for the long allele of that gene (based on Caspi et al., Influence of Life Stress on Depression: Moderation by a Polymorphism in the *5-HTT* Gene, *Science*, 2003.). In this circumstance, the genotype does not *make* the diagnosis of severe depression, but it *supports* the diagnosis that was made on clinical grounds. *(3) The person's genotype may help to explain a person's violent or criminal behavior.* For example, a male who has the low activity allele of the *MAOA* gene and who experienced serious child maltreatment is more likely to manifest violent and antisocial behavior as an adult than a male who has the high activity allele of this gene (based on Caspi et al., Role of Genotype in the Cycle of Violence in Maltreated Children, *Science,* 2002.). In this circumstance, the genotype does not make a specific diagnosis or support a specific diagnosis, but it does help to explain that a particular person may have a predisposition to maladaptive behaviors. The interaction between genetic and environmental factors has been called G x E interaction. Testimony regarding these and similar G x E interactions may be appropriate in the penalty phase of a trial regarding mitigation and perhaps in juvenile court. That is, a defense attorney might argue that the defendant did not ask to have a particular genetic makeup and never asked to be the victim of child abuse. But these factors – without his desire, knowledge, or awareness – make it more likely he would commit a violent act later in life. The faculty of Vanderbuilt Forensic Services have genotyped 20 criminal defendants for the *MAOA* and *SLCA4* genes. In this paper, the results of this genotyping and will relate examples of testimony regarding behavioral genomics at several criminal trials including one case in which this testimony apparently affected the outcome of the trial, will be presented.

Genotyping, Gene X Environment Interaction, Testimony

I10 Psychiatric Issues in Toxic Building Syndrome

Joseph N. Kenan, MD, 436 North Roxbury Drive, #201, Beverly Hills, CA 90210; and Daniel A. Martell, PhD*, Park Dietz & Associates, 537 Newport Center Drive, Suite 200, Newport Beach, CA 92660*

After attending this presentation, attendees will understand the evaluation of individuals who are claming psychiatric damages resulting from toxic building.

The presentation will impact the forensic community by demonstrating the rigorous evaluation procedures needed to evaluate psychiatric damages for those claiming injury.

The presence or absence of psychiatric injury due to an exposure to a toxic building is sometimes controversial and other times obvious. Obvious cases occur when a previously well individual is exposure to a known poisonous agent and shortly after is clearly psychiatrically troubled. Controversial cases include cases include whether the agent is not proven to be poisonous, or the quantity of exposure is not known to be harmful. In addition, the forensic psychiatrist must evaluate for psychiatric stressors, unrelated to exposure to the building toxin that may be contributing to the individual's psychiatric pain. Dr. Martell and Dr. Kenan will examine the psychiatric and psychological techniques needed to evaluate these complex cases.

Toxic Building, Mold, Sick Building

I11 Compliant Child Victims of Sexual Abuse: Confronting an Uncomfortable Reality

Kenneth V. Lanning, MS, CAC Consultants, 4121 Plank Road, #115, Fredericksburg, VA 22407*

After attending this presentation, participants will be able to recognize the inconsistencies in the way the criminal justice system deals with children as victims and as offenders, identify some of the intervention problems created by not recognizing the reality of children as human beings with needs, wants, and desires who learn to manipulate their environment, and be able to discuss and consider possible changes in intervention attitudes and procedures for dealing with child victims.

This presentation will impact the forensic science community by increasing the likelihood that more child victims will disclose and more accurately disclose their sexual victimization.

In this presentation, the term *compliant* will be used to describe those children who in any way, partially or fully, cooperate in or "consent" to their sexual victimization without the treat or use of force or violence. Because children cannot legally consent to having sex with adults, this compliance should not in any way alter the fact that they can be victims of serious crimes. The term compliant is being used because at this time I cannot think of a better one. The primary purpose of this discussion is to bring out into the open possible reasons for this compliance (i.e., grooming and seduction) and to discuss its complexity and significance for child victims and professional interveners.

Compliant, Child, Victimization

I12 Transexualism as a Natural Variation of Gender Identity and Implication of Benefits

Park N. Dietz, MD, MPH, PhD, Park Dietz & Associates, Inc., 2906 Lafayette, Newport Beach, CA 92663*

After attending this presentation, attendees will have an understanding of the history of the medicalization of gender identity disorder and the reasons why it should not be considered a "disease" or "illness," but rather a natural variation in the human condition.

This presentation will impact the forensic science community by increasing awareness among forensic scientists of the current debate regarding conceptualization of the gender identity disorders and the implications of these concepts for civil rights, medical benefits for inmates, and government subsidies for sex reassignment surgery.

Medicalization is the process through which a condition is redefined as being within the jurisdiction of medicine. With respect to those transgendered people who became diagnosed as transsexuals or as gender identity disordered, medicalization spread beyond the pages of arcane sexological texts through a confluence of factors that included the international news story about Christine Jorgensen and the work of the Erickson Educational Foundation through which one transgendered person of means influenced the thinking of other transgendered persons, the public, and members of the medical profession, particularly Harry Benjamin in New York and the Gender Identity Clinic at Johns Hopkins in Baltimore. Harry Benjamin, a gerontologist, supplied patients to Johns Hopkins, the Erickson Foundation provided the funding to the Gender Identity Clinic at Johns Hopkins, and Johns Hopkins provided a sufficient dose of legitimacy to the entire enterprise through which transsexualism and gender identity disorder became official psychiatric diagnoses that other institutions and practitioners would carry on the work begun there even after Johns Hopkins closed its program.

Variations in gender identity reflect the *content* of thinking, in particular the subjective perceptions of the individual with respect to gender identity, from which follow certain behaviors. In a gender identity disorder, there is no demonstrable pathology of the brain or any other organ, no biological abnormality, no abnormality of the form of thinking, and no impairment of any mental process (e.g., consciousness or intelligence). To be a disease, a condition must arise as result of a pathological process, and that pathology must occur within the individual and reflect abnormal structure or function of the body at the gross, microscopic, molecular, biochemical, or neuro-chemical levels. Transsexualism and gender identity disorder do not meet this criterion.

Even if gender identity variations are ultimately understood as neurobiological phenomena, this would not be evidence that they are diseases any more than is left handedness. Additionally, if variations in gender identity reflect the interaction between neurobiological substrates and the social environment they would be best viewed as analogous to language acquisition. Thus, in the absence of a pathological basis for classification as a disease, gender identity is no more a disease than left handedness or fluency in French as a primary language.

Transsexualism and gender identity disorder, defined by any of the widely accepted criteria, are not illnesses or diseases. They are variants of the human condition with respect to subjective gender identification. If in a particular instance, it is an unwanted variation of human nature, it is in the values of those making this judgment that the problem lies. The classification of a condition as illness or disease should not be based on what is wanted or unwanted, as to do so is to invite the medicalization of sexual deviations, criminality, misconduct, and unpopular religious or political beliefs.

In the latter half of the 20th Century, it was useful to transgendered persons to transform public opinion away from such concepts of their behavior as sin, crime, degeneracy, or perversion by medicalizing the concepts of transsexualism and gender identity disorder. This process of medicalization achieved substantial success in reducing some kinds of discrimination and harassment of transgendered persons. But such political triumphs carry a price, one of which is the perception that the condition is an undesirable deviation from normality that should be prevented or treated where possible.

Gender identity disorder is not an illness or disease, but rather a range of natural variations in the human condition with respect to subjective identifications of gender identity. These variations, once sorted out from homosexuality and transvestism, have been medicalized for roughly half a century, despite the absence of any evidence of underlying pathology that could warrant a designation of the condition as a disease or its manifestations as an illness. Medicalization can create a diagnostic category, a class of patients, and a treatment industry, but it cannot create an illness or disease.

The medicalization of gender variation (transgender phenomena) played an important and useful role in protecting gender-varied people from punishment, in reducing intolerance, and in fostering the exploration of psychological, medical, and surgical interventions that might be of value. Demedicalization is a necessary step toward societal acceptance of transgendered persons.

Transexualism, Gender Identity Disorder, Demedicalization

I13 Sexual Violence and Victimization in Prison: An Overview of Federal Legislation, Research, and Litigation Issues

Janet I. Warren, DSW, University of Virginia, 1230 Cedar Court, Suite B, Charlottesville, VA 22903*

The goals of this presentation are to provide a review of: (1) prior research on rape in prison, (2) a summary of the PREA federal legislation passed in 2003, (3) epidemiological research conducted by the BJS, (4) predictive research on individual, group, and institutional risk factors, and (5) review of broader issues concerning sex in prisons, disease control, and same sex experiences.

This presentation will impact the forensic community by demonstrating the sexual violence and victimization in prisons.

This presentation will present an overview of the recent Prison Rape Elimination Act (PREA) that was passed by Congress in 2003 to address and eradicate rape in male and female prisons. It will review prior research on this topic and the epidemiological and predictive research that has been funded as a part of this initiative. The inter-dynamics of consensual, bartered, and coerced sexuality will be explored as it affects many aspects of prison life including inmate on inmate physical violence, group rioting and gang conflict, staff on inmate improprieties, and prison infractions and administrative reviews. Predictive research will also be presented as it informs our inquiry into gender differences in institutional violence; the relationship between predictors of sexual and non-sexual violence; the relationships between physical, sexual and relationship violence; and the role of individuals, group and institutional factors in determining the extent and type of sexual relationships that emerge in this type of setting. Broader questions concerning the role of sex and love in prison, disease prevention, and same sex sexuality will also be identified as broader topics that emerge from this more theoretical and empirical inquiry.

Sex in Prison, Sexual Violence, Sexual Victimization

I14 Risk Assessment and Treatment of Paraphilic Sex Offenders

Fabian M. Saleh, MD, University of Massachusetts Memorial Medical Center, Department of Psychiatry, 55 Lake Avenue, Worcester, MA 01604*

At the end of this presentation participants will be able to describe approaches to risk assessment of sex offenders and describe pharmacologic treatments for paraphilic sex offenders.

The purpose of this presentation is to describe pharmacological treatments for juvenile and adult sex offenders and to review basic approaches to sex offender risk assessments.

Individuals who engage in sexual offenses may be afflicted with a paraphilic disorder or sexual deviation syndrome. Paraphilias are psychiatric disorders characterized by deviant and culturally non-sanctioned sexual fantasies, thoughts and/or behaviors. Though afflicted individuals usually become aware of the unconventionality of their sexual deviancies around the time of puberty, the preponderance does not seek treatment voluntarily and preemptively. A small proportion of these individuals may also suffer from symptoms of mental illness that can go unrecognized. Approaches to management involve assessing risk and offering pharmacological treatment if needed. Several pharmacologic agents have been tried to ameliorate symptoms, including testosterone-lowering and serotonergic medications. Various modalities have also been proposed and used to assess an individual's risk for engaging in problematic sexual behaviors. In assessing risk, ethical dilemmas often arise, especially related to the role of mental health professionals in assessing risk, judging the adequacy of consent, and distinguishing between correctional and treatment functions. The purpose of this workshop is to describe pharmacological treatments for juvenile and adult sex offenders and to review basic approaches to sex offender risk assessments. Finally, the presentation will include commentary related to ethical considerations in working with this population. Through case examples, discussions about particular issues faced by audience members will be encouraged.

Sex Offenders, Paraphilias, Treatment

I15 Risk Assessment and Treatment of Pedophilic Sex Offenders

Fabian M. Saleh, MD, University of Massachusetts Memorial Medical Center, Department of Psychiatry, 55 Lake Avenue, Worcester, MA 01604*

After attending this presentation, participants will be able to describe approaches to risk assessment of sex offenders, describe pharmacologic treatments for paraphilic sex offenders, and discuss ethical considerations in treating and assessing sex offenders.

The purpose of this presentation is to describe pharmacological treatments for adult pedophilic sex offenders and to review basic approaches to sex offender risk assessment.

Individuals who engage in sexual offending behavior may present with paraphilic disorders, such as pedophilia or sexual sadism. Paraphilias are psychiatric disorders characterized by deviant and culturally non-sanctioned sexual fantasies, thoughts, or behaviors. Though afflicted individuals usually become aware of the unconventionality of their sexual deviancies around the time of puberty, the preponderance of paraphilic patients seeks treatment after being arrested for a sexual offense(s). A small proportion of these individuals may also suffer from symptoms of mental illness that can go unrecognized. Approaches to management involve assessing risk and offering pharmacological treatment if needed. Several pharmacologic agents have been tried to ameliorate paraphilic symptoms, including testosterone-lowering and serotonergic medications. Various modalities have also been proposed and used to assess an individual's risk for engaging in sexual offending behavior. In assessing risk, ethical dilemmas often arise, especially related to the role of mental health professionals in assessing risk, judging the adequacy of consent, and distinguishing between correctional and treatment functions. The purpose of this presentation is to describe pharmacological treatments for adult paraphilic sex offenders and to review basic approaches to sex offender risk assessment.

Pedophilia, Risk Assessment, Management

I16 Stalking and Unwanted Obsessive Attention

James Wright, MPA, 200 Lakeside Close, Nellysford, VA 22958*

After attending this presentation, attendees will have a basic understanding of the behavior and dangers of individuals who pursue others.

This presentation will impact the forensic community by promoting a better understanding of the dynamics of stalking cases.

Beginning about three decades ago, all states and the federal government enacted legislation regarding stalking behavior. Mental health professionals have been assessing and treating those who engage in the behavior for much longer. While the issue of stalking has long been known to the criminal justice system and mental health professionals, there is all too often a reluctance to take a multidisciplinary approach to the proper and safe management of these cases.

The motivations of stalkers, the real or imagined relationships they have with their targets, and underlying disorders combine to make these cases very complex to understand and address. By being able to identify and better understand the behavior of stalkers, both investigators and clinicians can gain insight into their motivation and, in many cases, anticipate their next actions.

Stalking, Obsessive, Erotomania

I17 Behavioral Science and National Security

Rick Malone, MD, MPH, Christopher Lange, MD, Marshall Smith, MD*, and Sean McDonald, PhD*, Walter Reed Army Medical Center, Department of Psychology, 6900 Georgia Avenue North West, Washington, DC 20307*

After attending this presentation attendees will be familiar with the interface between psychiatrists/psychologists and the intelligence community, and understand guidelines for evaluating or treating personnel with Top Secret clearances.

This presentation will impact the forensic community by improving the quality of services provided in the national security setting.

Psychiatrists and psychologists in a variety of settings may encounter patients involved in intelligence activities or undercover law enforcement operations. These patients may be legally prohibited from disclosing the details of their involvement, even though these activities themselves may be at the very heart of the psychosocial stressors prompting the evaluation. Levels of classification of national security information have been established by executive order and each federal agency responsible for such information has published similar regulations to implement these requirements. Top secret information may be part of a special access program (SAP) or sensitive compartmented information (SCI), with stringent security requirements. The procedures for obtaining special one-time access to classified information if needed for a case will be discussed, along with the potential pitfalls of bringing this into an evaluation. When a request for evaluation is specifically directed toward suitability for a security clearance, the general principles of conducting any forensic psychiatric examination apply. Furthermore, specific guidelines for determining eligibility have been enumerated in Director of Central

Intelligence Directive 1/14 (18), and are incorporated in the regulations issued by each federal agency affected, including each of the military services. The guidelines are divided into thirteen areas of human conduct that adjudicators consider in determining whether someone represents a security risk, four of which may require evaluation by mental health professionals. There may be significant differences in the mental health information a security manager needs to adjudicate a clearance determination compared to the information a treating psychiatrist or psychologist considers relevant for clinical decision-making. These guidelines will be reviewed with an emphasis on providing answers that are indeed responsive to the questions being posed, and not simply clinical opinions with limited objective data. Other applications of behavioral science including support of military intelligence operations and counterintelligence activities will be discussed.

National Security, Classified Information, Military Intelligence

I18 Psychological Impact on Guards at Guantanamo Bay Prison Camp - A Case Study Plus Others

John R. Smith, MD, 1416 Westchester Drive, Oklahoma City, OK 73120*

After attending this presentation, attendees will have an understanding of the impact of observing torture and threats on guards in relationship to long term psychological symptoms and the impact on subsequent duty behavior.

This presentation will impact the forensic community by promoting the understanding of the affects on guards Guantanamo Bay.

This presentation will focus on the psychological impact of being a guard at Guantanamo Prison for "enemy combatants." The source of the referral becomes important as the soldier had seen two mental health professionals before being referred to me.

The presentation will focus first on the establishment of the therapeutic relationship - especially trust. The particulars of the case which are special to the position he held could not otherwise be discussed. His duties included, but were not confined to preparing prisoners for their interrogations. The second aspect will be a description of the prisoners' physical and psychological reactions which deeply affected this soldier. Thirdly, the symptom picture of the Guard and the treatment provided in the time available will be briefly discussed.

Following a detailed presentation of the soldier referred to above, comments will be made on other guards who were present at Guantanamo, although at a more recent date. The core of the presentation will, however, be about the Guard who was there in the very early days of the opening of the prison.

A question will be raised about whether PTSD can develop in a soldier who has seen no combat and is engaged as a guard doing duties expected of him. (The Army has a policy, for instance, that no health care professional can have PTSD unless they are engaged in direct combat, but not from performing their duties as ER-Nurse, X-Ray technician, etc.)

Guantanamo, Torture, Guards

I19 Infanticide by Starvation and the Medea Complex: A Case of a Statistically Rare Form of Crime

Giuseppe Troccoli, MD, Department of Criminology and Forensic Psychiatry - University of Bari, ITALY, Largo Giordano Bruno 65, Bari, 70121, ITALY; Vito Romano, MD, Medicina Legale "Miulli", Acquaviva delle Fonti, Acquaviva delle Fonti - Bari, 70100, ITALY; Biagio Solarino, MD, Sezione di Medicina Legale, Università degli Studi di Bari, P.zza Giulio Cesare, 11, Bari, 70125, ITALY; Ignazio Grattagliano, PsyD, and Roberto Catanesi, MD, Section of Forensic Psychiatry, University of Bari, Piazza Giulio Cesare, Bari, 70124, ITALY*

After this presentation participants will learn how to better understand the dynamics that play a significant role in committing such a rare form of crime as the one described in this case.

This presentation will impact the forensic science community by illustrating the in-depth explanation of a rare and complex case in which an exceptional form of neglect, abuse and anger directed toward a little child is not caused by a relevant psychopathology, but mostly by personal/relational dynamics and socio-cultural factors.

Infanticide is the murder of a child carried out by one or both of his/her parents. There are different ways to carry out an infanticide, as well as different motives.

The case presented here involves a statistically rare form of infanticide, in which the death of female child under 18-months-old occurred as a result of a three month period of severe abuse, neglect, and malnutrition, to the extent of starvation.

The mother was a 22-year-old woman who lived with a 42-year-old man. She was raised by her grandmother, as both her parents were emotionally distant from her. She grew up in poverty. Her mother – who had worked as a prostitute - died after having suffered from alcoholic cirrhosis when she was about fifteen and her father had previous penal convictions.

When she was 18, she married a man and had two children. They had substantial financial difficulties and continuous conflicts that were worsened by the fact that her husband was unemployed and forced her to work as a prostitute.

At the age of 19 she met a client, whom she soon began to date, even though she knew that this man already lived with a woman and had two children. She fell in love with him, soon idealizing that sentimental relationship, to the point of believing they could have a future together and raise a stable family. Therefore, she left her husband. She and her children moved in with the new partner, but he abandoned her after only one or two months, while she was newly pregnant.

She continued to believe in this idealized relationship, but the man never came back. After a while, she returned to live with her husband for a few months, during which she worked as a prostitute again, until the birth of her third child, the baby girl who would be later left to die from starvation and whose father was the one she lived with for about one or two months before being aware of her pregnancy.

She left her husband for the second time and let another man move in with her. This man, who had prior penal convictions, did work somehow, but did not have a steady income. When she turned 21, she had her fourth child with the latest partner, but never stopped thinking about that man who had abandoned her. Her current partner often noticed her crying and became jealous of the other man. The woman had conflicting feelings towards that little baby, having chosen to not have an abortion in order to keep the baby's father tied to her. A few days after the birth of her fourth baby, she left the third one in the care of some relatives for a few months.

When the third child returned home with her, she only gave her small quantities of food (mostly milk, or water with sugar and breadcrumbs), left her in the stroller all the time - not allowing her to take her first steps - and without a blanket during winter (there was no heating system in her apartment). She also used to throw objects at the child when she was crying.

She referred to that baby as the "evil" child, due to her feelings of revenge (resulting from ambivalent love/hate feelings) directed toward the absent father, but also due to popular "magic" beliefs that she was under a spell of bad fate.

Her partner was involved in these dynamics and contributed to the same neglecting and abusing behaviour, which, finally, led to the death of the child after about three months.

A relevant psychiatric disorder was excluded in both the mother and her current partner and the explanation for the crime emerged from the study of the personal history and relational dynamics between the couple.

That child was the symbol of a personal failure for both the mother and her current partner.

For the mother, that baby was the concrete representation of the abandonment from the man (the natural father) on whom she had relied for her personal and family gratification. Moreover, that baby was another symbol of failure, as she represented an attempt to gain control over the father, who, on the contrary, decided to leave anyway. In other words, she failed in her personal realization. All her feelings of anger were projected on the baby and those same feelings were shifted from the real target (the man) and re-directed toward the symbolic target (the baby). In some way, these dynamics resembled the description of the so-called "Medea Complex", in which the mother killed her own children to gain revenge on the father, thus inflicting the ultimate punishment on him.

Confirmation of these specific dynamics was also evident from the realization that her other three children were healthy, well fed and treated normally.

The feelings of anger and hate were also apparent from the fact that the parents never called the baby by her name, but with demeaning nicknames as "The Palermitan" (the father was from Sicily), or "The Dwarf", from the mother, and "The Monster" from her current partner.

The latter also considered that baby as the symbol of the woman's relationship with another man, towards which he showed open feelings of jealousy and anger. In other words, the baby symbolized the failure of his personal realization with his woman.

Infanticide, Starvation, Media Complex

I20 Pitfalls in Sex Offender Commitment Hearings

Fabian M. Saleh, MD, University of Massachusetts Memorial Medical Center, Department of Psychiatry, 55 Lake Avenue, Worcester, MA 01604*

Upon completion of these presentations, participants will learn about sexual offenders, sexual dangerous person proceedings, and the management and treatment of sexual offenders.

This presentation will impact the forensic community by discussing etiological factors associated with sexually offending behavior; reviewing various profiles associated with rape behavior; discussing the psychiatric evaluation of a rapist in sex offender commitment proceedings; and discussing the appropriate and inappropriate use of psychiatric diagnoses and actuarial instruments in commitment hearings.

Rapists remain the subject of media attention and controversy. With the adoption of sex offender commitment statutes in many states, there is a pressing need to properly evaluate and assess these individuals. Such evaluations require an assessment of the individual's diagnosis and prognosis as well as an assessment of the individual's risk for future sexual offending behavior.

A review of recent literature discussing the phenomenology and etiology of sexual offending behavior, the common use and misuse of psychiatric diagnoses in sex offender commitment hearings (e.g., Paraphilia Not Otherwise Specified), and the treatment options for sex offenders will be presented.

Sex Offenders, Treatment, Civil Commitment

I21 Adolescent Sexual Offenders

Fabian M. Saleh, MD, University of Massachusetts Memorial Medical Center, Department of Psychiatry, 55 Lake Avenue, Worcester, MA 01604*

Upon completion of the program, participants should be able to: (1) appreciate the differential diagnosis of sexually offending behavior among adolescent sexual offenders, (2) know how to evaluate paraphilic and non-paraphilic sex offenders, and (3) understand the rationale for the use of medications in this population.

This presentation will impact the forensic community by reducing the likelihood of sexual recidivism among adolescent sexual offenders.

Some adolescents who engage in sexual offending behavior may suffer from a paraphilia, a psychiatric disorder characterized by deviant and impairing sexual fantasies, thoughts, or behaviors. Though there is no known cure for these conditions, paraphilias can be effectively managed using a multimodal treatment approach. This may include the use of psychotherapeutic and pharmacological treatment interventions.

Adolescence, Sexual Offender, Treatment

I22 Sex, Insanity, Competency, and Dangerousness. Forensic Psychiatry Landmark Cases: Impact on Defense and Prosecution Legal Strategies. Catch and Release? If You Did the Deed - What Happens Next?

Jennifer O'Day, MD, University of California, San Fernando Valley Forensic Psychiatry Training Program, 14445 Olive View Drive, 6D129, Sylmar, CA 91342; Karen Rosenbaum, MD*, 244 E 77th Street Apartment 23, New York, NY 10022; Lorie Gearhart, MD*, 1430 Wildwood Drive, Los Angeles, CA 90041; Robert Burchuk, MD*, 6320 Canoga Avenue, Woodland Hills, 0 91367; Barbara J. Justice, MD*, PO Box 467, 11054 Ventura Boulevard, Studio City, CA 91604; and Christopher F. Shahzaad, MD*, Metropolitan State Hospital, 11401 Bloomfield Avenue, Program V/Unit 413, Norwalk, 0 90650*

The goal of this presentation is to review landmark forensic psychiatry cases, review standards for detention under current law, and highlight interplay of social values and evolution of the law.

Historically, forensic psychiatric case law has evolved as a reflection of scientific understanding and social values. Present day case law has established standards for personal responsibility, creating options for both criminal exculpation and expanded civil detention. This presentation will impact the forensic science community by exploring the highlights.

After attending this session, attendees will understand the critical and central role that forensic psychiatry has played and continues to play in the development of social mores, regulations and the law. From acts as violent as rape, assassination and murder to the development of criteria for the detention of the criminally mentally ill, psychiatry has played a role in the fate of the perpetrator and the victim. In the struggle to balance the rights provided in our constitution with the protection of society and influenced by the moral climate of society, psychiatry has been a major actor in the drama.

Members of the panel will explore the nexus of psychiatry and the law and its impact upon the evolution of public policy. Historical questions related to legal capacity and criminal responsibility will be detailed. The management of the dangerous and potentially dangerous mentally impaired has challenged society and repeatedly led to stormy debate. Landmark cases are often reflective of vigorous differences in perspective. The review of these cases are frequently both enlightening and entertaining while providing food for thought. The resolution of these cases may surprise the unknowing viewer.

The manner in which changing values, beliefs and knowledge have influenced the development of forensic psychiatry as a separate and distinct discipline of psychiatry and how that discipline has matured to have its own unique perspective on various issues that affect the public at large as well as the individual will be highlighted. The forensic psychiatrist is often called upon to violate the sanctity of physician patient confidentiality. When and under what circumstances other psychiatrists are required to also violate confidentiality is of interest to the public at large.

The panel will discuss matters concerning the criminally insane who commit both major and minor crimes. How are they to be evaluated? What are the current standards? How and why have those standards changed over time? The volatile issues of incompetency to stand trial and the criteria to be met for designation as not guilty by reason of insanity will be reviewed. When should a person who transgresses society's rules be held responsible and when should he or she not to be held responsible? How long should they be detained? Where and under what circumstances? Should treatment be forced?

Always explosive and ever present is the conundrum presented by sexually violent predators. How do we balance their constitutional rights with the need to protect society? How much are we concerned about their constitutional rights? How long should they be confined? Should there be forced treatment? Is there any real treatment?

Forensic Psychiatry, Landmark Cases, Psychiatric Defense

I23 When Juveniles Commit Murder: An Overview of Facts and Challenges

Solange Margery, MD, Forensic Psychiatry Fellowship, Saint Vincent's Hospital, New York Medical College, 144 West 12 Street, Room 175, New York, NY 10011; and Stephen Billick, MD*, 11 East 68th Street, Suite 1-B, New York, NY 10021-4955*

After attending this presentation, attendees will have a basic understanding of the different types of juvenile homicide, characteristics of the juvenile offenders and the way the juvenile justice system and the adult criminal courts handle them.

This presentation will impact the forensic community and/or humanity by raising awareness into the need for further studies about juvenile violent behavior and the special challenges that this population present to the courts.

The presentation will offer a general overview of the different types of juvenile homicide with an emphasis on psychiatric factors that might lead to the crime. The authors will review psychiatric diagnoses that are related to an increase incidence in violence. The presentation will include a review of psychological factors that affect the legal procedures, such as competence, or that might serve as mitigating circumstances, such as history of abuse. There will be a short description of other aspects that might affect the jury's attitude towards the juvenile offender.

This presentation will review some of the most relevant elements of the judicial system and its historical background, including a description of cases that had an impact on current laws. Controversial topics will be addressed, such as the insanity defense in the juvenile population and the dilemma of what is appropriate punishment. The authors will talk about concerns regarding punishment, such as life imprisonment and executions, the latter no longer allowed. There will be a review of what is currently available for the rehabilitation of this population.

The authors will review several cases that will highlight the facts and challenges described above.

Juvenile crime, Homicide, Psychiatry

I24 The Criminalization of HIV

Francisco Velarde, MD, University of Southern California, Institute of Psychiatry, Law and Behavioral Sciences, 2020 Zonal Avenue, Los Angeles, CA 90086; and Kaushal K. Sharma, MD, PO Box 6275, Huntington Beach, CA 92646*

After attending this presentation, attendees will learn more about the HIV/AIDS epidemic, and the laws governing HIV transmission.

This presentation will impact the forensic science community by discussing the impact this illness has had in shaping social policy; specifically, in regards to right to privacy, disclosure, and informed consent. The legal impact associated with the laws governing HIV transmission will also be addressed.

This presentation impacts the community in general and the forensic community specifically by increasing awareness that HIV/AIDS remains a significant public health issue of concern. The HIV/AIDS epidemic was first recognized in the United States in 1981. Since then, AIDS surveillance data using a standardized, confidential name-based reporting system has been used. Recently, revised data from the CDC reports that through 2005 a total of over 956,000 persons in the United States were reported as having AIDS.

This epidemic has had a powerful influence on the societal, economic, and personal health of this country. U.S. Public Health policy and the medical institutional roles have a responsibility to monitor, inform, and assist in the treatment of societal ailments. Within this duty also lies the struggle to maintain patient confidentiality and their personal integrity. The rights of privacy in regards to one's medical record have been clearly delineated by state and federal laws. This balance between individual confidentiality and the preservation of public health is a dynamic entity that must be continually addressed and monitored.

U.S. Public Health policy guidelines recommend that persons who are infected with HIV inform their sexual partners of their status. The decision as to when or who should inform individuals of their partner's HIV status can be a complex task involving issues of shame, rejection, stigma, or social isolation. Public Health studies have found that HIV infected individuals are not disclosing their status to sexual partners and that nondisclosers are more likely to engage in unsafe sexual practices. Studies also reveal that approximately 40% of HIV positive persons do not disclose their status. If individuals with HIV do not disclose their status to partners but engage in safe sex practices, is such behavior ethically defensible? This unilateral risk reduction strategy does not allow one's partner the opportunity to make an informed choice.

The intentional or reckless transmission of the human immunodeficiency virus is an illegal act. Persons who engage in such actions can be charged with criminal transmission of HIV, murder, manslaughter, attempted murder, or assault. The issue of how and to what extent criminal law should play a role in this challenge to public health will be discussed. Criminal law has been one of the regulatory mechanisms used in the U.S. to address/influence the risk behavior of person's with HIV/AIDS. This influence may be imparted in the form of deterring unsafe behavior, endorsing a social policy against this behavior, or restricting the individual through imprisonment.

The presentation explores the ways in which criminal law would better serve the preservation of public health by implementing and endorsing more specific prohibitions against unsafe practices. The medical community, through its research has discovered the means for transmission of this infectious disease. The law would better serve the community if it reflected prohibitions of known dangerous practices, and encouraged persons to become more aware of risk behaviors.

HIV, Disclosure, Criminal Law

I25 Stalking By Proxy

Kaushal K. Sharma, MD, PO Box 6275, Huntington Beach, CA 92646; and Risa Beth Grand, MD, University of Southern California, Institute of Psychiatry, Law and Behavioral Science, PO Box 86125, Los Angeles, CA 90086-0125*

The goal of this presentation is to assist forensic practitioners in new and emerging phenomenon.

This presentation will impact the forensic science community by enhancing knowledge database of forensic practioners.

Fifteen years ago, in 1993, at the meeting of the American Academy of Forensic Sciences, Dr. Zona and Sharma presented the emerging issue of stalking and obsessional subjects. In those days, stalking was usually done in a more personal fashion by stalker either writing letters to the victim or appearing at the victim's door. With increasing popularity of other means of communications like SMS, TXT, IM, and e-mail, method of stalking has also changed. In this paper, Dr. Grand and Dr. Sharma present issue of internet and text messaging based stalking. In a 2000 paper, Dr. Jaffe and Dr. Sharma explored the issue of Cybersex. Last year, Dr. Grand and Dr. Sharma pursued this issue further in our paper dealing with consent in Cybersex. Here, Dr. Sharma and Dr. Grand discuss a rather interesting case study of such stalking by proxy. This is akin to a not so uncommon movie theme of "good guy vs. bad guy" theme existing in the same person or twin brothers or what used to be called multiple personality disorder.

In the field of medicine, certain conditions are presented to a clinician in a disguised manner. The presumed patient, even if suffering from ill health is not the only person who is in need of intervention. This is referred to as "Induced Disease by Proxy." Probably the best known of these is *Munchausen's by Proxy Syndrome*. Sometimes it is also referred to as *Polle Syndrome*, a name attributed from the daughter of Baron Munchausen's who supposedly died from such pathology.

This paper deals with a relationship disorder. The stalker, from all outward behavior is like any other typical stalker. However he has access to information not commonly available to a stalker. For example frequent change of phone numbers does not deter him from finding out the new phone number, sometimes within a few days. He is also able to locate new address with ease. The perpetrator is stalking an unsuspected victim with increasingly aggressive threats. However the perpetrator, in his real life is pretending to hide his pathology and projects this pathology to the assumed stalker. The victim who knows the perpetrator as a friend does not realize that this so called friend is stalking her with a false identity. This leads to interesting and dangerous consequences for the victim when the stalker by proxy, invites other people at random, to start stalking the same victim. Finally when caught, the presumed friend and stalker are found to be one and the same. When evaluated the stalker's psychosexual pathology and relationship issues become apparent.

Dr. Sharma and Dr. Grand focus on such uncommon stalking behavior and using case example outline pathology of the suspect, the victim and their multi-dimensional relationship.

Stalking, Cybersex, Dangerousness

QUESTIONED DOCUMENTS

J1 Genuine and Disguised Signatures - An Empirical Approach

Linton Mohammed, MFS, San Diego County Sheriff, Crime Lab, 5255 Mount Etna Road, San Diego, CA 92117 ;and Bryan Found, PhD, and Doug Rogers, PhD, La Trobe University, Bundoora Campus, Melbourne, 3086, AUSTRALIA*

After attending this presentation, document examiners will learn how measured characteristics of genuine and disguised signatures can help in determining authenticity.

This presentation will impact the forensic community by helping to provide a basis for a more empirical approach to signature examinations.

The examination and comparison of signatures to determine their authenticity is a task commonly faced by Forensic Document Examiners (FDEs). The examiner has to determine if a questioned signature is genuine, simulated (forged), or disguised. The strategy of disguise is used by a writer to deny having written his own signature at a later date. A disguised signature may be considered to be a type of genuine signature. The ramifications of an examiner opining that a signature was simulated, when it fact it is a disguised signature can be quite serious in terms of a person's loss of freedom or property and vice versa.

The traditional document examination literature has described the various characteristics of genuine, forged, and disguised signatures. These characteristics have been inferred from observations on static signatures. This paper will investigate the characteristics of genuine and disguised signatures that were captured in the digital domain. There is overlap in some of the features of simulated and disguised signatures and it can be a challenge for the FDE to determine how the signature was executed. Recent research has indicated that there may be some limitations as to how strongly an examiner can conclude whether a signature is simulated or disguised. Some commentators suggest that the furthest an examiner can go is to say that the questioned signature (if simulated or disguised) exhibits features that are not natural to the known writer.

Structurally, signatures can be grouped into three types: "text-based" (where all allographs are legible), "stylized" (where no allographs are legible) and "mixed" (where there are both legible and illegible allographs present). The presence of these structural types in the population is of interest as they may impact on the strategy that a writer uses to disguise their signature. In order to investigate whether the structural variants impact on disguise strategy, the signing behavior of 90 writers (30 "text-based", 30 "stylized" and 30 "mixed") will be analyzed in the dynamic domain. Each writer will be asked to provide 10 normal signatures (GEN), five disguised signatures (DNC) where no contextual scenario is provided, and five disguised signatures (DWC) where subjects were provided with the context that they were to sign as though they were in a bank or similar setting where there was a model signature for comparison. All signatures are to be recorded using a Wacom Intuos 3 digitizing tablet sampling at 200 Hz and 0.0005 cm resolution. Movalyzer software (Version 3.94) [Neuroscript Software, Inc.] will be used to examine and compare the genuine and disguised signatures with respect to response time, mean velocity, movement time, mean pressure, mean number of strokes, and fluency measures such as acceleration maxima. This empirical data will be used to determine whether changed features associated with disguise are different depending on the type of genuine signature normally performed. Traditional views regarding the discrimination of simulated and disguised signatures will be reassesses as to their validity based on whether differences in disguise strategies are present between the different genuine signature types.

Document Examination, Genuine Signatures, Disguised Signatures

J2 Skill Based Testing in Forensic Document Examination: Is There a Future?

Derek L. Hammond, BA, United States Army, Criminal Investigations Lab, 4930 North 31st Street, Forest Park, GA 30297-5205*

After attending this presentation, participants will gain an understanding of some of the issues surrounding skill-based testing currently being debating in the field of forensic document examination.

This presentation will impact the forensic community by helping participants become better prepared to assess the value of current and proposed testing programs available to FDEs.

Recently the idea of skill-based testing (e.g., validation trials, "error rate" testing) has been a significant topic for discussion in the field of forensic document examination. Opinions have varied as to whether or not this type of testing is necessary or even needed at all. This presentation will discuss various view points and the options available to the forensic document examiner who wishes to participate in error rate testing.

Error-Rate Testing, Forensic Document Examination, Skill Based Testing

J3 Micro-Spectroscopic Examination of Writing Inks

Albert H. Lyter, PhD, Federal Forensic Associates, PO Box 31567, Raleigh, NC 27622*

The goal of this presentation is to inform the audience of new techniques for the examination of writing ink.

The availability of new technology or the availability of technology of which one is unaware will impact the forensic community by increasing the efficiency and/or completeness of forensic examinations.

Forensic science practitioners are always faced with the problem of "trace" amounts of materials upon which their analysis relies. With the advent of micro-spectroscopic techniques based on fiber optic instrumentation, it is prudent to investigate the applicability of these techniques to the examination of materials commonly found in forensic matters. One such class of materials is writing inks. Previous work that reported the characterization of writing inks and measured changes in the writing ink due to the age of the writing have used spectroscopic methodologies. This work will investigate the use of micro-spectroscopic methodologies as a replacement or improvement of the reported techniques that are presently in use. Adherence to spectroscopic principles, determination of detection limits and examples of practical applications will be reported on a wide range of different writing ink types and formulations. Clear applicability is demonstrated for the use of these types of instrumentation for the examination of writing ink.

Ink Analysis, Micro-Spectroscopy, Ink Dating

J4 Evaluation of the Individuality of Handwriting Using FLASH ID – A Totally Automated, Language Independent System for Handwriting Identification

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The goal of this presentation is to expose attendees to an innovative and highly effective means of automatic handwriting-derived biometric identification using the "FLASH ID" software package. Attendees will become familiar with the statistical techniques behind this software. They will learn how a writer is characterized through quantitative analysis of a writing sample and they will see how a data base of writers is scored and sorted to identify the writer of a questioned document from among the population of writers in a data base. Finally, attendees will learn about the validation of the concept of handwriting uniqueness using empirical studies of measurable features extracted from handwriting samples.

This presentation will impact the forensic community by providing information of the ongoing collaboration of three organizations who are working to use automated biometric identification of handwriting tools to assist forensic document examiners (FDEs). Developers, statisticians, FDEs, and research scientists have been working to develop and apply biometric identification tools to support forensic handwriting individualizations and to address statistical issues involving individuality in the context of handwriting.

Forensic document examiners routinely perform handwriting comparisons for writer identification. The underlying premise for such identifications is that each person incorporates distinguishing individual features into his/her handwriting. During *Daubert* admissibility hearings, the validity of this foundation of individuality has been challenged. A collaborative research effort addressing this challenge has resulted in FLASH ID, a totally automated language-independent system for handwriting identification. FLASH ID uses an innovative quantification of handwritten text and computationally intense statistical methods for discrimination among writers. This presentation will consist of three presentations focusing on: (1) development and functionality of the FLASH ID system, (2) statistical methods for biometric identification with handwriting, and (3) empirical testing to assess the individuality of handwriting and how it relates to *Daubert.*

The "FLASH ID" software package will be presented as a fully operational software system that can address the immediate needs within the forensic community related to using handwriting as a biometric identifier. The presenter will illustrate how individual features, available and quantifiable within a person's writing, can be empirically captured into a "loss less" data structure that preserves the topology and geometry of the original writing. Statistical algorithms are created to reduce the very large number of feature measurements down to a very few, called a writer's "biometric kernel," that captures those elements that link the writing to its writer. The Biometric Kernel is the statistically-derived subset of those measurements that truly captures the essence of an individual's writing. Once the Biometric Kernel is established, FLASH ID can act on any unknown sample of handwriting and will return the nearest value in its handwriting reference database that provides the closest match to the questioned writing sample. FLASH ID represents a new approach toward using handwriting as a biometric identifier that does not attempt to replicate the actions of a forensic document examiner. Rather, it brings to bear the power of what computers do very well—rapid capture and processing of large quantities of data—into the hands of forensic experts.

A method of quantification of handwriting originally applied to optical character recognition has been demonstrated to provide a powerful foundation for biometric identification using handwriting. A recognized character in a document is associated with a mathematical graph, which is an array of curves that intersect or end in vertices. The frequency pattern of graph types observed in a document for each separate alphabetic character is a very powerful biometric identifier of the writer of the document. For instance, using pair-wise comparisons of 292 copies of a modified London business letter written by 100 writers (approximately 3 documents per writer), this biometric identifier correctly linked the documents for each writer. A similar exercise using only segments of the London letters showed that about 50 characters suffice for identification with high accuracy. This exercise with discordant segments demonstrated that identification accuracy was context independent. Further, additional information about the writer's profile are obtained using a minutia level biometric identification, which is based on physical feature measurements on the graph associated with a character. Based on minutia level biometric kernel-based identification alone, the true writer of a questioned document will be retrieved from a data base of known writers with high accuracy if that writer's minutia characterization is stored in the data base.

As a residual biometric that can link individuals to documents, handwriting provides an important data source for both law enforcement and intelligence purposes. In the form of FLASH ID, the forensic science community will now have a tool that harnesses the power of automation to leverage the effectiveness of document examiners by capturing similarities embedded among multiple writing samples and graphically showcasing these similarities supported by the statistical analysis that led to their identification. The technology underlying FLASH ID is language independent; that is, the empirical and analytical techniques that power the handwriting-derived biometric process have been demonstrated to function in different languages with completely different scripts. In this way, FLASH ID will extend document forensics across language barriers—something that is not commonly practiced today.

FLASH ID represents a totally automated process for extracting graphical data from handwritten documents, analyzing this data using robust statistical methods and matching documents based on similarity of the captured writing. This presentation will highlight the high level features of this research, supported by more detailed poster presentations regarding the FLASH ID system, statistical characterization of handwriting using features derived with FLASH ID, and statistical concepts for assessing handwriting individuality.

Handwriting, Individuality, Statistics

J5 The Effect of Writing Speed on Handwriting in Turkish Alphabet

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After attending this presentation, attendees will understand effect of writing relative speed on handwriting in Turkish Alphabet.

This presentation will impact the forensic community and/or humanity by enabling question documents examining effect of writing speed on handwriting in Turkish Alphabet.

What is relative speed of writing? Does it mean the writer is writing at one mile per hour then increases his writing speed five miles per hour, etc.?

No! Relative speed of writing is not a measurement of how fast the writer is writing at any given point in time. Rather, it is the result of an analysis of the psychological factors affecting handwriting. Relative speed of writing is important. While the absolute speed with which a person writes can vary significantly, the relative speed with which that writer writes remains uniform.

The relative speed of writing is one of its most important features; at the same time it is one of the hardest to assess accurately, being a matter of deduction from a number of clues, and of estimation, rather than being capable of specific measurement. Relative speed of writing is not a measurement of how fast or slow the writer is writing at any given point in time. Rather, it is the result of an analysis of the psychological factors affecting handwriting. The speed of writing is therefore dependent upon: the speed of mental imagery and nervous impulse, the tone and speed of muscular function. So, if the speed of writing can be deduced reliably from examination of the trail, we have arrived at an important assessment that gives us a reflection of the mental, nervous, emotional and physical activity of the writer.

The relative speed of writing is not easy to measure and interpret in the study of questioned documents. Yet in many forensic cases, the estimation of speed is of critical importance to solve a questioned document case. A common approach is to examine the place of dots for small letters "i" and "j" in a handwritten document as is the case in English alphabet. The Turkish language has the same dotted characters as well as small letters with dots, cedillas and umlauts like "ç, ğ, ö, ü, and ş." The purpose of this study is to determine whether diacritical marks in these letters can also be used to discern the speed of writing.

Sixty individuals (thirty male, thirty female) are asked to perform a fast handwriting test using same kind paper and pen. These persons wrote on the same position. They are asked to write a given text with Turkish diacritical marks slow and fast. In the handwritings, the speed is measured by determining how much each diacritical mark deviates from its proper location on the letter. In those documents with the text written slowly, all marks are found in their exact locations. In the fast written documents not all are seen in the same position and even some are omitted. It is also noted that they are written very close to the letters making them appear one single and elongated character. This suggests that these elongated letters can be used to estimate the speed of handwriting. The handwriting by females shows differences from that by males. Females are more careful and systematic in producing letters and adjusting the speed.

In conclusion, it seems clear that Turkish diacritical marks add certain advantages to the identification of a handwritten document. They help to determine the relative speed better than those languages with minimum number of marks on their letters.

Handwriting Examination, Relative Speed of Writing, Turkish Alphabet

J6 Decoding the United States Postal Service Barcodes

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The goal of this presentation is to inform the forensic community about the information contained in USPS barcodes and how to decode them.

This presentation will impact the forensic community by highlighting an area of specialized technology.

After viewing the presentation, attendees will understand the information which can be gained from barcodes found on mail delivered via the United States Postal Service (USPS). Barcodes are used by USPS for a variety of reasons and contain information including zip code of addressee, sender, rate information and time stamping. Depending on the type of case and the mailed item, decoding barcodes on the package could provide investigation leads. The presentation will highlight a threatening letter case involving the reuse of an envelope. The case required the separation and decoding of overlaid POSTNET (Postal Numeric Encoding Technique) barcodes. The POSTNET barcode can be 32, 52, or 62 bars in length depending on the information included. POSTNET barcode is read in groups of five bars containing two tall and three short bars (additional bars are frame bars). POSTNET barcode always includes the five digit zip-code of the recipient. Longer POSTNET barcodes include additional recipient address information. The bars are tall and half bars which represent numerals. Decoding of the POSTNET barcodes in this case provided the zip code of the original recipient of the envelope. The envelope also contained MLOCR (multi line optical character reader) information. MLOCR is comprised of seven alpha and numerical characters which serve to identify companies authorized to preprint barcodes and provide rate information. Decoding the MLOCR in this case provided information on the company which mailed the envelope to the original recipient. While the decoding of barcodes cannot specifically identify an individual it can assist in narrowing a field of suspects, disproving a story, establishing a geographical area or other helpful information to piece a case together.

In addition to the discussion of POSTNET and MLOCR barcodes, other USPS barcodes will be discussed including: PLANET, intelligent and applied identification tag (ID tag). Discussion will include description of barcode and information contained as well as different tools which aid in decoding the barcodes. The PLANET barcode has two forms origin confirm and destination confirm. This barcode is used to assist tracking of mail and confirm delivery. The PLANET barcode contains customer information, mail piece type, and mailer information. In appearance, PLANET barcode is similar to POSTNET. However, PLANET is read in groups of five containing three tall and two short bars and is 62 or 72 bars long. The intelligent barcode is a relatively new barcode and is based on algorithms allowing for more information with fewer bars. The intelligent barcode combines PLANET and POSTNET barcodes into one which is 65 bars long. The bars are a combination of full bars, ascenders and descenders (half bars), and trackers (quarter bars). The intelligent barcode is printed by authorized companies and includes company identifiers, recipient zip-code information and confirmation information. Decoding this barcode is achieved using an online decoder. The ID tag is the fluorescent orange barcode often located on the reverse of envelopes. The ID tag contains information on the machine which processed the piece of mail including date and time. Due to the large volume of mail processed by USPS this barcode is most useful within 14 days of being applied. USPS barcodes contain information regarding sender, recipient, and other information which potentially could aid an investigation. This presentation places emphasis on the potential importance of decoding barcodes to forensic investigations along with instructions on how the different barcodes are deciphered.

POSTNET, MLOCR, ID Tag

J7 Microscopic Examination of Blue Gel Inks After Cellulase Digestion of Paper

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The goal of this presentation is to teach an assay which allows for the separation of gel inks from paper substrates so they can be studied using microscopic methods.

This presentation will impact the forensic community by providing a procedure which will allow the separation of non-soluble pigmented inks from paper so the further instrumental methods can be applied to their identification.

Gel pens or pigmented inks have been difficult to investigate due to their insoluble nature. Microscopic techniques[1] have shown promise in the pursuit of differentiation, but may only be applicable if the inks can be removed from a paper substrate.

This study focuses on the use of an enzymatic assay to dissolve paper offering a potential method for removing ink from paper and thus allowing microscopic examination of the ink without interference from the paper

substrate. Two types of cellulase from the species *Trichoderma viride* and *reesei,* respectively, were used to digest one millimeter hole punches of paper samples containing gel inks from 36 different blue gel pens. The enzyme was used in a concentration of 2.5 mg/ml and diluted to 1:2 with citrate buffer at a pH of 4.8. The units of activity were 9.285 unit/ml for *Trichoderma viride* and 8.125 unit/ml for *Trichoderma reesei*. The digestion of the paper was performed at 50 °C directly on depression slide enabling samples to be observed microscopically without having to transfer sample. Comparisons were made with standards of gel inks placed directly on glass depression slides and put through the same digestion process. Examination of digested material was performed with bright field, dark field and phase contrast microscopy.

Ten soluble inks were tested but in all cases ink standards were either washed away or significantly diluted to where they could not be examined. For test samples, six of the soluble inks turned paper fibers blue under all three applied methods. Using phase contrast, some of these fibers appeared lime green and purple and under dark field the fibers appeared bright blue. Black particles were observed in two of the soluble gel inks with no other indication of ink. Two soluble inks were completely washed away during the digestion process.

Twenty-six non-soluble blue gel inks were similar digested and examined microscopically. After digestion, these inks appeared as scattered particles some of which were free floating in the digestion solution and some were still attached to fibers. There was a relationship between the amount of standard ink left on the depression slide after digestion and the size of the ink particles on the digested paper samples. In particular, gel inks from Zebra tended to yield smaller ink particles. Non-soluble gel inks that were not affected by the digestion process as observed on standard samples were more likely to remain attached to paper fibers. The colors of the non-soluble gel inks varied from blue, blue-green and purple when visualized under bright field. Phase contrast either increased the amount of colors visible (as in the case of some blue-green inks appearing purple and green under phase contrast) or made the ink appear a darker shade. Dark field microscopy enabled the visualization of colors along the edge of gel inks and increased the variation in color allowing for better discrimination of samples. Several of the gel inks contained black clumps or angular particles, which were visibly present in the sample and not washed away by digestion.

Digestion time of twenty-four to forty-eight hours was used with no indications that longer incubation times increases discrimination. Problems with the formation of crystals due to precipitation of citrate buffer sometimes occurred, but diluting the sample with deionized water and reducing drying time diminished the amount and size of these crystals.

Gel inks, Cellulase, Microscopic

J8 FLASH ID: A Totally Automated, Language Independent Approach for Handwriting Derived Biometric Identification

Mark A. Walch, MPH, The Gannon Technologies Group, 1000 North Payne Street, Alexandria, VA 22134*

After viewing and discussing this presentation, attendees will be familiar with the "FLASH ID" software package developed by the Gannon Technologies Group in collaboration with George Mason University with extensive guidance and technical input provided by forensic document examiners and researcher scientists from the FBI Laboratory.

FLASH ID as a fully operational software system that can address the immediate needs within the forensic community related to using handwriting as a biometric identifier will be presented. The presentation will illustrate how individual features, available and quantifiable within an individual's writing, can be empirically captured into a "loss less" data structure that preserves the topology and geometry of the original writing. The presentation will continue into the statistical analysis of this data structure to capture those elements that link the writing to its writer. A more in-depth discussion of statistical methods will be in a complementary poster presented by Gantz et al. Step-by-step screen shots will be shown illustrating the methods for taking known writing samples and capturing them as a data structure based on Graph Theory replete with both topology and hundreds of detailed physical measurements. It will then be shown how this data structure can be analyzed using statistical methods to distill the topological and physical features into a "biometric kernel." The Biometric Kernel is the statistically derived subset of those measurements that truly captures the essence of an individual's writing. Otherwise stated, the Biometric Kernel consists of those features that hold most consistent within an individual's writing and vary the most across multiple different writers. Once the Biometric Kernel is established, FLASH ID can act on any unknown sample of handwriting and will return the nearest value in its handwriting reference database that provides the closest match to the questioned writing sample.

A key point to be made to the attendee is how FLASH ID represents a new approach toward using handwriting as a biometric identifier that does not attempt to replicate the actions of a forensic document examiner. Rather, it brings to bear the power of what computers do very well—rapid capture and processing of large quantities of data—into the hands of forensic experts.

This presentation will impact the forensic community by. The core message will be rooted in two important aspects of the technology used to build FLASH ID. First, FLASH ID represents a totally automated process for extracting graphical data from handwritten documents, analyzing this data using established statistical methods and matching documents based on similarity of the captured writing. Second, the technology underlying FLASH ID is language independent; that is, the empirical and analytical techniques that power the handwriting-derived biometric process have been demonstrated to function in different languages with completely different scripts.

As a residual biometric that can link individuals to documents, handwriting provides an important data source for both law enforcement and intelligence purposes. In the form of FLASH ID, the forensic science community will now have a tool that harnesses the power of automation to leverage the effectiveness of document examiners by capturing similarities embedded among multiple writing samples and graphically showcasing these similarities supported by the statistical analysis that led to their identification. FLASH ID will also extend document forensics across language barriers—something that is not commonly practiced today.

Handwriting, Biometric, Software

J9 Statistical Characterization of Writers for Identification

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After viewing and discussing this presentation, attendees will be familiar with the statistical techniques behind a writer identification technology that is based on an innovative quantification of handwritten text and computationally intense statistical methods. Attendees will learn how a writer is characterized through quantitative analysis of a writing sample and they will see how a data base of writers is scored and sorted to identify the writer of a questioned document from among the population of writers in a data base. An oral presentation at this conference provides a high level summary of the biometric identification results that have been attained by applying various statistical algorithms to the quantification of handwriting. This presentation provides lower level details showing how statistical methods are used to characterize writers.

This presentation will impact the forensic community by making attendees aware of the mathematical quantities that underpin the biometric identification with handwriting and the efforts of the three cooperating organizations to assist forensic document examiners (FDEs) in exploiting these quantities to support their practice. These organizations are Gannon Technologies, Inc., the Document Forensics Laboratory at George Mason University and the FBI Laboratory.

Other oral and poster presentations at this Conference address the handwriting quantification technology developed by Gannon Technologies, Inc. A recognized character in a document is associated with a mathematical graph, which is an array of curves that intersect or end in vertices. The frequency pattern of graph types observed in a document for each separate alphabetic character is a very powerful biometric identifier of the writer of the document. However, this poster presents statistical details for the minutia level biometric identification, which is based on physical feature measurements on the graph associated with a character.

There are hundreds of separate feature measurements tied to even the simplest graph with only a few curves and vertices. Reducing the very large number of feature measurements down to a very few that characterize the way the writer writes the given character is a challenge that statisticians call the curse of dimensionality. Two approaches have been taken to meet this challenge. The first approach that was implemented performed separate head-to-head statistical comparisons between the writer's sample and a sample from each writer in a test bed data base. For each test bed writer, a discriminant analysis procedure selects a subset of feature measurements that separate the samples of the two writers. The entire procedure is repeated starting with a reduced set of feature measurements that were broadly selected to discriminate the writer from other writers in the test bed. Several repetitions reduce the feature measurements to ten or fewer, called a biometric kernel, which characterize the writer for the particular character and graph pair. The full characterization of the writer is the full collection of biometric kernels corresponding to each character-graph pair that was observed in the writer's sample documents.

A second approach focuses on the importance of a single feature measurement on a character-graph pair for a particular writer. For that writer and single feature measurement, a t-test is performed against each other writer in a test bed, and the p-values from the t-tests are recorded. After transforming and combining these p-values, a decision is made on the importance of this single feature measurement in distinguishing the particular writer from all other writers in the test bed. Next, information is combined from all feature measurements on the same character. For the particular writer, each decision made on the importance of a feature measurement for a character-graph pair gives rise to a p-value. Techniques used in the analysis of microarray data are especially suited for determining the weight that should be placed on each feature measurement for a character-graph pair. It is this collection of weights that determines the biometric kernel that characterizes the writer for the particular character-graph pair.

Based on minutia level biometric kernel-based identification alone, the true writer of a questioned document will be retrieved from a data base of known writers with high accuracy if that writer's minutia characterization is stored in the data base.

Handwriting, Statistics, Biometrics

J10 A Comparison Between Biometric and Forensic Handwriting Individuality

Christopher P. Saunders, PhD, George Mason University, Document Forensics Lab, 4400 University Drive, MS, 1GB, Fairfax, VA 22030; Linda J. Davis, PhD, George Mason University, Department of Statistics, 4400 University Drive, MS 4A7, Fairfax, VA 22030-4444; Andrea Lamas, BS, George Mason University, 4400 University Drive, MS, 1GB, Fairfax, VA; and JoAnn Buscaglia, PhD, Federal Bureau of Investigation Laboratory, Counterterrorism and Forensic Science Research Unit, Building 12, Quantico, VA 22135*

The goal of this presentation is to describe one approach to linking validation of the concept of handwriting uniqueness to empirical studies of measurable features extracted from handwriting samples.

This presentation will impact the forensic community by assisting in the validation of the premise of the uniqueness of handwriting profiles using empirical studies. This research will provide sound statistical support for handwriting individualizations in light of the *Daubert* standard.

Forensic handwriting individuality refers to the proposition that each individual in a population has a unique handwriting style. An empirical study cannot validate this proposition due to the impossibility of observing sample documents written by each person in a relevant population. However, the proposition that handwriting is unique is one of the key premises on which the Forensic Document Examiner (FDE) relies in making a positive identification (i.e., individualization) of the writer of a given handwriting exemplar.

One proposed measure of the quality of a biometric identifier for individualization is the chance of observing two individuals in a relevant source population that are indistinguishable with respect to that biometric, a so-called random match probability (RMP). The "smaller" the RMP, the "better" is the biometric identifier. The RMP can be investigated empirically by applying the biometric identifier to a representative sample of individuals from the population. Furthermore, the RMP provides an upper bound on the chance of observing two individuals who are truly indistinguishable regardless of how microscopically they are compared. Therefore, although an empirical study cannot "prove" uniqueness of handwriting, it potentially can be used to show that the chance of observing two individuals with the same handwriting profile is very small. In a practical sense, the chance of such an observation is so small that it can be said that a handwriting profile is unique. This approach to individualization is similar to that used in the reporting of forensic DNA-analysis.

The empirical estimation of a small probability, such as a random match probability in a population where individuals tend to be different (if not ultimately unique), is a difficult problem. The estimation problem is further complicated in the current scenario by the inherent variability in handwriting samples. Some classical methods for estimating small probabilities related to random matching, focusing on construction of upper confidence bounds will be reviewed. Some new methods that more efficiently utilize the information from all pairwise comparisons of samples by modeling the dependency structure between individual comparisons will also be proposed. These new methods can also be used when all samples are distinguishable, a situation where many of the classical methods fail.

The newly proposed analysis techniques are applicable to any biometric identifier that can be used to compare two handwriting samples. Also, they have broad applicability to other forensic identification fields where pairwise comparisons can be used to estimate properties of biometric identifiers.

The classical and proposed estimation methods and the associated conclusions concerning handwriting uniqueness will be illustrated and compared using the handwriting biometric identifiers developed by Gannon Technologies Group and the George Mason Document Forensics Laboratory as applied to a FBI database of 500 writers with approximately 10 writing samples per writer.

Handwriting, Individualization, Statistics

J11 Application of Raman Spectroscopy to the Analysis of Questioned Documents

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The objective of this presentation is to familiarize the forensic community with surface enhanced Raman spectroscopy and its application to questioned document analysis.

This presentation will impact the forensic science community by exposing it to raman spectroscopy, its techniques, and applications.

After viewing the presentation, attendees will understand general principles of surface enhanced Raman spectroscopy and its use in questioned document examination.

Surface enhanced Raman spectroscopy is a technique rarely applied to the questions of forensic science. That is rather unfortunate as SERS can be effectively used to evaluate minute samples and is capable of greatly improving Raman signal. This presentation focuses on the application of SERS to the analysis of dyes found in common ballpoint ink formulations. Normal Raman and SERS spectra of ten dyes, including Methyl violet, Sudan black B, and Victoria blue B, were collected. Normal Raman spectra were collected using Raman microscope with 785 nm laser and FT-Raman spectrometer with 1064 nm laser. SERS spectra were obtained using silver colloid and the 785 nm laser. SERS results showed excellent peak intensity and signal to noise ratio. Dyes were easily differentiated and the spectra could be used to determine dye composition of ink.

Raman, Ink Analysis, SERS

J12 Criminal Codes and Ciphers

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The goal of this presentation is to introduce attendees to cryptographic tradecraft common to criminals/inmates.

This presentation will impact the forensic science community by showing the value of criminal codes and ciphers to investigations.

Criminals have long employed manual cryptographic techniques to communicate with confederates or clandestinely maintain records of criminal enterprises. The Cryptanalyst Forensic Examiners of the FBI Laboratory's Cryptanalysis & Racketeering Records Unit (CRRU) decipher encrypted records and communications from street and prison gangs, organized criminals, drug traffickers, foreign and domestic terrorists, and violent criminals. Despite the prevalence of encoded and enciphered documents in criminal cases throughout the nation, the CRRU is the only laboratory unit in the country that has professionally trained law enforcement cryptanalysts.

The presentation will introduce attendees to common manual cryptographic methods used by criminals, and provide an overview of the unique examination services offered by the CRRU to federal, state and local law enforcement. The entertaining and informative presentation would also include interesting studies of nationally known cases where cryptanalysis has played a major role including:

- The enciphered messages written by the infamous Zodiac serial killer from the 1960s and 70s (featured in the recent move "Zodiac"), including the message that remains unsolved to this day.
- The coded admission of Joseph Smith, the man convicted of the video taped abduction and murder of 12 year old Carlie Brucia in Sarasota Florida in 2004.
- The 1997 Aryan Brotherhood murder hit order that was encrypted using a cipher invented over 400 years ago by Sir Francis Bacon and resulted in multiple coordinated homicides and assaults across the nation.

Cryptanalysis, Codes, Ciphers

J13 Characterizing Writing Inks on Paper Using DART Mass Spectrometry

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The goal of this presentation is to provide details on how mass spectrometry with the new DART (direct analysis in real time) ion source may be used to differentiate and analyze inks on documents without altering the appearance of the document.

Ink analysis is typically limited to optical inspection and thin layer chromatography. Although these are often sufficient, mass spectrometry provides substantially more information. The DART ion source allows inks to be analyzed by mass spectrometry directly on the document. This approach to ink analysis will impact the forensic science community by providing a new method for rapidly analyzing inks that provides more detailed information than typical methods.

DART mass spectrometry provides a rapid, nondestructive method for the forensic analysis of inks on questioned documents. The DART ion source was introduced in 2005. It vaporizes and ionizes a small amount of material from the surface of a sample, such as a written document. The ions are then swept into and analyzed by a mass spectrometer with an atmospheric-pressure inlet. No sample preparation is required. The document is simply held in the sampling stream, which is open to the room. The amount of material removed is so small and the heating is so gentle that the appearance of the document is not altered.

Most ink analysis techniques rely principally on the ink dyes, but many inks contain similar dyes. For example, many black ballpoint inks contain only crystal violet, its homologues (methyl violet and tetramethyl para rosaniline), and metanil yellow. As a result, it is difficult to differentiate such inks from one another. These inks can be differentiated by DART mass spectrometry, however, because DART spectra contain peaks from ink components other than dyes. The non-dye peaks often dominate DART ink spectra. The gentle sampling by the DART ion source volatilizes some dye, but it more readily vaporizes more volatile materials, such as vehicle, lubricant, and stabilizer components. These colorless materials allow inks with similar dye compositions to be differentiated. They also are particularly important for distinguishing pigment-containing inks. Because pigments are particulate in nature, they are not readily analyzed by any ink analysis approach, including DART mass spectrometry.

DART ionization causes little or no fragmentation of the sample molecules, so the mass spectra are dominated by intact-molecule ions, M^+, and protonated molecules, $[M+H]^+$. Each ink component therefore typically produces a single peak in the spectrum, and there is little overlap among peaks from different components. The DART source is used in combination with a time-of-flight mass spectrometer, which produces highly accurate mass determinations. Because of the minimal overlap and accurate masses, it is possible to identify many ink components unambiguously.

A library of DART ink spectra is presently being built. How well various inks can be identified from their DART mass spectra is being tested using spectrum-matching library-search software. Both commercial library software using nominal (i.e., integer) masses and non-commercial software using accurate (to 0.003 mass units) masses are being investigated. For the small number of inks analyzed so far, even the data in the nominal-mass library has been precise enough to correctly separate all but extremely similar (perhaps identical) ink formulations from one another. An ultimate goal of

the present work is the assembly of a library containing thousands of entries, which forensic scientists may then use as a reference for identifying inks found on questioned documents.

Because DART mass spectra contain peaks from vehicle components, they are sensitive to the age of the writing. This fact potentially could affect the ability to identify an ink from its DART spectrum. On the other hand, it could allow the age of writing to be estimated from its spectrum. Both of these potential consequences will be discussed.

Ink, DART Mass Spectrometry, Documents

J14 Out of the Ashes: A Holocaust Diary Revealed

Emily K. Jacobson, MA, United States Holocaust Memorial Museum, 100 Raoul Wallenberg Place South West, Washington, DC 20024*

Upon completion of this lecture, participants will understand how the field of paper conservation relates to that of forensic sciences, particularly in the study of questioned documents. They will be shown how and what conservators do to analyze and treat documents using a specific case study. This case study of a burned diary includes discussion on how different lighting techniques and computer manipulation were used to make a burned document legible.

This presentation will impact the forensic science community by introducing the field of paper conservation and the resources that conservators use to preserve and restore paper materials. Paper conservators and forensic scientists have many common goals in the investigation of paper, paper materials, and paper manufacture and can benefit from the sharing of information.

Twenty small, charred and brittle fragments of a diary were donated to the United States Holocaust Memorial Museum (USHMM) collection in 2002 by the family of Lusia Hornstein. Lusia, a Holocaust survivor, requested that her family donate it to the USHMM, while she was ill and dying in the hospital. For unknown reasons, and despite the fact that Lusia Hornstein frequently spoke and wrote about her experiences during the Holocaust, she kept the existence of this diary a secret for over fifty years.

The twenty diary fragments were wrapped in a piece of a Polish newspaper and placed in an envelope, on which Lusia wrote a notation outlining the diary's history. This notation contains the only available information about the diary's author, Debora, who was killed by a bomb in Warsaw during the Polish uprising of 1944. In early 1945, Lusia retrieved Debora's diary from behind a radiator in the bombed-out remains of the house where Debora had lived.

The diary is written in black ink on both sides of a blue-lined, wove paper. Each fragment is approximately 3 ¾" x 3" inches. Initial examination of the diary showed it to be in varying degrees of deterioration. Some pages were in fair condition and legible, while other pages were charred, brittle, broken and mainly illegible. Numerous pages were fused together and had also become physically distorted from the heat. The purpose of the conservation treatment of these pages was to physically stabilize them, but not bring them back to their original condition since their burned and charred nature is an intrinsic part of their story.

The diary pages were so brittle and fragile that the originals could not be handled in order to be translated. Initially, the translator used good quality photocopies that were made from digital images; however the charred areas remained too dark to be legible. Different lighting arrangements during photography, coupled with manipulation of the images using the computer, allowed the contents of almost all of the fragments to be read. This also led to the discovery that the fragments could be matched together, allowing for an even fuller translation. This is a wonderful example of how easily available computer technology can be used to recover information from an artifact, without endangering the artifact itself.

Burned, Paper, Conservation

J15 The LongPen™ - The World's First Original Remote Signing Device

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The goal of this presentation is to discuss the history and technical aspects of the Longpen™, a pen and video device invented by Margaret Atwood in 2004 to facilitate long distance signing.

This presentation will impact the forensic science community by describing the appearance and forensic characteristics of original ink signatures and text produced by the LongPen™ and to discuss implications for forensic document examiners.

The Longpen™ is an internet age signing device. This presentation will impact the forensic community by educating forensic document examiners as to the history and technical aspects of this device and to describe the appearance and forensic characteristics of original ink signatures and text produced with this technology.

The LongPen™ is a remote controlled pen and video device invented by Canadian author Margaret Atwood, and initially conceived to bring "live" author signings to far away locations. An early version of the LongPen™ was privately demonstrated in November of 2004. The first public demonstration and transatlantic signing (London to Toronto) took place on September 24, 2006. More and more authors are using the device and new applications are being developed.

The first part of the paper will discuss the history and the technical aspects of the LongPen™. The second part of the paper will discuss the appearance and forensic characteristics of remotely produced original ink signatures and/or text and implications for forensic document examiners.

LongPen™, Remote Signing, Margaret Atwood

J16 The Correlation of Photoreceptor Defects to Electrophotographic (Toner Based) Documents

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The goal of this presentation is to offer an overview of equipment not previously used for the purpose of forensic document examination.

The widespread use of low cost laser printers and multi-function devices utilizing toner has increased the volumes of documents produced by an electrophotographic (EP) process. Of these documents questions regarding the device that produced them arise. Common questions include whether or not questioned documents were printed by a suspect printer or copied by a multi-function device which can perform scan, copy, print and fax functions. In order to answer such questions the forensic examination of the components in a suspect EP device may be required.

Traditionally such examinations were limited to forensic work that could be done with; the optical comparison of specimen test prints made from the device and/or from test prints from different time periods, and the chemical analysis of the toner with its related constituent materials.

Examination of the questioned documents may disclose the presence of individual defects commonly referred to as "trash marks". Some of these marks may be observed to have a periodic pattern on the page. It is known that individual identifying features in the components of the EP device such as the photoreceptor, transfer roller, and the related roller components causes these periodic marks. Of these components the defects on the photoreceptor are probably the easiest to view and correlate as repeating defects on the printed page. When the coating of the photoreceptive material has worn down to the underlying metallic surface a repeating spot of toner that is not part of the image to be copied/printed appears on the document. Although direct physical examination of the photoreceptor may reveal the larger defects by visual inspection the electrical properties of the photoreceptor cannot be determined in this manner.

Automated equipment for testing the electrical properties of photoreceptors in the electrophotographic industry has been in use since the mid 1990s. The focus of such testing has been for the quality control of photoreceptors, in particular the recycling/refill industry where used photoreceptors get recoated with photoreceptive materials. The potential use of such equipment in forensic document examination has several benefits: (1) the quantification of the overall voltage properties of the photoreceptor, (2) the detection of small scale defects sometimes referred to as "pinhole" defects on the photoreceptor surface not visible to the unaided eye, and (3) the possibility of detection of non-homogeneous voltage distributions on the photoreceptor allowing for the possible correlation to the production of a questioned document having a similar non-homogeneous deposition of toner.

In this feasibility study points (1) and (2) described above were addressed.

Different printed pages were made on the same laser printer but with different cartridges (photoreceptors). After the documents were printed the cartridges were disassembled and the photoreceptors tested for their electrical properties in order to locate defective areas. Defective areas on the photoreceptor where the photoreceptive material was worn right to the supporting roller will not retain charge and will print onto the document a repeating "trash mark". The shape of such "trash marks" is dependent on the shape of the photoreceptor defect that may be individual features. Additional individual features may also be present in the geometric patterns that multiple "trash marks" will have with each other. The location of such defective areas on the photoreceptors was visualized by plotting the voltage data for the entire circumference and length of the photoreceptor. These defective areas were then compared to individual defects on the printed pages to determine whether a correlation between them was possible.

Document Examination, Electrophotography, Laser Printer

J17 Marketing Forensic Laboratory Services

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The goal of this presentation is to impart some of the management techniques that have worked when the lab needs more or less caseload.

This presentation will impact the forensic community by providing some ideas that they may want to implement in their own laboratory.

It seems that forensic laboratories almost never reach caseload equilibrium; in other words, the right number of examination requests for the number and experience level of the examination staff. When there are not enough cases, the lab director needs to reduce the "threshold resistance" felt by the submitters and/or reduce services provided. When there are too many cases so that output quality is challenged, it is the lab director's job to whittle the caseload down and/or to increase staff with the appropriate amount and type of experience.

Several techniques employed in laboratories where the primary evidence is questioned documents and the fingerprints found on those documents, will be discussed. To increase the caseload, all sorts of variations on the training theme need to be instituted. Road shows, continuing professional education sessions, quarterly newsletters or web feeds, laminated instruction cards, and evidence workshops may be utilized. It may also be necessary to supply physical evidence collection and packaging tools to investigators. Better customer service may also be helpful. The lab may need to work on its "branding," which is a marketing term that is similar to reputation in meaning.

It is first necessary for the lab to figure out who their customers are and make contact with those customers. This may not be as easy as it initially appears; is the customer the investigatory agents, the agency executives, the U.S. Attorney, outside agencies like the Court or the public at large? Should all the stakeholders be treated as customers? If the lab is constantly in contact with their customers, they don't have to worry about any competing jurisdiction or being "redlined" by their agency.

After that, it should be determined which customers are the satisfied, dissatisfied and unsatisfied. Contact needs to be made with the dissatisfied so that lab services may be improved and win them back as customers. Contact must also be made with the unsatisfied about using the lab's services. (The unsatisfied don't know about the lab or how the lab may help them.) This contributes to the branding of the lab. Some labs are well known and respected by the customer while others are not. In the author's lab, examiners are encouraged to become certified, do research and present technical papers. They are asked to look for ways to make it easier to do business with the lab and to shorten case turnaround times. Examiners are requested to cheerfully answer all questions and thank agents for the work. Dealing with the lab should not only assist the agent by fulfilling his or her request, attempting to either identify or eliminate subjects, but should be a pleasant endeavor.

In order to decrease the caseload, variations on the filtering of case requests may be required. It must be determined which cases are going to do the most for the agency. Certain cases are clearly within the mission while others, which may be easier to work, are clearly not. Other factors, such as the amount of loss or a terrorist association, may take priority. Laboratories that handle administrative as well as criminal cases may make distinctions between their values.

There may be a means of screening cases and providing a "reduced" service. An experiment of reviewing all cases for whether or not comparison exemplars were on file will be related. If exemplars were on file, the case was passed along to the regional expert in that lab system to execute a complete report. If there were no exemplars on file, no comparison could be conducted. The next step in the process – dealing strictly with documents as evidence – was to determine if alteration, indications of counterfeit production, previously made links, or indented writing was present. If any of these were present, the case was once again passed along for report writing. However, if none of these things were found, a standard memorandum was sent out notifying the submitter.

Sometimes, internal obstacles, such as the workflow or too few essential instruments, can be changed in order to assist the examiners in expediting production. Accreditation efforts may need to be put on hold until the caseload pressure has diminished. Examiners may become very specialized in doing certain types of cases and thus, are able to work them faster. (However, examiners are not machines and this lack of variation as a steady diet may become boring, leading to greater employee turnover.)

Concrete examples of techniques which have been successful and unsuccessful in both instances will be presented.

Caseload Management, Marketing, Lab Services

J18 Analysis of Writings Made With Black Gel Pens

Rachel Dubin, MFS, Elizabeth Hirst, BS, and Walter F. Rowe, PhD, George Washington University, Department of Forensic Sciences, 2036 H Street, Washington, DC 20052*

After attending this presentation, attendees will learn about the difficulties encountered in the analysis of black gel inks. They will also learn about the application of thin-layer chromatography, visible-near infrared reflectance spectrophotometry and scanning electron microscopy to the analysis of black gel inks.

This presentation will impact the forensic community showing the value of scanning electron microscopy as a tool for the analysis of black gel inks, which are difficult to characterize by more conventional means.

Forensic document examiners are frequently asked to identify the type of writing instrument that has been used to create a specific document. These examinations are conducted in cases that involve fraudulent checks, forged signatures, altered or forged documents, ransom notes and threatening letters. The advent of the gel pen complicated the work of document examiners by giving them a new type of writing implement to identify.

Gel pens were first manufactured in Japan in 1984 by Sakaura Color Products Corporation, as a "green" alternative to inks that contained volatile organic compounds. Gel inks are an environmentally friendly alternative to traditional types of ink. Multiple factors have led to the growing popularity of these pens. Gel pens are inexpensive, their writing is archival quality; they are long writing and can be purchased in almost any color.

After the introduction of the gel pen to the American market, methods were needed to allow document examiners to classify and differentiate this type of ink. Currently, there are a number of methods being used to analyze gel pen inks. These methods include visual examination with a variety of illuminants (e.g. room light, infrared and ultraviolet), thin-layer and gas chromatography (TLC and GC), visible-near infrared reflectance spectrophotometry, Raman scattering and scanning electron microscopy (SEM).

Mazzella and his co-workers used three techniques to determine if blue gel pens could be differentiated. Thirty-three samples were examined using filtered light examination, Raman scattering and SEM. It was determined that differentiation was possible among samples of blue gel pens, and that the blue gel writings exhibited four different morphologies when examined with the SEM. It was concluded that Raman scattering and the SEM had the highest discriminating power when examining blue gel ink.

Wilson, LaPorte, and Cantu have reported on the analysis of black gel pens using microscopy, visible and near infrared reflectance, near infrared luminescence, spot tests, thin-layer chromatography (TLC), visible-near infrared reflectance spectrophotometry and gas chromatography-mass spectrometry. This group developed a flow-chart that differentiated black gel inks into nineteen groups. Not all brands of black gel pens could be uniquely distinguished.

In the present study, writing samples made with black gel pens were examined by a variety of techniques, including light microscopy, thin-layer chromatography, visible-near infrared reflectance spectrophotometry, x-ray fluorescence (XRF) and SEM. Writing samples for all examinations were prepared on filter paper. Ink samples for TLC were extracted from the filter paper by using methanol that was spotted on silica gel TLC plates; the TLC plates were developed with a ethyl acetate:ethanol:water (75:35:30) mobile phase. Visible-near infrared reflectance spectrophotometry and XRF were performed directly on the filter paper samples without additional sample preparation. Writing samples to be analyzed with the SEM were first sputter-coated with a 350-400 Angstrom coating of gold and palladium.

After examining all samples it was concluded that light microscopy and XRF study did not provide much differentiation of the black gel pens. One ink showed the presence of copper and another the presence of iron. This finding suggests that SEM-EDS analysis of black gel inks will not be especially informative. TLC provided limited differentiation of the black gel inks: eight samples were found to contain dyes in addition to pigments; two samples showed streaking; and the colorants in nine samples did not migrate at all. This finding is consistent with the results reported by Wilson, LaPorte and Cantu. The visible-near infrared reflectance spectra of the samples from 400 nm to 1000 nm were subjected to *k* means clustering in order to identify the wavelengths that provided the greatest differentiation of the spectra. Principal component analysis (PCA) was then performed using these wavelengths. PCA identified six non-overlapping sample clusters in the reflectance spectral data. This is in contrast to the results of Wilson, LaPorte and Cantu, who identified three groups of reflectance spectra for black gel inks. An interesting correlation between the TLC results and the visible-near infrared reflectance spectra was observed: if a black gel ink showed no migration on the TLC plate, its reflectance spectrum was flat from 400 nm to 1000 nm.

From the SEM electron micrographs, the black gel inks could be placed in three main groups, based on the appearance of the gel ink on the paper fibers: smooth, smooth with particles and filamentous. Five samples were observed to have a smooth distribution of gel ink; six samples were found to have a smooth texture with a beaded appearance caused by the projection of pigment particles from the surface of the dried ink; and the remaining six samples had a filamentous appearance. Within each category, additional differences between brands of gel ink were noted. Mazzella apparently did not encounter blue gel inks with a filamentous appearance; this is a new category that has not been previously reported. This research demonstrates the value of SEM for the examination of black gel inks.

Gel Pens, Scanning Electron Microscopy, Spectrophotometry

J19 Discriminatory Power of Various Dichroic Filters in the Differentiation of Ballpoint Pen Inks

Derek L. Hammond, BA, U.S. Army, Criminal Investigations Lab, 4930 North 31st Street, Forest Park, GA 30297-5205*

Upon attending this presentation, attendees will understand the value and limitations associated with the non-destructive examination of blue-blue and black-black ballpoint pen inks using selected dichroic filters.

Results stemming from the analysis of approximately 2000 pen-pair samples using six (6) different dichroic filter combinations will impact the forensic science community by providing attendees with data on the validity and reliability of this rapid and inexpensive method to non-destructively differentiate ballpoint pen inks.

Dichroic filters have long been a staple for the forensic document examiner in the viewing and differentiation of writing instrument inks. Although they have been in use for over fifty years, it appears that technological advances in infrared viewing systems have relegated the Dichroic filter to a "gone but not forgotten" forensic tool. In comparison to the advanced instruments of today (e.g., Foster & Freeman's Video Spectral Comparator systems) Dichroic filters remain inexpensive, easy to transport, and continue to provide a rapid means to non-destructively examine and/or compare various writing instrument inks. Data on select Dichroic filter sets (e.g., Roscolux #20/83, Roscolux #21/80, Lee #21/79, Lee #20/79, and Lee #20/85) in the differentiation of blue-blue and black-black ballpoint pen inks will be presented and compared with results obtained through other non-destructive examination methods.

Dichroic Filter, Ballpoint Pen Inks, Ink

J20 Analysis of Dry Erase Markers

Christie L. Mitchell, MFS, and Walter F. Rowe, PhD, Department of Forensic Science, George Washington University, 2036 H Street, Washington, DC 20052*

After attending this presentation, attendees of this presentation will learn about the composition of dry erase markers and about the best methods for the analysis of writings made with these writing instruments.

This presentation will impact the forensic community by highlighting problems with the application of conventional analytical methods used in questioned document examinations (such as thin-layer chromatography) to the analysis of dry erase markers. This paper will also present an analytical protocol combining visible-near infrared reflectance spectrophotometry and Fourier-transform infrared spectrometry that provides a high degree of brand differentiation.

Dry erase markers are commonly found in schools, offices, and homes but there has not been much published research on the differentiation of the brands of dry erase markers currently available. This type of research would be significant for questioned document examiners because it would enable them to determine the brand of dry erase marker that may have been used in the production of a questioned writing. In this study, nine different brands of dry erase markers were studied. Black, blue, red, and green markers were obtained for six brands and black, blue and red markers were obtained for three brands. A variety of analytical techniques were applied to the markers in an attempt to distinguish dry erase markers of the same color but distributed under different brand names. Dry erase marker were placed on filter paper "scribble sheets" and observed under a variety of illuminants (253.7 nm, 375 nm, 450 nm, 485 nm, 525 nm, and 570 nm). No fluorescence

was observed for any of the dry erase markers under any of the above wavelengths. The visible-near infrared reflectance spectra of dry erase markers on filter paper "scribble sheets" were recorded in triplicate with a UV/VIS/NIR spectrophotometer over the range of 400-1000 nm with a resolution of 1 nm. The resulting spectra were subjected first to *k* means clustering in order to identify the wavelengths of light that gave the greatest brand differentiation for each color. These wavelengths were then used to perform principle component analysis (PCA) on the reflectance spectra. Some brand differentiation was observed within each of the different color groups, including the black markers.

Solubility tests and thin-layer chromatography were also applied to the dry eraser markers. Such tests have been mainstays of questioned document examiners for many years. The following solvents were used in the solubility tests: petroleum ether, hexane, toluene, methylene chloride, butanol, ethyl acetate, hexafluoro-2-propanol, chloroform, ethanol, pyridine, acetone, acetonitrile, dimethylformamide, methanol, water, bleach, concentrated ammonia, 5% NaOH, 5% HCl and 5% HNO_3. Pyridine was the only solvent in which all the dry erase marker were soluble. None of the markers were soluble in non-polar solvents or in highly polar solvents, but were soluble to varying degrees in solvents of intermediate polarity. The variation in solubility in the solvents of intermediate polarity provided some differentiation between brands of the same color marker. Thin-layer chromatography was performed with both normal-phase silica gel plates and diphenyl reverse-phase silica gel plates. No significant migration or separation was observed for any of the dry erase marker samples on either type of plate. Several different mobile phases were used, including variations of the ethyl acetate : ethanol : water (70:35:30) mobile phase on the normal-phase silica gel plates and an ethanol : phosphate buffer solution (65:35) mobile phase on the reverse-phase silica gel plates. It was determined that the colorants in dry erase markers irreversibly bind to the stationary phases of both types of plates. Therefore, the thin-layer chromatography technique is not a viable analytical technique for the analysis of dry erase markers. It was also noted that the colorants in many of the dry erase markers bind irreversibly to the cellulose fibers in filter paper. This finding suggests that cotton swabs should not be used to sample dry erase markers.

Finally, Fourier-transform infrared (FTIR) spectrometry was applied to the dry erase markers. FTIR mainly characterizes the non-colorant solids in the dry erase markers (e.g., waxes and release agents). Samples were prepared in potassium bromide disks and the infrared spectra were scanned from 4000 to 400 cm^{-1}, with a resolution of 4 cm^{-1}. Most of the infrared spectra contained a strong carbonyl peak between 1730 and 1740 cm^{-1}. This is consistent with ester functionalities in waxes. Dry erase marker samples could be grouped according to the absorptions between 1700 cm-1 and 400 cm-1. Overall, FTIR provided a similar degree of differentiation of the dry erase markers compared to visible-near infrared spectrophotometry. The two techniques can be combined to provide a higher degree of brand differentiation than either technique used separately. For example, visible-near infrared spectrophotometry placed the nine brands of black dry erase markers in four groups, while FTIR distinguished five groups. When the two methods of analysis were combined, the nine brands of dry erase marker were placed in seven groups.

Dry Erase Markers, Spectrophotometry, FTIR

J21 The Application of Write-On Document Comparison Software to Complex Handwriting Comparisons

Brian S. Lindblom, BA, 389 Roosevelt Avenue, Ottawa, ON K2A 1Y9, CANADA*

The goal of this presentation is to teach the use of various program features and options to aid in the analysis of questioned handwriting.

This presentation will impact the forensic science community by providing a substantial aid for side-by-side comparison of extended handwriting and for the preparation of detailed court charts.

Version 2 of this program has recently been released and extensively tested for this research. Many significant improvements have been made to key features of the program, including association properties; search criteria; and reporting/chart functions. Specific functions of the program will be discussed and a live demonstration will show how the software can be used in complex extended handwriting cases.

Handwriting, Computer Software, Forensic Conclusions

J22 Is Formal Training Important?

Karen S. Runyon, BA, 400 South 4th Street, Suite 505, Minneapolis, MN 55415*

This presentation will examine learning styles, educational methods, and training systems within scholastic thought and custom. Training practices within the forensic document profession will be discussed and contrasted with other disciplines within forensic science and other professions within society. The development of training standards in Scientific Working Groups will be reviewed, as well as research demonstrating what produces top-level performance and leads to the acknowledgment of one as having expertise.

This presentation will impact the forensic community by promoting understanding as to training practices that will assist in producing expertise. It will also serve to produce boundaries as to practices that lead to unreliable experts.

Training, Forensic Document Examination, Expertise

J23 Analysis of Inkjet-Printed Documents I: Physical and Chemical Challenges

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After attending this presentation, attendees will have a better understanding of the kinds of materials used in inkjet printer inks, and the unique challenges of the analysis of color formed by discontinuous combinations of a limited number of dyes or pigments.

With a good scanner and color printer, fraudulent currency, postage stamps, collectibles, and identification can now be easily generated. It is important to understand the variables involved that could possibly connect a questioned document to a certain type of inkjet printer. These observations will impact the forensic community by being useful when fraudulent printed documents are under study.

This presentation will provide insights into the power of currently available inkjet printers that can be used for generating fraudulent documents and the variety of physical and chemical parameters associated with the printed output that examiners might encounter.

In analyzing a questioned document, many aspects can be defined using simple microscopy. Is the item printed using a press, an intaglio method, or is it the output of a copy machine? Is it the product of an inkjet or laser printer? Such information may allow for authenticity to be established, or may be an important link back to a specific device used for the document's creation. The focus of this presentation is on inkjet printers. Modern inkjet printers most often use a four-ink color system (cyan, magenta, yellow, black). Increased complexity results as new systems become available that use a larger number of inks, and have the capability of printing on not only traditional paper but photo-quality paper as well. In most cases, it is easy to determine that a document has been printed with an inkjet printer, since modest magnification reveals individual ink spots, however developments continue. Some printers are capable of printing clusters of spots in addition to single, isolated spots. Printers with variable resolution may lead to overlaps of spots, making the output difficult to interpret. In addition to

replaceable reservoirs of ink, some inkjet printers are also using gloss optimizer, a "clear coat" that can stabilize printing on glossy paper.

Some observations that we have made, that may be important in characterization of inkjet-printed documents, include the order in which colors are applied. A second interesting feature is the appearance of small amounts of unexpected colors - due to printers that actively keep jets clear by using them during printing, even for colors not needed.

The primary interest in our laboratory is the analysis of colorants, and the forensic applications of this capability. Inkjet printer inks are rapidly changing from being dye based to pigment based. "Archival quality" prints using pigments are reported to be capable of lasting more than 100 years without fading - a very different situation from dye-based inks, which can fade over a period of months. In order to chemically analyze components of a document printed using an inkjet printer, information on the distribution of color on the substrate is very useful to have and understand.

With a good scanner and color printer, fraudulent currency, postage stamps, collectibles, and identification can now be easily generated. It is important to understand the variables involved that could possibly connect a questioned document to a certain type of inkjet printer. These observations will be useful to the forensic community when fraudulent printed documents are under study.

Questioned Documents, Inkjet, Pigments

J24 Analysis of Inkjet-Printed Documents II: Colorant Analysis by Laser Desorption Mass Spectrometry

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After attending this presentation, attendees will have a better understanding of the method of laser desorption mass spectrometry (LDMS), its utility in the analysis of colorants such as pen inks, and the special challenges that inkjet-printed documents provide.

This presentation will impact the forensic community is in the development of new tools for the questioned document community for analyzing increasingly complex evidence, such as that generated by a modern inkjet printer.

While LDMS has been demonstrated to be an ideal tool for identifying dyes in pen inks and pigments such as those found in automotive paintings, inkjet printer inks provide unique chemical and physical analytical challenges for this method.

LDMS has been used effectively to identify dyes such as those used in blue, black and red ballpoint pens. It will be also shown that such dyes change with time on paper, and the chemical reaction products can be used to estimate the age of the document. Many inkjet printer inks use dyes, although the dyes are difficult to detect from paper, in contrast to pen ink dyes. It is believed the dyes used are multiply charged dyes that cannot be simply ejected from the surface using a pulsed UV laser, because the multiply-charged dyes adhere strongly to the surface. A number of methods for lowering the charge on the dyes are evaluated, such that they can be analyzed. For example, a given dye may contain four sulfonate groups and may exist as the tetrasodium salt. If ammonium compounds are added to the surface, the ammonium ions can donate protons to the sulfonate groups, resulting in a lower overall charge on the molecule, such that they can be analyzed. LDMS has been able to successfully use LDMS to analyze pigments such as those used in artists' paints, automobile coatings, and in pigmented pen inks. However, there are very specific chemical and physical requirements for a solution to successfully be used as an inkjet printer ink, to allow for picoliter amounts of ink to be deposited on a surface. Manufacturers report that fine pigment particles, sufficiently small that they will not clog up a printer jet, are coated with charged resin molecules. After ink is deposited on a paper surface, the surface may be further coated with a clear coat by the printer to stabilize the dried ink spots, which may otherwise chip off. Coating on top of coated pigment particles make it difficult for the traditional use of LDMS, since the colorant is under layers of transparent material. In some cases, solvent can be used to expose sufficient amounts of the pigment for LDMS analysis.

Clearly, inkjet printed documents can be mistaken for authentic documents, due to the high quality and resolution of the final product. Chemical analysis as well as physical analysis may be able to link the document with a specific type of printer. LDMS can assist in analyzing the component that can be seen, the colorant - whether it is a pigment such as copper phthalocyanine or dye such as crystal violet.

The impact of this work is the development of new tools for the questioned document community for analyzing increasingly complex evidence, such as that generated by a modern inkjet printer.

Questioned Documents, Laser Desorption Mass Spectrometry, Inkjet Printers

J25 Examining PDF Files and Associated Documents

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After attending this presentation, attendees will: have an increased understanding of documents involving Adobe® Systems Incorporated's Portable Document File (.pdf) format digital file features, be aware of additional resources applicable to .pdf files, and understand a new method to determine the authenticity of documents recorded in .pdf files.

This presentation will impact the Forensic Document Examination community by providing a method to assist forensic document examiners in determining the genuineness of documents recorded in .pdf files.

An investigative inquiry involving a fraudulent document and the .pdf digital file source of the document, posed the question of whether the .pdf file contained information to confirm the document's manner of production. Subsequent research involved manipulation of test documents recorded in .pdf format digital files. The manipulation procedure involved application of a technique previously used to recover redacted texts on .pdf format digital files. Testing confirmed that this .pdf file manipulation technique was successful in exposing the cut-and-paste production of some documents recorded in .pdf format. Factors effecting the success and failure of the technique are also discussed.

This presentation documents research that confirms .pdf format digital files can provide information regarding how some documents were produced.

Redacted Text Recovery, Digital Cut-and-Paste Documents, Fraudulent Digital Documents

J26 The Analysis of Non Ballpoint Inks Using Gas Chromatography/Mass Spectrometry: Relevance to Ink Dating

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The goals of this presentation are to: (1) determine how often 2-phenoxyethanol and other common volatiles occur in non-ballpoint inks, (2) determine and compare the relative abundances of common volatiles to recognize patterns in solvent evaporation rates, and (3) identify discriminating characteristics among non-ballpoint ink formulae based on manufacturer, pen model, ink type, and year of production.

Limited resources currently exist pertaining to non-ballpoint ink analysis. A comprehensive study of these inks will impact the forensic

community by assisting forensic document examiners in cases involving comparisons, discriminations, or age determinations. From the extrication of an ink sample, it is possible to determine the mechanism of ink distribution, the ink cartridge material, and the relative age of the ink sample. With further research, a reproducible dynamic method for age determination may be achievable.

The objective of this presentation is to determine how often certain volatiles and semi-volatile organic compounds, particularly 2-phenoxyethanol, occur in non-ballpoint inks. Utilizing gas chromatography/mass spectrometry (GC/MS), the volatiles will be characterized by their abundance, ratio in respect to other volatiles, and intensity over time.

Dynamic approaches to ink dating involving solvent evaporation have been tested. Although this is not a novel method, little research has been conducted on non-ballpoint inks. The basic method involves extraction of the ink from an absorbent medium using an organic solvent followed by GC/MS analysis. Subsequent analyses are made after subjecting the ink to natural aging.

In this study, non ballpoint inks were analyzed using gas chromatography and mass spectrometry over a period of natural aging. The general term non ballpoint can be divided into 4 categories: fiber tip, gel, rollerball, and fountain. Black and blue ink samples from these 4 groups were placed onto Whatman™ filter paper No. 2 (scribble sheets), and the ink from 10-1mm hole punches was extracted with acetonitrile. A second extraction took place 28-31 days after the initial scribble sheet was prepared. Through GC/MS instrumentation, each extraction was analyzed to determine the concentration and identity of volatile components.

This research has been successful in providing information and data regarding the composition and characteristics of non ballpoint inks. The identification and rate of occurrence for each volatile has been established by the mass spectrometer and internal standards. Gas chromatography shows significant changes in the concentrations and ratios of major volatiles over a short period of time. The proprietary information and relative volatile abundances for each ink will be organized in a database to facilitate the act of recognizing patterns and establishing general assumptions regarding the entire population of non ballpoint inks.

Non-Ballpoint Inks, Phenoxyethanol, Ink Dating

J27 Forensic Examination of Pressure Sensitive Adhesive Tape

Gregg M. Mokrzycki, MFS, Federal Bureau of Investigation, 2501 Investigation Parkway, Quantico, VA 22135*

After attending this presentation, attendees will learn about the forensic information that can be gleened from pressure sensitive tape, a new technique for cleaning the tape, and how to conduct tape edge comparisons.

This presentation will impact the document community by helping investigators realize the value of this often overlooked piece of evidence and by enabling forensic examiners to better examine tape and present their findings to investigators and juries.

An explanation of how one type of pressure sensitive tape is manufactured will also be discussed so that attendees can see how identifying characteristics are imparted onto tape.

Pressure sensitive tape is a vital piece of documentary evidence because it is often used by the perpetrator of a crime as a means of sealing envelopes without depositing DNA through saliva. Additionally, since the forensic value of tape is sometimes ignored by the user, there may be less imperative to discard possible comparative tape fragments or tape rolls when investigators collect evidence. Since tape fragments typically have two sides useful for comparison, this enables investigators to collect potential comparative material that were used both prior and following to when the tape fragment was used in a crime. This increases the possibility of finding tape matching the item in question and may make it less likely for the suspect to remember and discard tape fragments of evidentiary value.

This presentation will instruct how tape should properly be removed from a document and prepared for examination. The preparation process will explain how hexane and a sonic cleaner or xylene is used to remove the adhesive from the back of the film and how to mount the material on glass slides for viewing. It will also discuss the characteristics of tapes and explain the manufacturing techniques so attendees can understand why definitive opinions may be rendered when conducting tape examinations.

Tape, Adhesive, Documents

J28 Methods of Assessment of True, Simulated, and Counterfeit Watermarks

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After attending this presentation, participants will gain a knowledge base upon which to rely when selecting an assessment method for suspect watermarks.

International travel documents and currency contain true watermarks. The ability to identify counterfeit versions of these items is critical to financial and security interests. This presentation will impact the forensic community by providing technical information essential to this effort.

The watermark has long been used as a document identification and security feature, with the earliest watermarked papers dating from 1282 in Italy. These marks included various information about the paper, such as the maker, manufacturing date, quality, or size. It would be many years before the next major advancement; in 1848, an Englishman, William Henry Smith, invented the "light and shade" watermark.

Since then, watermarks have been used as anti-counterfeiting security elements in currency and identification documents. High quality watermarks are difficult for counterfeiters to simulate, and are relatively inexpensive compared to other high-tech document security devices.

In the 20th century, the use of watermarks in the paper used for corporate and government correspondence was widespread. However, this practice has been practically eliminated, perhaps due to the high cost of watermarked paper and the widespread use of office-based computer printers.

Recently, companies marketing document security elements have introduced products that they describe as watermarks, or as being like a watermark; they can more accurately be described as "simulated watermarks". Based on this development, it became necessary to rename the watermark; it is now commonly referred to as a "true watermark". Unfortunately, the new lower cost alternatives are more susceptible to counterfeit reproduction. In fact, some of the legitimate techniques utilize the exact methods used by counterfeiters to reproduce "true watermarks".

In order to establish a scientific basis for the assessment of "true watermarks", "simulated watermarks" and counterfeit watermarks, extensive analyses of all three are being conducted.

The types of assessments can be grouped into three categories: chemistry, digital, and physical. The chemical testing includes Fourier transform infrared (FTIR), gas-chromatography coupled with mass spectrometry (GCMS), and pyrolysis (py-GCMS) characterization of the watermarks.

The digital assessment methods identified to date are ImageXpert (a commercially available image quality measurement system) and transmitted-light scan measurements. The physical assessments are examinations using x-ray, ultraviolet and infrared sources, transmitted light and micrometer.

The use of physical assessments to differentiate true watermarks from counterfeit watermarks has an historical basis; visual examinations using transmitted light reveal differences in design and detail, x-ray examination reveals the absence of an image when a counterfeit watermark is present.

The reliability of these two assessments, as well as the others listed above, will be tested in the current research.

The assessments in the other categories do not have an historical basis; the chemistry assessments are both classic and innovative, while the digital assessments are totally innovative.

Based on the fundamental differences in the methods used to produce true watermarks and the simulated/counterfeit versions, the working hypothesis for all of the assessments conducted in the current research is that they will show considerably different results for the two test groups and that they may show similar results within the simulated/counterfeit group.

Equipped with the results of this research, forensic document examiners will gain a knowledge base upon which to rely when selecting an assessment method for suspect watermarks.

Watermark, Counterfeit, ImageXpert

K1 Gas Chromatography of Postmortem Blood Revealing Sevoflurane in a Patient Six Hours Post-Op

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Attendees will understand basic physiology and properties of sevoflurane, a general anesthetic used in same-day surgeries. Attendees will also learn that sevoflurane may interfere with an ethanol peak with a certain method of gas chromatography.

This poster will impact the forensic science community by alerting the community to the possibility of the presence of "ethanol" peaks on gas chromatography due to sevoflurane in post-operative patients.

A 54-year-old female patient underwent facelift surgery which lasted approximately six hours. During surgery, sevoflurane was used for induction and maintenance of anesthesia. There were no intraoperative complications. The patient was discharged home about one hour and forty-five minutes post-op at 1645 hours. Her only post-op complaint was of a migraine headache, which was treated with topiramate (Topamax®). Patient history as detailed by her family, stated that the patient consumed only ginger ale and yogurt prior to going to sleep after surgery. At 2100 hours, she was sleeping soundly. At 2115 hours, she was not breathing and unresponsive. Postmortem examination revealed focal moderate calcific atherosclerotic narrowing of the proximal left anterior descending coronary artery, microscopic fibrosis of the superior interventricular septum of the heart near the atrioventricular node, and mild to moderate microvesicular steatosis of the liver. Postmortem toxicology revealed the presence of citalopram (Celexa®), lidocaine, morphine, and fentanyl. Gas chromatography (GC) of postmortem blood revealed a peak at 2.496 seconds retention time, consistent with ethanol (retention time 2.3 ± 0.1 sec). The concentration of ethanol was calculated to be 0.05 g/dL. Antemortem blood also revealed ethanol by GC at a concentration of 0.04 g/dL. However, the vitreous fluid was negative for ethanol.

Due to the family's insistence that the patient had not consumed ethanol, possible interferences were sought. Of the medications the patient received, sevoflurane was the best possible medication to cause interference. Sevoflurane [fluoromethyl 2,2,2,-trifluoro-1-(trifluoromethyl) ethyl ether] is a four carbon molecule that exists as a liquid and is used for induction and maintenance of anesthesia. A review of the literature revealed two manuscripts which reported ethanol and sevoflurane peaks to be within 0.1 and 0.15 seconds of each other (Biomed Chromatogr 2004; 18: 714-18 and Clin Chem 2001; 47: 281-91, respectively). Ethanol-negative blood was spiked with varying dilutions of sevoflurane, which co-eluted with ethanol. For example, the retention time of the 1:20,000 dilution was 2.483 seconds. Volatile analysis was performed with a head space procedure, using *n*-propanol as the internal standard. The column was a 6 foot Porapak-S at a temperature of 180°C. Instrumentation was Shimadzu GC-I 4A, Kyoto, Japan. Due to the high volatility of sevoflurane, a linear concentration curve could not be produced.

A study by Kharasch et al. of sevoflurane's metabolism and pharmacokinetics shows that it can still be detected in a patient's blood several hours after an administration of three to five hours (Anesthesiology 1995; 82: 1369-78). The average half-life of sevoflurane in that study was 2.8 ± 1.0 hours. The above patient died approximately six hours after the end of anesthetic administration. The long detection time may be partially due to the high partition coefficient for adipose tissue. Adipose tissue dominates the pharmacokinetics past three hours post-administration (BMC Clin Pharmacol 2007; 7:1-21). The above patient had a body mass index of 28.6 kg/m^2, indicating a possible increase in body fat percentage over normal.

Therefore, although ethanol cannot be completely excluded, it is likely that the above patient did have sevoflurane in her blood, causing an interfering peak on gas chromatography. An interfering peak was obtained when ethanol-negative blood was spiked with sevoflurane. However, due to the high volatility of sevoflurane, consistent data points could not be obtained to determine the concentration of sevoflurane in the patient's blood.

Gas Chromatography, Sevoflurane, Ethanol

K2 Signature Analysis of 25 Illicit Cocaine Samples and a Comparison to Analysis by AccuTOF™ DART™

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After attending this presentation, attendees will gain an enhanced understanding of multiple techniques for characterization of illicit cocaine and their ability to assess purity, level of performance, and their ability to determine specific compounds of interest.

This presentation will impact the forensic science community by providing a comparison of established quantitative, chromatographic method to a novel qualitative time-of flight mass spectrometric method to determine the purity of illicit cocaine and its relative abundance of signature compounds.

Introduction: Characterization of 25 illicit cocaine samples was undertaken in support of a research project funded in part by the National Institute of Justice (NIJ Award # 2006-DN-BX-K019) examining the ratios of cocaine-related compounds in hair samples contaminated with cocaine. Various coca-related compounds, isotope ratios and solvent determinations among other parameters are used to determine the manufacturing process and geographical origin of cocaine exhibits. Furthermore, this information is a useful tool to answer questions related to cocaine distribution and trafficking.

A novel application of direct analysis in real time (DART) sample introduction coupled with time-of-flight (TOF) mass spectrometry was evaluated for analyzing 25 samples of bulk powdered illicit cocaine hydrochloride salt seized by the Drug Enforcement Administration (DEA). The cocaine samples were analyzed by the DEA to determine their "signature" including their purity and the presence of specific compounds including products of manufacture, adulterants, and other cocaine analytes including oxidation products. The results of the analysis were then compared to data obtained by CFS to assess the AccuTOF-DART's level of performance.

Methods: Analysis was conducted in positive mode using AccuTOF-DART mass spectrometry. After analysis of the cocaine samples, each data set was examined for the presence of cocaine analytes (e.g., cocaine, benzoylecgonine, ecgonine ethyl ester, cocaethylene, norcocaine, anhydroecgonine methyl ester, truxillines, other ethyl esters) and a number

of compounds typically found in illicit cocaine. These compounds include methyl isobutyl ketone (MIBK), methyl ethyl ketone (MEK), ethyl acetate, n-propyl acetate, isopropyl acetate, mannitol, and petroleum ethers. Data obtained from both DEA signature analysis and AccuTOF-DART were compared to evaluate the level of performance of the AccuTOF-DART. Samples were also submitted to the Armed Forces Institute of Pathology (AFIP) for a limited GC-EI-MSD method as an additional confirmation of the norcocaine content.

Results: The AccuTOF-DART analysis of the cocaine samples resulted in the detection of the analytes anhydroecgonine methyl ester (AEME), tropacocaine, and trimethoxycocaine. Although AEME was easily detected, tropacocaine and trimethoxycocaine were detected intermittently, as were truxillines and MEK. In most samples, there was an ion present at 290.151 m/z, which is the M +H value of $C_{16}H_{19}NO_4$. This ion is consistent with both benzoylecgonine and its isomer norcocaine which have indistinguishable accurate masses. The table below shows the number of illicit cocaine samples in which the various components were detected by the three analytical processes (TOF-DART, DEA signature analysis, and AFIP GC-EI-MSD).

Using TOF-DART, further testing would be required under a different set of instrument parameters in order to distinguish the presence of norcocaine and/or benzoylecgonine. In these 25 cocaine samples, only trace quantities of cocaethylene were detected by DEA signature analysis.

Conclusions: This study has demonstrated the AccuTOF-DART's ability to analyze cocaine quickly and effectively. The TOF-DART is an adequate screening tool, but it does not currently have the level of performance required for purity calculations. The AccuTOF-DART provided some, but not all of the signature compounds determined to be present in the samples analyzed by other established methods. Within these 25 cocaine samples, one cocaine sample had norcocaine present at approximately 8% when compared to the cocaine. However, because of the intermittent detection of some of the analytes, variables such as sampling and instrument parameters need to be further investigated. Based on these samples, the DART-TOF would be a useful tool for the screening of samples and in some but not all circumstances may provide conclusive determination of chemical identity. These data will be used for future contamination studies in hair performed at RTI.

Technique	AEME	BE	CE	NCOC	Trimethoxy-cocaine	Tropacocaine	Truxillines	Total Cinnamoyls
TOF-DART	22	25*	ND	25*	5	7	25	ND
DEA	ND	21	7	21	25	25	25	25
AFIP	23	NR	ND	7	NR	NR	NR	NR

* NCOC and BE indistinguishable by TOF-DART.

Cocaine, TOF-DART, Analysis

K3 Macronutritional Composition Induced Differential Gastrointestinal Absorption Kinetics of Alcohol: A Pharmacokinetic Analysis of Alcohol Absorption in the Postprandial State

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After attending this presentation, attendees will gain an understanding of the variable impact that a meal induces on the absorption rate of alcohol based on the macronutritional composition of the food—the nutritional components of food that provide calories or energy (proteins, fats, carbohydrates).

This presentation will impact the forensic community by providing additional knowledge to be used during interpretation on the rate that alcohol is absorbed in the postprandial state.

The current method of assessing gastrointestinal absorption of alcohol in the postprandial state include both the size of the meal as well as the time lapse since the meal was consumed relative to the ingestion of alcohol. It is hypothesized that an ingestion of alcohol following a meal will display differential gastrointestinal absorption rates dependent upon the macronutritional composition of the meal. It is further hypothesized that the glycemic index (GI)—a measurement of the magnitude and rate at which ingested food causes the level of glucose in the blood to rise—can be utilized as a third parameter in the absorption rate constant when predicting gastrointestinal absorption kinetics.

These hypotheses were investigated in a two-day study distinguished by the prandial state of five healthy, non-alcoholic male volunteers (four Caucasian and one African American) with mean age 24y (range 21y to 27y), mean height 186cm (range 183cm to 190cm), and mean weight 90kg (range 63kg to 114kg) who were on no medication and had no evidence of gastrointestinal disease. Informed consent was obtained through Georgia Public Safety Training Center study protocols for conducting controlled alcohol drinking studies. Volunteers were instructed to restrict any food consumption for at least three hours prior to the study on each day. Volunteers were administered five separate diluted (diet soda, caffeinated) ingestions of alcohol (40% alc/vol) for a total mean consumption of 0.80g/kg (range 0.68g/kg to 1.00g/kg) ethanol over a course of two hours. Alcohol administration schedule and net weight remained constant for the respective volunteer on each study day. Day one assessed the absorption kinetics in the fasting state for all volunteers. On day two, the volunteers were separated into three groups dependent upon the type of meal administered: Group A) High GI (two volunteers) – 350kcal total [72g carbohydrates (0g fiber), 10g protein, and 2.5g fat]; Group B) Medium GI (one volunteer) – 352kcal total [36g carbohydrates (0g fiber), 43g protein, and 4g fat]; and Low GI (two volunteers) – 349kcal total [0g carbohydrates (0g fiber), 76g protein, and 5g fat]. For each study day, the breath alcohol concentration (BrAC) was recorded on a set schedule (90min, 150min, and 210 min elapsed time from scenario beginning) using the Intoxilizer 5000.

Results of the study revealed that all volunteers displayed similar absorptive kinetics and peak BrAC on study day one in the fasting state (volunteer # [1] 0.099 g/dl, [2] 0.106 g/dl, [3] 0.106 g/dl, [4] 0.124 g/dl, [5] 0.111 g/dl). On study day two, in the postprandial state, all volunteers displayed attenuated, but differential peak BrAC, dependent upon the assigned group. Group A) High GI – volunteers (#[1] and [2]) exhibited a mean decreased peak BrAC of 13% (range 8% to 17%). Group B) Medium GI – the volunteer (#[3]) exhibited a decreased peak BrAC of 32%. Group C) Low GI – volunteers (#[4] and [5]) exhibited a mean decreased peak BrAC of 42% (range 37% to 46%).

The results of this study show that peak BrAC following a meal with low GI will be lower than following a comparable meal with similar calories but higher GI. This finding provides significant insight as to the effect the macronutritional composition of a meal as measured by postprandial glycemia (GI) has on the absorption kinetics of alcohol in the postprandial state. Whereas high GI foods result in faster rates of gastric emptying signified by elevated postprandial glycemia and therefore increased absorption kinetics of alcohol. On the other hand, low GI foods result in slower rates of gastric emptying signified by little or no postprandial glycemic response and therefore slower absorption kinetics of alcohol in the gastrointestinal tract. Current methods of predicting postprandial absorption kinetics would suggest no intergroup variation in day two of the study where obvious variation existed. These results warrant further studies with a larger sample size including gender and ethnic variation to verify these preliminary findings.

Alcohol, Absorption, Glycemic Index

K4 Prevalence of Desmethylsertraline in Postmortem Tissue Samples

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After attending this presentation, attendees will better understand the distribution of desmethylsertraline in postmortem tissue samples and its relationship to the study of postmortem toxicology.

This presentation will impact the forensic science community and analysts/pathologists involved in postmortem undertaking toxicology investigations by making them more aware of the levels of this drug that may be found in tissue samples.

Aims: The aim of this poster presentation is to inform the forensic toxicology community about levels of the primary metabolite, desmethylsertraline, of the selective serotonin re-uptake inhibitor (SSRI) sertraline found in postmortem tissue samples. Levels of this particular metabolite are referenced to parent drug/ metabolite in blood and tissue postmortem samples.

Methods: In 2006, over 890 cases were submitted to the Forensic Toxicology Laboratory, Center for Forensic Sciences in Syracuse, NY (CFS) by the Medical Examiner's Office. In each of the cases, analyses of blood/vitreous humor, tissue (liver), and urine were performed for volatiles (GC-FID), drugs of abuse (ELISA), and weak acid neutral/ bases (GC-MS). Tissue samples were analyzed as 1: 4 homogenates of the original sample. Where sertraline was confirmed by GC-MS amongst other confirmed drugs (some 23 cases) in blood and tissue samples, quantitative analysis of setraline/ desmethylsetraline was performed employing a liquid-liquid sample extraction (n-butyl chloride/ ammonium hydroxide/ 0.1 M sulfuric acid) using certified reference standards for calibrators and controls. Chromatographic analysis was performed by GC-MS/ GC-NPD (internal standard: Mepivicaine). This was carried out according to the standard operating procedure currently in use at CFS.[1] Data from the analysis of setraline/desmethylsetraline in blood/tissue samples were collected and assessed. This information (along with other quantified drugs) was used to offer an interpretation to the office of the Chief Medical Examiner for Onondaga County to assist with the determination of cause and manner of death in forensic investigations.

Results: In this presentation, data from the sertraline/ desmethylsetraline analysis of the postmortem samples are presented. The range of desmethylsertraline in postmortem tissue samples was 0.78 mg/kg to 402 mg/kg. The corresponding range of the parent was 0.04 mg/kg to 188mg/kg. Blood levels were reported as 0.05 mg/ L to 1.51 mg/ L desmethylsertraline and 0.03 mg/L to 0.45 mg/L sertraline, respectively. In several cases i.e. # 5, 10, 14, 16, 19, and 21, respectively the levels of the primary metabolite reported in tissue samples reached 402, 51, 50, 70, 34, and 242 mg/kg, respectively. In cases like these drugs such as buproprion/ metabolite, fluoxetine/ metabolite, and tricyclic antidepressants were also present with and without the presence of ethyl alcohol.

Conclusions: Sertraline is metabolized in the liver by CYP2D6 to the primary metabolite desmethysetraline. This hepatic isoenzyme (2D6) of the cytochrome P450 group is also involved in the oxidative metabolism of other drugs. It has been reported that desmethylsetraline may accumulate in plasma due to it's slow elimation (t $_{1/2}$ 62-104 hrs).[2] In the cases presented this may be a similar effect occurring (i.e., accumulation) in the liver tissue giving rise to excessive figures. It has been reported that desmethylsetraline has only 10-20% of the pharmacological activity of the parent drug,[2] at these levels it is pertinent to ask what effect this compound on the toxicity and cause of death and its impact on postmortem drug re-distribution.

Based on data presented, toxicologists involved in the analysis of sertraline/desmethylsertraline in postmortem cases (especially tissue samples) should review all the relevant information pertaining to these cases before offering advice/ interpretation. High levels as seen in the presented cases may skew the interpretation as to a possible overdose in the assessment of cause and manner of death.

References:

1 Forensic Toxicology Laboratory Standard Operating Procedures Manual, Center For Forensic Sciences, Syrcuse NY (2006).

2 R.C. Baselt, Disposition of Toxic Drugs and Chemicals in Man 5th Ed (2000).

Desmethylsertraline, Chromatography, Toxicology

K5 Strychnine Poisoning

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The goal of this presentation is to present a case of strychnine poisoning as it is not a common or easily diagnosed.

This presentation will impact the forensic science community by demonstrating the difficulties encountered by the forensic medical doctor during investigations of homicide or suicide by strychnine poisoning.

Introduction : In Europe and North America, Strychnine is commonly known as a restricted use pesticide. In France, its use as a pesticide is forbidden. Historically, intoxications were rare and causes were generally accidental, sometimes suicidal and in limited cases homicide-related. The mechanism of neurotoxicity of strychnine is well understood and the management of strychnine poisoning is well documented. There are data about survival after strychnine poisoning and the kinetics of elimination of strychnine. Strychnine concentrations in fluid samples of fatalities have been reported. Strychnine poisoning is uncommon and often difficult to diagnose; many times toxicological analyses is performed on a few fluid samples.

Materials and Methods: This presentation reports a case of a 58 year-old man who ingested a potential poison or medication in order to commit suicide. The autopsy did not reveal a traumatic cause of the death. An autopsy was performed and samples of cardiac blood, femoral blood, gastric content, bile urine and vitreous humour were analyzed. Moreover some kind of "balls" were found in the gastric contents. From these samples, ethyl alcohol (GC) and other toxins (EIA, LC/DAD, GC/MS) were investigated in order to determine the origin of the death.

Results: Ethyl alcohol was found in urine (0.14 g/L), in gastric content (1.14 g/L) and bile (0.31 g/L). Regarding other toxins, none were found in the samples. A high concentration of strychnine in both cardiac (7 µg/mL) and femoral blood (0.64 µg/mL), in gastric content (130.5 µg/L) and bile (21.9 µg/L) was detected. A bottle containing 10 g of white powder was also received. The bottle was found on the victim's bed table. The content of this bottle was also analyzed by chromatography which confirmed the bottle contained strychnine. The death was determined to be a fatal intoxication by strychnine.

Discussion: When investigating a toxic death, strychnine intoxication is not the first hypothesis of most death investigators. A background check of the decedent is sometimes helpful in the final death determinations. In this case the man was a gamekeeper and could readily obtain strychnine. The bottle on his table confirmed the suspicion. Fluids taken during autopsy allowed for strychnine determination of several fluids that are not typically reported in the literature. Toxicology confirmed the strychnine poisoning which was recent because of the high concentration in gastric content and the low urine concentration. In the blood, the concentration was lethal (more than 10x the commonly lethal dose). In the literature, the blood is always analyzed, sometimes the gastric content and in very few occasions the urine is also analyzed.

This case demonstrates a fatal and acute strychnine poisoning with the presence of high strychnine concentrations in different fluids.

Strychnine, Poisoning, Toxicology

K6 Development of a Comprehensive Forensic Drug Information Web Site and Concentrations Database

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Upon completion of this presentation, participants will learn about: (1) a Forensic Drug Information (FDI) web site that provides access to a drug induced/drug related deaths database that allows for direct online data entry by medical examiners, (2) the use of the database to analyze drug toxicity characteristics and patterns including the influence of factors such as other drugs, patient characteristics, sample site, and time since death and other selected death investigation findings on concentrations or toxicity potential, and (3) the use of the web site to find summaries of key drug characteristics and links to Medline/Toxline abstracts involving specific drug overdose and toxicity reports.

Deaths associated with drug ingestions can be difficult to interpret for several reasons, including possible interactions or varying patient characteristics, unclear relationships of drug/metabolite concentrations to toxicity, or the influence of sample site and postmortem interval on concentrations. Although some references provide toxic and lethal drug concentration ranges, they usually involve blood or plasma and have not been established for many drugs. The Drug Abuse Warning Network (DAWN) provides valuable information about drug ingestions that result in deaths or emergency department visits; however, actual concentrations are not recorded, in addition to other limitations. This presentation will impact the forensic science community by demonstrating how the Forensic Drug Database (FDD) is designed to collect a broad range of drug and metabolite data and characterize the interrelationships among possible factors influencing toxicity. If certain patient attributes or drug combinations are found to be associated with death, educational efforts can be targeted to help prevent these types of deaths. Medical examiners can enter data from drug-induced or drug-related death cases directly into the FDD from remote locations. At present, data from over 600 cases have been entered. Simple database reports can be run from the Forensic Drug Information (FDI) web site, with participating medical examiners and coroners having complete access to the data reports.

The objectives of this project were to: (1) develop an online drug induced/related deaths database that allows for direct data entry by medical examiners, (2) classify the data using standardized DAWN terminology, (3) describe drug toxicity characteristics and patterns including the influence of factors such as other drugs, patient characteristics, sample site, and time since death and other selected death investigation findings on concentrations or toxicity potential, and (4) develop a forensic drug information web site providing database access and other features.

A Forensic Drug Information (FDI) web site (http://www.forensicdi.org) was developed that includes three main parts: (1) Forensic Drug Database (FDD) – compiles data about the drug(s), concentrations, and other relevant information found in drug-induced or drug-related death cases, (2) Database Reports – allows for online user-customized and administrator generated reports from data stored in the FDD, and (3) Literature Abstracts - contains regularly updated links directly to the Medline/Toxline abstracts of reports of specific deaths involving drugs (legal, illicit), listed alphabetically by drug name.

As of July 2007, the FDD contains over 640 cases of drug-induced or drug-related deaths compiled from the files of the West Virginia Office of the Chief Medical Examiner. Of these decedent cases, approximately 34% were female and 66% were male. The most commonly detected drugs were methadone (32% of cases), cocaine (23% of cases), diazepam (21% of cases), ethanol (20% of cases), and hydrocodone (19% of cases). Cases are continually being added to the FDD, and new medical examiners interested in contributing case data to the database are welcome (visit FDI web site to register). A variety of types of reports and statistical analyses of the drugs, decedent characteristics, and concentrations are currently in preparation. Participating medical examiners will have access to these database reports in addition to the other web site features.

*The authors would like to acknowledge and thank Lixin Wu and Nan Wu for all their work in development of the FDI web site and FDD.

Drugs, Concentrations, Toxicity

K7 A Method for the Determination of Amphetamines and Methylenedioxyamphetamines in Oral Fluid by Gas Chromatography/ Mass Spectrometry

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Upon reviewing this poster presentation, observers will become familiar with a validated GC/MS method for detecting and quantifying amphetamines and methylenedioxyamphetamines in oral fluid, which may be easily applied in a forensic drug testing laboratory. This presentation will impact the forensic science community by demonstrating how the increase in popularity of using oral fluid in forensic drug testing has provoked a need for improved and reliable methods for drug extraction, detection, and quantitation. SAMHSA is currently evaluating oral fluid (OF) in an attempt to provide a set of universal standards for laboratories. This study yields data which may be applicable to developing future SAMHSA guidelines.

The authors present the validation of a gas chromatography/mass spectrometry (GC/MS) method for the detection and quantification of amphetamine (AMP), methamphetamine (MAMP), 3,4-methylenedioxyamphetamine (MDA), 3,4-methylenedioxymethamphetamine (MDMA) and 3,4-methylenedioxyehtylamphetamine (MDEA) in oral fluid. Prior to extraction, 500 uL of oral fluid was pretreated with 250 uL of 0.7M sodium periodate for 15 min. The sample was then made basic with 200 uL 1N potassium hydroxide and extracted with 1.0 mL of n-butyl chloride. After separation, the extracted amphetamines were derivatized with heptaflurobutyic anhydride (HFBA) including removal of excess HFBA by washing with 1N potassium hydroxide and water. The amphetamines were separated and quantified in an Agilent 5973 GC/MS equipped with a HP-Ultra 1, 12m X 0.2mm X 0.33um capillary column with a 4mm splitless liner. The oven temperature program was: initial 60°C for 0.2 min., then ramped at

20°C/min. to 180°C, held for 0 min., then ramped at 2°C to 185°, held for 0 min. Under these conditions the retention times in minutes of amphetamine HFBA derivatives were: AMP, 4.75; MAMP, 5.40; MDA, 6.68; MDMA, 7.54; MDEA, 7.95. The drugs were quantified with their respective deuterated species as internal standards. The MSD was operated in the SIM mode monitoring the following m/z ions: AMP-HFB, 240, 91 and 118; MAMP-HFB, 254, 210 and 118; MDA-HFB, 162, 240 and 375; MDMA-HFB, 254, 210 and 389; MDEA-HFB, 268, 240 and 403; $^{2}H_{10}$-AMP-HFB, 244 and 97; $^{2}H_{11}$-MAMP-HFB, 260 and 213; $^{2}H_{5}$-MDA-HFB, 167 and 380; and $^{2}H_{5}$-MDMA-HFB, 258 and 213; and $^{2}H_{16}$-MDEA-HFB, 274 and 244.

Amphetamine and MDA displayed a linear range 10-2000 ng/mL with a 10 ng/mL LOQ and LOD. Methamphetamine was found linear from 5-2000 ng/mL with a 5 ng/mL LOQ and LOD. The assay was less sensitive for MDMA and MDEA with a LOQ and LOD of 20 ng/mL; however, the assay was linear up to 3750 ng/mL for these analytes. The method yielded excellent precision. At a proposed cut value of 50 ng/mL and ± 25% of this cut-off (target values 37.5 ng/mL and 62.5 ng/mL), the %CV values were <5% for each amphetamine at the three target concentrations. The method was applied to specimens obtained with two different oral fluid collection devices; the Intercept (Orasure Technologies) and the Salivette (Sarstedt). A notable interference with the AMP-HFB 91 m/z ion and the MDEA-HFB 240 m/z ion was observed in oral fluid collected with the Intercept device. No interferences were observed with specimens collected by the Salivette device. The present method was found to be reliable for the determination of amphetamine, methamphetamine and their commonly abused methylenedioxy-derivatives in oral fluid.

Oral Fluids, Amphetamines, MDMA

K8 Pattern of Drug Abuse Fatalities in Teenagers

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After attending this presentation, the participants will learn the trend and pattern of drug abuse deaths among teens and will understand the urgent need to develop an effective prevention and treatment programs for teenager addicts.

Drug abuse deaths represent one of the most serious public health problems in children. These study findings show a significant increase of drug abuse deaths among teens in the State of Maryland over the past 16 years. This presentation will impact the forensic community and humanity as it suggests that additional steps are required to reduce drug abuse in teenagers.

In the United States, there is growing concern about an increase in illicit drug use and associated fatalities among young people, especially teenagers. The Office of the Chief Medical Examiner (OCME) has recorded a significant increase of drug abuse deaths among teenagers in Maryland since 1999. This study focuses on the trend and pattern of fatal drug abuse among teenagers in the State of Maryland investigated by the OCME.

A retrospective study of Maryland OCME cases, over a 16-year period between 1991 and 2006, yielded a total of 149 deaths caused by drugs of abuse among teenagers age 13 –19 years in Maryland. Ninety-six deaths (65%) were the result of narcotic drug use, such as heroin/morphine (N=59), methadone (N=18), methadone and heroin/morphine (N =3), oxycodone (N= 9), fentanyl (N = 5), tramadol (N= 1), and propoxyphene (N= 1). Twenty-nine deaths (19%) involved both narcotics and cocaine use; 4 deaths (3%) involved both narcotics and methylenedioxymethamphetamine (MDMA), and 6 deaths (4%) were due to cocaine use exclusively. Volatile substances accounted for 14 deaths (9%), including butane (N= 6), freon (N=4), nitrous oxide (N= 3), and propane (N= 1).

Over the sixteen-year study period, the number of drug abuse deaths among teenagers increased sharply in Maryland from six cases in 1991 to 15 cases in 2006, a 150% increase. Narcotic drugs, especially heroin/morphine and methadone played a major role in the rising number of teenager drug abuse deaths. From 1991 to 1998, 22 teenagers died of narcotic drug intoxication. Of the 22 narcotic drug abuse deaths, 18 deaths were due to heroin/morphine use, 1 death was from methadone and heroin/morphine use, 2 deaths involved fentanyl use, and 1 death was caused by tramadol use. From 1999 to 2006, 74 teenagers died of narcotic drug use, with 40 deaths due to heroin/morphine use, followed by methadone use (N = 18), oxycodone use (N =9), fentanyl use (N =3), methadone and heroin/morphine (N =2), and propoxyphene (N =2).

Maryland is made up of 23 counties and Baltimore City. The majority (77.9%) of teenager drug abuse deaths occurred among county residents. Teenager drug deaths in the counties increased sharply from 30 cases during 1991 through 1998 to 86 cases during 2000 through 2006. The number of teenager drug abuse deaths in Baltimore City stayed relatively constant over the 16-year period with a slight decrease (19 cases between 1991 and 1999; 16 cases between 2000 and 2006).

In Maryland, drug abuse deaths in teenagers occurred more frequently in March, October, and November. Fewer deaths occurred in April, June, and December than in the other months.

White teenagers (86%) were much more frequently involved in drug abuse deaths than black teenagers. More male teenagers (81%) died of drug abuse than female teenagers. During 2005 and 2006, 17 of 166 teen homicide victims (10%) showed evidence of some form of illicit drug activity.

Drug Abuse Deaths, Epidemiology, Forensic Toxicology

K9 Interpretation of Fentanyl in Postmortem Cases

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After attending this presentation, attendees will have an increased knowledge of the application of High Performance Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS) to the analysis of Fentanyl, in postmortem specimens and of the concentrations of fentanyl encountered during analysis of these specimens.

Fentanyl is a synthetic opiate analgesic. It is frequently administered as a transdermal patch and is a substance of abuse. This presentation will impact the forensic community by increasing awareness of the very high potency of fentanyl and the frequency of its use both alone and in combination with other intoxicants. The presentation will also demonstrate the need for very sensitive analytical methodologies for its detection and quantitation.

Methods: Twenty-three medical examiner cases containing fentanyl were identified by a positive ELISA, by a gas chromatographic/mass spectrometric (GC/MS) screen, or by the presence of a transdermal patch on the body. Fentanyl was quantified in blood by LC/MS/MS using multiple reaction monitoring techniques and fentanyl-D5 as internal standard. Molecular ions (m/z 337.3 and 342.3) were refragmented to yield ions of masses 188, 132 and 105 (Fentanyl) and 188, 137 and 105 (Fentanyl-D5). Specimens, standards and controls (0.5 mL) were basified by addition of 0.05 mL concentrated ammonium hydroxide solution and were extracted with 1.25 mL hexane:ethanol (95:5). The organic solvent was decanted, forced through a 0.2 micron acrodisc syringe filter and evaporated. The residues were reconstituted into 0.25 mL mobile phase and twenty microliters (20µL) were injected. Chromatography was performed on a Varian Pursuit column (C-18, 3 micron, id = 2 mm, l = 50 mm) and an aqueous formic acid : acetonitrile gradient solvent system. The calibration range of the assay was 0.5 to 20 µg/L. Positive controls were run at 2.5 and 15 µg/L. The limit of quantitation (generally 0.5 µg/L) was defined as the lowest standard or control that assayed within twenty percent of target, with acceptable ion

qualifier ratios. Samples containing greater than 20 µg/L of fentanyl were diluted prior to analysis.

Results: Fentanyl was the major intoxicant in 13 cases and was present in a further 10 cases in combination with at least one other significant intoxicant, such as methadone, an opiate, cocaine or ethanol. The fentanyl content of the 13 fentanyl-"primary" cases ranged between 3 and 49 µg/L (14 + 12 µg/L). In the 10 cases that contained other significant intoxicants, fentanyl concentrations were between 0.5 and 18 µg/L (5 + 5 µg/L) and seven of these cases contained less than 5 µg/L (0.5 to 4.6 µg/L) of fentanyl.

Conclusion: These data indicate that fentanyl is frequently encountered in combinations with other drug substances and that, in these combinations, even very small amounts of fentanyl may contribute to lethality. Sensitive methods of analysis, such as LC/MS/MS are required for quantitation of fentanyl in these cases. The data also indicate that interpretation of fentanyl levels in postmortem cases must be done on a case-by-case basis and must consider fully the combined effects of all intoxicants present.

Fentanyl, Postmortem, LC/MS/MS

K10 DART-TOF Applications in Toxicology and Controlled Substances

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After attending this presentation, attendees will be aware of applications for Direct Analysis in Real Time – Time of Flight Mass Spectrometry (DART-TOF) in the disciplines of toxicology and controlled substances. These applications were based on observations from data collected from casework and in the creation of user libraries. These libraries are comprised of pure compounds, analytes in solution and pharmaceutical preparations.

This presentation will impact the forensic science community by providing sample data and user libraries on a relatively new instrument so that forensic laboratories can understand how this new instrumentation could assist forensic laboratories in casework production.

DART-TOF is a novel technique that allows for the quick identification of target analytes. DART is unique ionization source in that it uses an open air sampling interface for rapid sampling and that enables the TOF-MS to provide real time mass spectrometry data. The selectivity of the instrument is based upon the high degree of mass accuracy and the fragmentation observed at high voltages. The DART-AccuTOF© instrument used was created by and purchased from JEOL.

In the discipline of controlled substances, the purpose of DART is to improve the efficiency of the identification of controlled substances, thus increasing the output production of the laboratory. Case samples were analyzed to evaluate the ability of this instrument to meet this objective. Concurrently, a library of over 400 controlled and non-controlled substances was constructed and compared to calculated masses found in the literature.

The types of samples currently being evaluated are Marihuana and pharmaceutical preparations. For Marihuana, it is important to be able to distinguish Δ9-Tetrahydrocannabinol and Cannabidiol in order for this instrument to be considered a conclusive examination for this substance. These two compounds have identical molecular formulas and can not be distinguished without fragmentation. This fragmentation was observed at higher voltages and different ionization modes. Signature fragments are being evaluated to distinguish compounds from one another when possible. Compounds that are potential interferences and have the same molecular weight as Δ9-Tetrahydrocannabinol was evaluated for their signature fragments.

Pharmaceutical preparations are an ideal candidate for quick analysis due to the fact the imprinted logo presumptively identifies which compounds are present, both controlled and non-controlled. Two compounds of interest due to the frequency of submission to the laboratory are codeine and hydrocodone. These compounds have identical molecular formulas and these compounds are being evaluated to determine how they can be distinguished by their signature fragments. A tablet library was also being constructed so that tablets from specific companies could be identified not only by their primary compound, but also by the ratio of inactive and inert ingredients.

In the discipline of toxicology, DART-TOF can be used to examine gastric contents and tablets found in gastric contents. Results from the analysis of toxicological specimens analyzed by DART-TOF will be presented.

DART, Controlled Substances, Toxicology

K11 Urinary Elimination of 11-Nor-9-Carboxy-Δ^9-tetrahydrocannabinol in Cannabis Users During Continuously Monitored Abstinence

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Attendees will learn about urinary elimination of 11-nor-9-carboxy-Δ^9-tetrahydrocannnabinol (THCCOOH) from cannabis users that self-reported weekly to daily use. These urine specimen data describe parameters pertinent to cannabis elimination.

Four inpatient studies of cannabis users (N=60; 6,158 individual urine specimens) were performed at the NIDA IRP with the objectives of examining the time course of THCCOOH elimination in urine. Protocols were approved by the NIDA IRB and each volunteer gave written informed consent. Subjects resided on a closed research unit under continuous medical surveillance. Individual urine specimens were collected *ad libitum* for up to 30 days. Volunteers consisted of 50 African Americans, 5 Caucasians, 3 Hispanics, 1 mixed race, and 1 American Indian. There were 46 male and 14 female participants ages 20 to 42 years. All self-reported cannabis dependence or use, and had a positive urine cannabinoid specimen to support exposure.

Specimens were screened by immunoassay with values ≥50 ng/mL classified as positive for cannabinoids. Urine specimens were confirmed for THCCOOH by gas chromatography/mass spectrometry (GC/MS) following base hydrolysis and liquid-liquid extraction. The limit of quantification was 2.5 ng/mL. Cannabinoid GC/MS concentrations (ng/mL) were normalized to the urine creatinine concentration (mg/dL) to account for the state of hydration and reduce variability with the final normalized units expressed as ng/mg. In 60%, the maximum normalized concentration occurred in the first urine specimen. In the other 40%, peak THCCOOH concentrations occurred as long as 2.9 days after admittance.

Data were divided into three groups, 0 - 50, 51 - 150, and >150 ng/mg, based on the normalized urine THCCOOH concentration in the first specimen after admittance. Mean ± SD, median and range of concentrations in the 0 - 50 ng/mg group (N = 19 subjects) were 23.7 ± 15.9, 27.8, 0 – 47.3 ng/mg. Data for the other groups were 97.2 ± 22.6, 96.1, 61.9 – 142.2 ng/mg

and 339.8 ± 247.3, 283.0, 155.1 – 1165.9 ng/mg, respectively for the 51 - 150 (N = 21 subjects) and >150 ng/mg (N = 20 subjects) groups. The mean intervals until the first negative specimen were 0.6, 3.2, and 4.7 days, respectively for the three groups. Mean % detection rates (percentage of positive specimens divided by total urine specimens for the day) on the day of the first negative specimen were 57.6, 73.4, and 79.8%, respectively. Mean times for the last positive urine specimen were 4.3, 9.7, and 15.4 days, respectively. The maximum time until the last positive urine specimen was 21.8 days for the 0 -50 ng/mg group, 25.3 days for the 51 – 150 ng/mg groups and 29.8 days for the >150 ng/mg group. These data reflect that the greater the initial THCCOOH concentration, the greater the interval until the first negative and last positive specimen.

These data will impact the field of forensic toxicology by increasing our understanding of cannabinoid elimination and improving interpretation of cannabinoid urine tests.

Cannabis Users, THCCOOH, Urine

K12 The Role of Steroid Abuse in Violent Deaths: A Case Report

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After attending this presentation, attendees will better understand the possible role of steroid substances abuse in violent deaths.

This presentation will impact the forensic community by providing additional support that extreme violence, homicide and suicide can be associated with steroid abuse.

A review of the literature revealed the association between substance abuse and criminal behavior. Anabolic androgenic steroids (AAS) are widely used by athletes to help increase strength and muscle mass. However, these substances can affect central nervous system causing irritability, anger and agitation and other psychiatric symptoms.

Methandriol (17α-methyl-5β-androstan-3α,17β-diol) is a synthetic anabolic steroid that is administered orally or intramuscular to treat androgen deficiency, rare forms of aplastic anemia or to counteract catabolic states, for example after major trauma. Methandriol is also commonly used by body builders to cause an increase of muscle bulk. Together with cardiovascular, endocrine, gastrointestinal and hepatic collateral effects, psychiatric changes can occur during prolonged use or after cessation of this agent. Mania and psychotic symptoms of hallucination, delusion and depression are described in AAS abusers. There is a considerable debate concerning effects of synthetic derivatives of testosterone on aggressive and on criminal behavior with domestic violence, suicide, and homicide.

This report documents a case of homicide-suicide committed by a law enforcement officer with no apparent reason. The perpetrator was a 29-year-old man; he had been employed with police service for nearly ten years. In a recent physician's assessment no psychiatric disorder or illicit drug and alcohol use were reported. He had no criminal record or reported previous instances of violent behavior. He was happily in love with a girl who described him as a mild-mannered, kindly and caring, although he did exhibit mild episodes of depression and anxiety.

He was pursuing body-building activities five year prior to the incident, and his relatives suspected he occasionally used steroids during the last six months prior to the fatal event. While he was working in the police station it is reported that he argued with his police lieutenant for trivial reasons. His colleagues reported his temper shortened incredibly in the following hours and, during the night, he took his service gun and fired against an officer who was sleeping in the same police station, killing him with six gunshot wounds to the head, neck, thorax, and upper extremities. He subsequently killed himself with a gunshot wound to the head.

At autopsy the pathologist observed his height was 190 cm and weight 90 Kg with diffuse and harmonic muscles hypertrophy. A left temporal entrance gunshot wound with central skin defect of 1.4 cm diameter and no adaptable ragged margins was disclosed. Another gunshot wound was ascertained at the right auricle. No more injuries or diseases were found except for mild myocardial hypertrophy and liver steatosis, as correspondent microscopic findings confirmed later. Toxicological examination of post-mortem blood and urine samples were conducted to determine whether death was related to illicit substance's abuse. The analytical procedures consisted of immunoassays and gas chromatographic methods, utilizing mass spectrometry detection (GC-MS).

A concentration of 3.4 ng/ml of Methandriol was detected in femoral blood as well as metabolites in urine with a concentration of 5.2 ng/ml. Blood alcohol concentration was determined to be 0.4 g/L and no alcohol was detected in the urine.

Although is not possible to exclude unknown problems with the victim, and his relatives or working history, autopsy findings and officer's toxicological analysis performed with GC-MS suggests that Methandriol abuse represented the principal etiology of the officer's violence, culminated in this tragic episode of homicide-suicide. This case confirms the possible role of steroid abuse in violent behavior.

Methandriol, Steroid Abuse, Homicide

K13 Specificity Characteristics of Buprenorphine Immunoassays and Their Effects on the Correlation of Immunoassay Apparent Analyte Concentration With GC-MS Concentrations of Buprenorphine and Its Metabolites in Urine

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After attending this presentation, attendees will better comprehend the effect of immunoassay (IA) specificity on the commonly adapted 2-stage test methodology - IA and GC-MS for preliminary and confirmatory tests - for the analysis of buprenorphine (B) and its metabolites in urine specimens.

This presentation will impact the forensic science community by reporting: (a) specificity characteristics of various commercially-available B IAs, and (b) the effect of these characteristics on the correlation of IA apparent B concentration in clinical urine specimens to the concentrations of B and its metabolites (norbuprenorphine, NB; B glucuronide, BG, and NBG) as determined by GC-MS.

Performance characteristics of five B ELISA (Immunalysis, Neogen, Diagnostix, IDS-B, IDS-NB) and one analyzer-based (CEDIA by Microgenics) reagents currently available from commercial sources were studied to better understand their analytical parameters, including calibration, cross-reacting characteristics, assay precisions and others. Information thereby derived were applied to the analysis of clinical urine specimens collected from heroin addicts under B "treatment" following required IRB protocols. Resulting IA *apparent* analyte concentrations were correlated against the concentrations of various metabolites as determined by GC-MS to better understand the effects of these IAs' specificity characteristics.

ELISA reagents studied were found to exhibit significant cross-reactivity toward BG in the order shown below: IDS-NB > Neogen > Diagnostic > IDS-B, while Immunalysis and Diagnostix reagents were found to significantly cross-react with NB. IDS-NB and Diagnostix reagents were also found to exhibit significant cross-reactivity toward NBG. The analyzer-based CEDIA reagent was found to show significant cross-reactivity toward

BG and some cross-reactivity toward NBG and NB. Unlike other reagents studied, IDS-NB reagent was also found to exhibit significant cross-reactivity toward morphine, codeine, hydrocodone, hydromorphone, oxycodone, and naloxone.

With different cross-reactivity characteristics, apparent analyte concentrations derived from various IAs were found to correlate with the metabolites' concentrations (as determined by GC-MS) in different ways. For example, showing significant cross-reactivity toward BG, CEDIA reagent generated apparent B concentrations that do not correlate well with the concentrations of B (Figure 1A) or BG (Figure 1B) alone, but with significant correlation with the total concentration of B (Figure 1C).

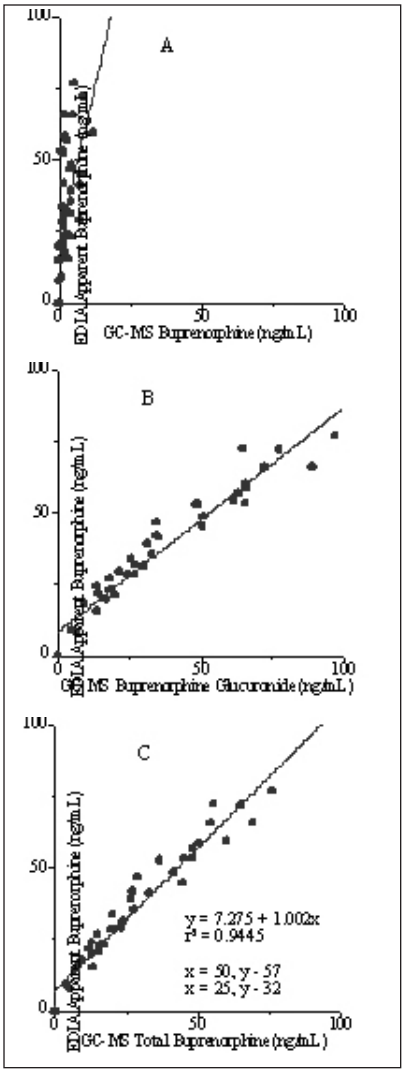

Figure 1. Correlation of CEDIA apparent buprenorphine concentration against GC-MS buprenorphine (A), buprenorphine glucuronide (B), and total buprenorphine (C) concentrations.

Buprenorphine, Glucuronide, Immunoassay

K14 Analysis of Goldenseal, *Hydrastis canadensis L.*, and Related Alkaloids in Urine Using HPLC With UV Detection

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After attending this presentation, attendees will be able to better detect alkaloids from Goldenseal, *Hydrastis canadensis L.*, as adulterants in urine samples using high performance liquid chromatography.

This presentation will impact the forensic science community by serving as a key aspect in detecting isoquinoline alkaloids resulting from Goldenseal, *Hydrastis canadensis L.*, in a basic urine drug test, which may lead to eliminating false negative drug results in toxicology laboratories.

Goldenseal root powder, *Hydrastis canadensis L. (family Ranulanceae)*, is one of the top selling herbal supplements on the market in the United States today. This may be in part to Goldenseal's use as a detoxing agent that drug users believe may provide false negative results during a urine drug test. This indigenous North American perennial herb is widely cultivated, and its extracts have been used for a variety of medicinal purposes and also as a dye. *Hydrastis canadensis L.* has been reported to contain several isoquinoline alkaloids, including 2-4% hydrastine and 2-3% berberine by weight. A number of other alkaloid containing plants have been reported for use in masking urine drug tests instead of Goldenseal, including Chinese Goldenthread (*Coptis chinensis*), yellow root (*Xanthorhiza simplicissima*), and Oregon grape (*Mahonia aquifolium*).

The main objective of the project was to create a test method for toxicology laboratories to detect Goldenseal, and related alkaloids, in urine samples using HPLC. An isocratic HPLC method with UV detection was developed to extract the alkaloids from 5 mL of urine. The urine samples were spiked with 100 µL of alkaloid standard (containing different concentrations of berberine and hydrastine). 5 mL of a 3:1 chloroform:isopropanol ($CHCl_3$:IPA) extraction solvent was agitated with the 5 mL of urine sample and the $CHCl_3$:IPA layer was removed. This process was repeated a second time with the $CHCl_3$:IPA solutions combined and concentrated using a stream of nitrogen gas. The residue was then reconstituted with 100 µL mobile phase and 10 µL injected onto the HPLC column. A mobile phase was prepared of 320 mL acetonitrile and 680 mL mobile phase buffer (1000 mL HPLC grade water, 2.3 g ammonium acetate, and 2 mL triethylamine). A 17 minute isocratic method was developed, with a flow rate of 2.0 mL/min, and UV detection at 230 nm using a C18 (250 mm X 4.6 mm) column at room temperature. The method showed good linearity with spiked urine samples for berberine and hydrastine standards at a range of approximately 12.74 ng/mL to 12.52 µg/mL. LOD for berberine in urine was 12.74 ng/mL and the LOD for hydrastine in urine was 54.5 ng/mL. Urine samples were also spiked with Goldenseal powder and liquid to determine whether Goldenseal would also show a presence in urine samples. The results show this method will enable laboratories to test for the herbal supplement in submitted urine samples on an as needed basis to further test suspect adulterated urines. The method used for the detection of goldenseal is not recommended however for use as a screening procedure in a production laboratory without the use of an autosampler.

Goldenseal, High Performance Liquid Chromatography, Toxicology

K15 Performance Characteristics of Cozart Rapidscan® Oral Fluid Drug Testing Following Controlled Dental Anaesthetics Infiltration

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After attending this presentation, attendees will understand some aspects of oral fluid drug testing after controlled dental anaesthetics infiltration and its interferences with the final results.

These early findings will impact the forensic community by providing a starting point for effectiveness of oral fluid drug testing when performed on patients who have undergone dental treatments.

Oral fluid is an interesting alternative matrix for drug testing in many environments, including law enforcement, workplace drug testing, and drug treatment facilities. The ease with which specimens can be collected and the potential for oral fluid drug concentrations to reflect blood-drug concentrations make it potentially valuable in a forensic setting. The possible effects on drug detection and quantification in patients who received local anaesthetics for dental treatments have not been examined. Drugs generally appear in oral fluid by passive diffusion from blood, but also may be deposited in the oral cavity during oral administration. Anaesthetic metabolites can be detected in oral fluid and could mimic drug metabolites thus giving a distorted result. The purpose of this study was to determine the performance characteristics of the Cozart Rapidscan oral fluid drug testing for the detection of cocaine and cocaine metabolites in oral fluid following controlled infiltration of Mepivacaine, Lidocaine, and Articaine.

Three different local dental anaesthetics were employed for this research: Mepivacaine 2% (Carboplyna, Dentsply Italia), Mepicavaine 3% (Scandonest, Ogna spa Italia), Lidocaine 2% (Ecocain, Molteni Dental srl Italia) and Articaine 4% (Alfacaina SP, Spada Dentsply Italia). Five volunteers, provided with informed consent, were selected and received local anaesthetic infiltration bilaterally in vestibular fundus of the mental area of the mouth, in different settings: 1.8 ml and 3.6 ml of mepivacaine 2% with 1:100.000 adrenaline; 1.8 ml and 3.6 ml of mepivacaine 3%; 1.8 ml and 3.6 ml of lidocaine 2% with 1:50.000 adrenaline; 1.8 and 3.6 ml of articaine 4% with 1:100.000 adrenaline. The four selected anaesthetic molecules were tested at cutoff concentrations. Oral fluid specimens (N = 200) were taken before anaesthetic infiltration and after 30, 60, 120 and 240 minutes following the infiltration, and were analyzed for cocaine and cocaine metabolites using Cozart rapidscan.

It was concluded that articaine local anaesthetic has a positive interference with the effectiveness of the saliva test for cocaine and cocaine metabolites with the Cozart device at a cutoff of 5 microgram/mL, while mepivacaine and lidocaine have no interference. Results from a larger group of subjects would be needed in order to validate these findings.

Oral Fluid, Cocaine, Dental Anaesthetic

K16 Evaluating the Significance of Variation of Drug Concentrations in Antemortem and Postmortem Blood and Tissue Samples

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Upon viewing this presentation, attendees will be able to examine the postmortem changes in blood drug concentrations over time. This will aid them in determining the role such factors as postmortem interval, storage conditions and biochemical transformations have on the interpretive value of quantitative data.

This is the first known comprehensive study of its kind in humans where samples are analyzed starting from the antemortem phase and followed through the postmortem phase. This presentation will impact the forensic science community by providing information that will aid in the process of relating antemortem to postmortem drug concentrations.

Postmortem (PM) forensic toxicology seeks to determine what role, if any, drugs or poisons played in causing or contributing to death. Drug related deaths can encompass everything from overdoses to non-compliance with prescription medications to drug-drug interactions. In situations where chemical substances may have played a role in a death, it is necessary to first identify which drug(s) are present, and then to determine the concentration(s) in blood and, sometimes, in tissues from the deceased. Proper scientific interpretation of postmortem drug concentrations may be critical in the correct assessment of the cause of death. To date there is no definitive way to correlate PM toxicological results with antemortem (AM) drug concentrations because the accurate relationship between PM drug concentrations to perimortem concentrations has yet to be established. The main reason for the hindrance is a phenomenon known as postmortem redistribution (PMR).

Put quite simply PMR is the name given for the movement of chemicals and drugs within the body after death. While living processes (including absorption, distribution, metabolism and excretion) have ceased, decomposition processes have begun. It is in-part, the decomposition processes (including autolysis), which allow for the release of drugs from their stored depots in tissues. The extent of redistribution may vary based upon a number of factors including: postmortem interval, sampling site (i.e. peripheral vs. central), environmental factors (i.e., temperature, humidity, etc.) and subsequent microbial activity present as a result of the aforementioned. Additionally, the chemical properties of drugs (and drug classes) play a significant role in their ability to redistribute. Some drug classes have a higher propensity than others to be sequestered in living tissues and subsequently released and redistributed after death.

This two part comprehensive study first examined the differences in AM and PM drug concentrations in blood and serum. AM samples collected from area hospitals were analyzed with the related PM samples obtained from the Miami-Dade County Medical Examiner's Office located in Miami, Fl. Multiple cases were collected, analyzed and evaluated both individually and collectively. Secondly, a study to establish of the stability of drugs within the preserved PM samples was conducted. The PM samples were analyzed at multiple time points to determine the pattern of drug concentration changes. The results of each individual case were evaluated, and the cumulative data were examined for evidence of trends or patterns.

All of the samples were maintained and analyzed solely on the grounds of the Miami-Dade County Medical Examiner's Office. The majority of the samples were stored in a walk-in refrigerator (7ºC), while some additional PM samples were frozen (-85º) upon receipt. Both liquid-liquid and solid-phase extraction techniques were utilized to produce specimens analyzed on such instruments as: GC/MS, GC/NPD and GC/ECD.

To date, PM concentrations of alprazolam, diphenhydramine, and methadone all show a decline of ≥ 20% over a two month period. When the same drugs are used to examine the differences between AM to PM drug

concentrations, almost invariably the AM concentrations are significantly (≥ 50%) lower than the PM.

The data generated here will help establish a correlation between PM and AM drug concentrations. In the future this information will help guide PM interpretation and give enhanced credibility to the field of PM toxicology as a whole.

Toxicology, Postmortem Redistribution, Postmortem Release

K17 A Two-Dimensional-Cryofocusing GC/EI-MS Method for Determination of Δ^9-tetrahydrocannabinol, 11-Hydroxy-Δ^9-tetrahydrocannabinol, and 11-Nor-9-carboxy-Δ^9-tetrahydrocannabinol in Human Urine

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The objective of this presentation is to provide a detailed description of a GC/MS procedure for the simultaneous quantification of THC, 11-OH-THC, and THCCOOH in human urine. The method utilizes two-dimensional chromatography and cryofocusing to enhance resolution and improve sensitivity.

The presentation will impact the forensic science community by allowing participants to develop and apply two-dimensional chromatography to the quantification of THC and major metabolites. The method may be a useful analytical procedure in forensic toxicology applications.

A sensitive and specific two-dimensional (2D) gas chromatography/electron impact-mass spectrometry (GC/EI-MS) method for simultaneous quantification of Δ^9-tetrahydrocannabinol (THC), 11-hydroxy-Δ^9-tetrahydrocannabinol (11-OH-THC), and 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (THCCOOH) in human urine was developed and validated. The method employs 2D capillary GC and cryofocusing for enhanced resolution and sensitivity. GC separation of trimethylsilyl derivatives of analytes was accomplished with two capillary columns in series coupled via a pneumatic Deans switch system. Detection and quantification were accomplished with a bench-top single quadrupole mass spectrometer operated in electron impact-selected ion monitoring mode.

To ensure complete hydrolysis of conjugates and capture of total analyte content, urine specimens were hydrolyzed by two methods in series. Two mL urine fortified with THC-d_3, 11-OH-THC-d_3, and THCCOOH-d_3 was hydrolyzed with 5000 units/mL of *Escherichia coli* b-glucuronidase (pH 6.8) for 16 h at 37°C in a shaking water bath followed by a second hydrolysis utilizing 10N NaOH at 60°C for 20 min. Specimens were adjusted to pH 5-6.5 with concentrated glacial acetic acid. Two mL of acetonitrile were added to precipitate protein followed by 2 mL 2N sodium acetate buffer (pH 4.0). Specimens were centrifuged and supernatants applied to conditioned solid phase extraction (SPE) columns. SPE columns (Clean Screen ZSTHC020, United Chemical Technologies) were washed with 3 mL deionized water, 2 mL 0.1N hydrochloric acid /acetonitrile (70:30 v/v), and dried by full vacuum for 10 min. After priming the sorbent bed with 0.2 mL hexane, analytes were eluted with 5 mL elution solvent (hexane:ethyl acetate 80:20 v/v) into tubes containing 0.5 mL ethanol and dried under nitrogen. Extracts were reconstituted with 25 µL acetonitrile, transferred to autosampler vials, and 20 µL BSTFA was added. Vials were capped and derivatized at 85°C for 30 min.

2D chromatographic separation was achieved with a primary DB-1MS capillary column (15 m x 0.25 mm i.d., 0.25 µm film; Agilent Technologies) and a secondary ZB-50 capillary column (30 m x 0.32 mm i.d., 0.25 µm film; Phenomenex). One µL derivatized extract was introduced in splitless injection mode. The Deans switch valve was programmed to divert "cuts" of the analyte elution bands to the secondary GC column for further chromatographic resolution. The secondary column was inserted through the cryogenic trap and the effluent end interfaced to the MSD for detection and quantification. Three analytes were quantified simultaneously with 2.5 to 300 ng/mL dynamic ranges for THC and THCCOOH and 2.5 – 150 ng/mL for 11-OH-THC. Calibration curves exhibited coefficients of determination (r^2) of 0.99 or greater (n = 12). Accuracy ranged from 87.6% to 102.1% for all analytes. Intra- and inter-assay precision, as percent relative standard deviation, were less than 8.6% for all analytes. Extraction efficiencies were 34.6 – 38.9% for THC, 44.0 – 52.8% for 11-OH-THC, and 39.3 – 54.9% for THCCOOH.

The combination of 2D-GC and cryogenic focusing achieved improved resolution of analyte from complex matrix components. The result was a rugged, flexible method with enhanced resolution power and lower detection and quantification limits compared to single dimensional chromatography. Focusing of the analyte band at the head of the secondary column markedly enhanced the chromatographic signal-to-noise (S/N), improving sensitivity. The method employs a rapid SPE and utilizes readily available single quadrupole GC/MS instrumentation. Acceptable assay characteristics and enhanced analytical sensitivity with improved S/N and detection limits were achieved. This method was applied to the analysis of urine specimens collected from individuals participating in controlled cannabis administration and monitored withdrawal studies, and may be a useful analytical procedure in forensic toxicology applications.

GC/MS, THC, Two-Dimensional Chromatography

K18 Simultaneous LC-MS/MS Quantification of Opiate, Cocaine, and Metabolites in Urine of Pregnant Substance-Abuse Treatment Participants

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After this presentation, attendees will be knowledgeable about opiate, cocaine and metabolites concentrations in human urine after illicit opioid and cocaine use by pregnant women.

The simultaneous LC/MS/MS analysis of 26 opiate and cocaine analytes in urine demonstrated that this technology was useful for monitoring multiple biomarkers of illicit drug use in opiate and cocaine dependent pregnant women. This presentation will impact the forensic science community by presenting data that will be evaluated to determine potential correlations with opioid and cocaine concentrations in meconium from infants of the women and with neonatal outcome measures.

Methadone maintenance is the only currently recognized pharmacotherapy for opiate dependency during pregnancy. Urine testing is an integral component of drug treatment, is a deterrent to drug use and is the most objective measure of drug use and effectiveness of new drug treatments. Urine drug testing provides a long detection window for drug abuse, from several days for opiates and cocaine, up to a month for chronic cannabinoid use.

Fifteen pregnant heroin dependent women from the Center for Addiction and Pregnancy (CAP) at the Johns Hopkins Bayview Medical Center (JHBMC) participated while enrolled in methadone maintenance treatment. Eleven African American and four Caucasian first-time drug treatment seekers had a mean ± SD age of 29.5 ± 6.7 years (range 19-40 years) and were between 8 and 28 weeks of gestation. Throughout gestation, participants received daily methadone (mean dose 75 ± 17 mg/day; range

45-110 mg/day), weekly individual and group counseling and specialized prenatal care. The protocol was approved by the JHBMC and the National Institute on Drug Abuse Institutional Review Boards. Participants provided written informed consent and earned vouchers for negative urine tests as part of behavioral contingency management.

Participants joined the study as early as eight weeks estimated gestational age (mean number of weeks on study 17.0 ± 5.8; range 8.2-27.2 weeks) and visited the clinic seven days per week. A variety of biological specimens, including urine, oral fluids, sweat and hair, were collected at fixed times during the study, under direct observation by trained staff. Urine samples were collected three times a week and stored at -20°C until analysis. The number of specimens collected was dependent on the enrollment period. A total of 284 urine specimens were collected from fifteen participants with a mean pH of 6.7 ± 0.8 (range 4.3-8.8). LC-APCI-MS/MS analyses were performed using an LCQ Deca XP ion trap mass spectrometer, equipped with an orthogonal APCI source, and interfaced to a Surveyor HPLC system. 100 µL of urine was fortified with deuterated internal standard working solution, briefly vortex-mixed and centrifuged to remove large particles (5 min at 510 *g*). Ten µL of supernatant were injected onto the LC-MS/MS. Pre-concentration during sample preparation was not required based on the sensitivity achieved. Urine specimens were analyzed for heroin and metabolites (morphine, normorphine, 6-acetylmorphine, codeine, acetylcodeine, norcodeine, noscapine and papaverine) and concurrently for cocaine and metabolites [ecgonine, ecgonine methyl ester (EME), ecgonine ethyl ester (EEE), anhydroecgonine methyl ester (AEME), *p*-hydroxybenzoylecgonine (*p*-OHBE), *m*-hydroxybenzoylecgonine (*m*-OHBE), benzoylecgonine (BE), benzoylnorecgonine (BNE), *p*-hydroxycocaine (*p*-OHCOC), *m*-hydroxycocaine (*m*-OHCOC), and norcocaine based on selected reaction monitoring.

Opiates were detected in 149 (52.5%) of urine specimens. Of fifteen participants, one had no opiate positive results, five had less than 20%, eight between 20% and 90%, and two more than 90% positive tests for opiates, often with high concentrations of morphine-3-glucuronide. Morphine, normorphine, 6-acetylmorphine (6-AM), codeine and norcodeine were the other primary opiates identified in urine specimens. 30 % of opioid positive specimens contained 6-acetylmorphine, a specific biomarker of heroin use. 165 (58%) specimens from all 15 participants tested positive for one or more cocaine analytes. Seven subjects had between 20 and 50% cocaine positive specimens, 5 between 50 and 80%, 3 more than 80%, and cocaine was found in all urine specimens of one subject, often with high concentrations. EME and BE were the primary cocaine analytes in urine specimens. EME was detected in 123 (43.3%) urine specimens with a median concentration of 115 ng/mL (range 51-33002 ng/mL), and BE in 84 (29.6%) with a median concentration of 47 (10-73758).

Opiate, Cocaine, LC-MS/MS

K19 Detection of Alcohol Metabolites in Urine Using HPLC With Conductivity Detection

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The goal of this presentation is to expand the current knowledge of detection methods for three Phase II ethanol metabolites (ethyl glucuronide, ethyl sulfate, and ethyl phosphate), and offer a simple, comparable method.

This presentation will impact the forensic science community by allowing the detection of alcohol intake without the worry of contamination due to bacteria, as well as offering a confirmatory analysis mid-assay.

After consumption of alcohol, the bulk of the ethanol dose (95-98%) is eliminated in a two stage oxidation in the liver, first to acetaldehyde then further to acetic acid. A very small fraction of ethanol (<0.1%) undergo phase II conjugation reactions to produce ethyl glucuronides via UDP-glucuronidase, ethyl sulfates via sulfotransferases, and ethyl phosphate via dephosphorylation of ATP. Modern postmortem and behavioral toxicology has focused on glucuronides, allowing for easy detection due to high abundance of metabolites from that pathway. This detection is not without its problems, including false negatives due to bacterial infections.

Previous work in this laboratory has used pulsed amperometric detection to detect ethyl-glucuronide, a metabolite of alcohol. This work expands on that, by allowing all three metabolites, ethyl glucuronide, ethyl sulfate, and ethyl phosphate to be detected in a single chromatographic run. All three are ionic in biological matrices, including urine, making them ideal candidates for conductivity detection following ion chromatographic separation.

This poster will outline the development of the ion chromatographic separation of the three metabolites and their subsequent detection using conductivity detection. Analytical figures of merit will be given, and the method will be compared against existing approaches. Sample preparation will be discussed in detail. This project will have long standing effects in the forensic science community by allowing detection of alcohol intake without the worry of contamination due to bacteria, as well as offering a confirmatory analysis mid-assay.

Alcohol, HPLC, Conductivity

K20 Extraction of Heroin From *Lucilla Sericata* Larvae by Pressurized Fluid Extraction

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The aim of this presentation is to outline a method for the rapid extraction of heroin and its metabolites from maggots using pressurized fluid extraction. It will focus on the preparation and extraction of samples and compare analysis times and efficiency with established extraction methods.

This presentation will impact the forensic science community by bringing attention to the potential use of pressurized fluid extraction for applications in entomotoxicology. A rapid and efficient extraction of heroin and its metabolites from a larval matrix is presented. This method could be extended to similar cartilage-like matrices such as finger and toenails.

The use of fly larvae as toxicological specimens was first reported in 1980 and has since been widely studied and utilized forensically as a means of diagnosing death by drug intoxication. Fly larvae (Diptera) are frequently found on decomposing bodies long after tissue samples (blood, urine, organs) commonly used for toxicological analysis are no longer available or suitable for analysis. Diptera, may feed on the tissue of a deceased individual who had taken drugs while alive, thereby ingesting any remaining drug as well as its metabolites. Drug accumulation within the maggot occurs as it develops and analysis can provide evidence for the presence of a drug in the cadaver.

Traditional methods for the extraction of substances from maggots, including manual homogenization and sonication, can be lengthy and time consuming. In this presentation, the use of pressurized fluid extraction for the detection of heroin and its metabolites in blow fly larvae, *Lucilla Sericata* (Diptera: Calliphoridae) is offered as a rapid and simple extraction method reducing overall analysis time. *Lucilla Sericata* were reared on pork liver spiked with varying concentrations of heroin and its metabolites. Concentrations were chosen based on those commonly found in tissue from heroin overdose victims. A surrogate spike (codeine-d3) was added to track extraction efficiency. Larvae were reared at 21.2ºC with cyclical artificial lighting simulating 14h daylight and 10h darkness. Larvae were harvested at 5 days and sacrificed by freezing to -80ºC. Prior to extraction, frozen larvae were ground using a mortar and pestle in liquid nitrogen. Extraction was carried out using pressurized solvent extraction by modifying previously reported methods for the extraction of substances from tissue samples. The extraction was carried out at 100ºC and 1500 psi using methanol as the extraction solvent. The extract was evaporated to required volume with nitrogen.

Qualitative analysis was carried out via an established and previously validated method on a gas chromatograph coupled with a mass selective detector. The instrument was operated in split mode with a 1 ul injection. An internal standard (heroin d-6) was used for the analysis.

Entomotoxicology, Pressurized Fluid Extraction, Forensic Entomology

K21 Assay of GHB Oxidation Activity Using a Succinic Semialdehyde-Hydrazine Adduct

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After attending this presentation, this presentation will provide attendees the opportunity to learn about the development of an assay for GHB oxidation, relying on the formation of a succinyl semialdehyde-hydrazine adduct, as determined by ultraviolet/visible absorbance (UV), high pressure liquid chromatography (HPLC) with UV and mass spectrometric detection (MS).

This presentation will impact the forensic and toxicological communities by introducing a new assay for the oxidation of GHB.

Forensic toxicologists and pathologists are regularly called on to evaluate the role and magnitude of effects of GHB in Drug-Facilitated Sexual Assaults (DFSA), accidental overdoses, and homicides. This laboratory is interested in the kinetics of GHB catabolism. The first step of GHB metabolism is oxidation to succinyl semialdehyde. Subsequently, oxidation of succinyl semialdehyde to succinate rapidly follows. To allow for an effective analysis of GHB metabolism based on product formation, or cofactor reduction, the assay methodology must effectively eliminate the oxidation of succinyl semialdehyde to succinate. The feasibility of utilization of hydrazine sulfate as an "aldehyde trap," allowing the termination of the reaction at succinyl semialdehyde via formation of a readily detectable, unique product, the succinyl semialdehyde-hydrazine adduct has been investigated. Previous studies suggest that hydrazine sulfate may be an effective means of trapping succinyl semialdehyde that would not be expected to interfere with the metabolism of GHB to succinyl semialdehyde.

The purpose of this study is to identify a succinic semialdehyde-hydrazine adduct for use in an HPLC-MS assay for oxidation of GHB. An HPLC method has been previously developed for identification and quantitation of succinic semialdehyde in urine. The HPLC is operated at a flow rate of 1 mL/min with a mobile phase of 80 mg/L ammonium acetate buffer (pH 3.6) in 1:1 acetonitrile:water. Post column, the flow is split 1:4 producing a flow rate of 200 µL/min to the mass spectrometer. Electrospray ionization was used in the negative ion mode. The temperature of the electrospray was set at 400ºC (Struys EA et al, J Inherit Metab Dis, 28:913, 2005).

The succinyl semialdehyde-hydrazine adducts can take several forms. The following ions have been identified when excess succinyl semialdehyde is reacted with hydrazine sulfate: succinyl semialdehyde (m/z 102) and succinyl semialdehyde-hydrazine adducts (m/z 141, 183, 225, 257). The m/z 141 is consistent with an adduct comprising a heterocyclic ring using one succinyl semialdehyde molecule and hydrazine. Higher m/z values are expected to correlate with an adduct comprising two succinyl semialdehyde molecules with hydrazine. Increasing the amount of hydrazine used in the assay causes the heterocyclic product (m/z 141) to be favored; which offers a single product measurable by UV and MS detection.

Formation of adduct is reliant upon formation of aldehyde. Therefore, quantitation of the succinic semialdhyde-hydrazine adduct allows for determination of the rate of GHB oxidation to succinyl semialdehyde. By optimizing the HPLC-MS method for the detection of the oxidized product (in this case the succinyl semialdehyde-hydrazine adducts), the method is functional for determination of the kinetics of GHB oxidation.

Gamma-Hydroxybutryrate, Assay, Succinyl Semialdehyde

K22 Cocaine Testing of Drug Treatment Patients - Comparison of Urine, Sweat, Oral Fluid, Skin Wipes, and Hair

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After this presentation, attendees will understand some benefits and limitations of urine, sweat, oral fluid, skin wipes, and hair as forensic drug testing matrices; some characteristic patterns observed in daily urinalysis; an improved sweat collection procedure; examples of false positives; and recommendations for prudent interpretations of drug test results.

This presentation will impact the forensic community by introducing ways to improve the reliability of drug testing and its interpretation/reporting.

This study compared the matrices of urine, skin swabs, sweat, and hair for monitoring cocaine use, with urinalysis being the gold standard, or arbitrator of use. Possible environmental contamination was measured through skin swabs. Unique aspects included *daily urine monitoring* (Monday-Saturday) of 35 participants for up to four weeks, simultaneous monitoring methods of all matrices, CI-GC/MS analysis to the limit of detection (LOD), and the potential for ongoing illicit drug use by participants in cocaine dependence treatment. This report expands an earlier pilot study. In the current cohort of participants, twenty showed virtually no cocaine use by urinalysis, four tested positive continuously, and eleven displayed infrequent use. Proposed new cut-off levels for the various matrices are based on receiver operating characteristic (ROC) curves widely used in clinical chemistry for cost/benefit analyses for a matrix assay using false positive and false negative rates to determine statistically how well it correctly identifies a positive result (defined as sensitivity) and how well it identifies a negative result (defined as specificity).

Identification of cocaine use was based on the intensity and shape of the urine BE excretion curve over several days and acceptable creatinine levels. Urine specimens exhibited a sensitivity of 0.86 at 100 ng/mL BE (n=934) and a specificity of 0.99. At 300 ng/mL BE, the sensitivity was 0.76 and the specificity was 0.998. The few false positives in urine were attributed to inadvertent ingestion of trace amounts of cocaine by the participants.

Skin swabs showed contamination on either hands or forehead, even with urine-negative participants. Generally, the skin contamination paralleled the drug use pattern detected by urinalysis. The amounts of cocaine on skin in some cases far exceeded the amounts attributable to drug use alone, with the excess caused by skin contact with drug residues.

Sweat was collected using PharmChek™ sweat patches applied on alternating arms at approximately four-day intervals. False positives (defined as the presence of drug or metabolite without intentional drug use) occurred at a 1.8% rate at the proposed cutoff concentrations, 75 ng cocaine/patch in this research. Using the ROC curves, the diagnostic test sensitivity was 0.60 (n=301). At the SAMHSA cutoff of 25 ng cocaine/patch a 10.6% false positive rate was observed. Pretreatment of selected patches with glycerol resulted in enhanced drug transfer from the skin to the patch when compared with non-treated patches.

Oral fluid was collected with Sarstedt Salivettes™. Oral fluid cocaine levels generally paralleled urine BE at substantially lower concentrations. For oral fluid cocaine or BE levels >15 ng/mL of extract, the diagnostic test sensitivity was 0.68 among chronic users (n=103) and 0.34 for occasional users (n=243). The specificity was 1.00 for chronic users and 0.97 among occasional users.

Hair was collected at the beginning and end of the 4-week study period. Although prior use patterns were unknown, the median cocaine concentration for African-American hair at the beginning of the study was 6.1 ng/mg hair vs. 1.2 ng/mg of Caucasian hair. African-American hair tended to retain cocaine longer so that at the end of the study the median level was 4.9 ng/mg

compared to 0.24 ng/mg for Caucasian hair. The concentrations of cocaine in the hair of individuals who were abstinent during the study period did not fall to zero even though no drug use was identified. ROC curves were not generated for hair due to limitations of the sampling interval and related hair growth.

These results indicate that, while each drug testing method has its strengths and limitations, urine appears to be less susceptible to environmental contamination than other matrices.

Cocaine, Drug Testing, Contamination

K23 Ethanol Elimination Rates From Time Discrete Blood Draws in Impaired Driving Cases

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After attending this presentation, attendees will gain insight into the pharmacokinetics of ethanol, specifically, its elimination in men. In this study, apparent elimination rates were calculated from 173 cases involving two time-discrete blood draws where the male driver was charged with the offense of driving while intoxicated.

This presentation will impact the forensic community and/or humanity by providing additional data that can be used by testifying forensic scientists in determining more accurate estimations of blood alcohol levels in drivers at the time of the incident.

Ethanol intoxication is a leading cause of motor vehicle accidents in the U.S. with a reported rate of alcohol involvement in 39% of all traffic fatalities in 2005[1]. During the same time frame in Texas, 46% of all traffic fatalities involved alcohol.[1] The Federal Bureau of Investigation estimated that about 1.4 million drivers in the U.S. were arrested in 2005 for driving under the influence of either narcotics or alcohol with males accounting for 81% of these arrests.[2, 3]

Current Texas law states that any accident resulting in serious bodily injury or loss of life allows for the collection of a suspect's blood for toxicological analysis. Since 2002, the Bexar County District Attorney's Office has requested that two blood specimens be obtained with an intended elapsed time interval of two hours between the blood draws. For the cases studied, from the years 2003-2007, the actual average elapsed time was 104 minutes. Blood draws were taken at local hospitals and transported to the Bexar County Medical Examiner's Office under the chain-of-custody by the arresting officer. The blood samples were then analyzed for ethanol concentrations using a direct-injection gas chromatography (GC) method.

Sample Preparation: 0.2 mL of sample blood was added to 4.0 mL of the internal standard (IS) solution, using a Repipet dilutor (LabIndustries, Dubuque, IA). The IS solution was composed of 0.25 mL n-propanol brought up in 1 L of deionized water (0.025% v/v). The analyte solution spiked with the IS was then transferred to a GC vial and loaded onto the injection tray.

Analysis: The samples were then analyzed on a Hewlett Packard 6890 GC. The method utilized an isothermal oven temperature of 40°C and a run time of 3 minutes. The gas chromatographic column employed was the Restek Rtx – BAC1 (30m x .53mm id, 3µm film thickness). The carrier gas was helium at a velocity of 11.2 mL/min and detection was accomplished by a flame ionization detector. Autoinjection and collection parameters were controlled by Agilent GC ChemStation software.

Ethanol elimination rates were calculated using the following:

$$\frac{[BAC]_1 - [BAC]_2}{\Delta T}$$

where *[BAC]* represents the reported ethanol concentrations in g/dL and ΔT equals the elapsed time between the two draws in hours.

Results: Ethanol was not detected in six cases out of the 173 studied and thus were excluded from data analysis. The range of calculated ethanol elimination rates were 0.0005 to 0.0682 g/dL/hr. The mean, median, and mode ethanol elimination rates were 0.0198, 0.0175, and 0.0175 g/dL/hr, respectively. Initial blood alcohol concentrations reported in the study ranged from 0.018 to 0.397 g/dL. Table 1 describes the relationship between the age of the male subject and the elimination rate while Table 2 examines how the elimination rate varies with a change in the initial blood alcohol concentration.

Table 1.

Age Range	N	Average Elimination Rate (g/dL/hr)
16-19	20	0.0194
20-29	73	0.0204
30-39	29	0.0156
40-49	27	0.0198
50+	18	0.0246
All Cases	*167*	*0.0198*

Table 2.

Initial BAC Range (g/dL)	N	Average Elimination Rate (g/dL/hr)
≤ 0.0499	6	0.0156
0.05-0.099	18	0.0170
0.1-0.149	42	0.0184
0.15-0.199	50	0.0201
0.2-0.249	35	0.0205
≥ 0.25	16	0.0248

No correlation was observed between a person's age and their elimination rate, however an increase in the rate of ethanol elimination was observed with increasing initial blood alcohol concentrations.

The overall variability of the elimination rates can be attributed to a mixture of genetic and acquired factors such as decreased enzyme activity, gastric contents, as well as a difference between the time of the incident and the first blood draw.

References:

1 http://www-nrd.nhtsa.dot.gov/pdf/nrd-30/NCSA/TSF2005/810616.pdf
2 http://www.fbi.gov/ucr/05cius/data/table_29.html
3 http://www.fbi.gov/ucr/05cius/data/table_41.html

Ethanol, Elimination Rate, Impaired Driving

K24 A Fast and Sensitive LC/MS/MS Method for the Quantitation and Confirmation of 30 Benzodiazepines and Non-Benzodiazepine Hypnotics in Forensic Urine Samples

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After attending this presentation, attendees will learn about using LC/MS/MS for analysis of benzodiazepines and non-benzodiazepine hypnotics in urine. These drugs are of interest because of increased use and abuse.

This presentation will impact the forensic science community by presenting a fast, simple, and sensitive technique to detect and quantify benzodiazepines and other hypnotic drugs in urine. The method presented has several advantages over the other techniques that are used.

Introduction: Benzodiazepines and other nonbenzodiazepine hypnotics, such as Zaleplon, Zolpidem, and Zopiclone are widely prescribed psychoactive drugs for the treatment of anxiety and sleep disorders. These substances frequently lead to dependence and abuse and some of them can affect judgment and behavior. As a result, these compounds are of great interest in forensic, toxicological and clinical research laboratories. The screening for benzodiazepines with immunoassay tests does not provide enough sensitivity and specificity. Analysis using gas chromatography with different detectors is difficult or impossible because of thermal instability and requires time consuming derivatization and clean-up steps. Liquid chromatography (LC) with UV detection cannot detect benzodiazepines at required concentration levels and lacks in selectivity.

LC with tandem mass spectrometric detection (MS/MS) with electrospray ionization (ESI) is the ideal technology for the analysis of polar and thermally labile drugs and their metabolites, yielding high sensitivity and specificity. Sample preparation is also fast and simple. The developed LC/MS/MS method detects 30 analytes in a single chromatographic run using two Multiple Reaction Monitoring (MRM) transitions to allow quantitation and confirmation.

Experimental and Results: Urine samples of forensic cases were diluted after addition of internal standards. LC separation was carried out using a Shimadzu Prominence LC using mobile phases of: (A) water with 0.2% formic acid and 2mM ammonium formate, and (B) acetonitrile with 0.2% formic acid and 2mM ammonium formate. A 3200 Q TRAP® LC/MS/MS system equipped with an ESI source operated in the MRM mode was used for detection. Two transitions were monitored. The first MRM was used to quantify the analyte and a ratio of the quantifier to the second qualifier MRM was used for confirmation.

Limits of quantitation in urine samples, accuracy and reproducibility of all analytes were studied. All targeted compounds could be quantified in urine samples after a dilution step at a concentration of at least 10 ng/mL. The high selectivity of MRM detection allows compound specific detection without interference of urine matrix or other drugs or metabolites being present in the sample. The dilution step of the urine sample preparation additionally ensures elimination or reduction of ion suppression which could be caused because of co-eluting matrix components.

Benzodiazepines, LC/MS/MS, Toxicology

K25 Disposition of MDMA and Metabolites in Human Sweat Following Controlled MDMA Administration

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After attending this presentation, attendees will learn that understanding the disposition and excretion of methylenedioxymethamphetamine (MDMA) and metabolites in the sweat of MDMA (ecstasy) users is vital for interpreting sweat and hair testing results in drug treatment, criminal justice and workplace drug testing programs.

This presentation will impact the forensic science community by demonstrating how this experimental MDMA administration study indicates that sweat testing may be an effective and reliable method for monitoring ecstasy use. These data provide a scientific database for interpretation of MDMA sweat test results.

Placebo, low (1.0 mg/kg) and high (1.6 mg/kg) oral MDMA were given double blind in random order to healthy volunteers (n=16) with a history of MDMA use. Participants provided written informed consent to participate in this IRB-approved study and remained on a closed clinical research unit for at least three days after each MDMA dose. PharmChek® sweat patches (n=688) were worn prior to dosing, reflecting previously self-administered drug, and during and after controlled MDMA dosing. Patches were analyzed by SPE and GC/MS for MDMA, methylenedioxyamphetamine (MDA), 4-hydroxy-3-methoxyamphetamine (HMA) and 4-hydroxy-3-methoxymethamphetamine (HMMA). Limits of quantification (LOQ) were 5 ng/patch except for MDMA (2.5 ng/patch).

MDMA was the primary analyte detected with concentrations up to 3007 ng/patch in 415 patches (60.3%). MDA was detected in 194 patches (28.2%) at concentrations <172 ng/patch, and HMA, and HMMA were not detected above the method LOQ. 234 patches (34.0%) were positive for MDMA at the 25 ng/patch screening and confirmation cutoffs, proposed by the Substance Abuse and Mental Health Services Administration (SAMHSA) for the detection of amphetamines. Four additional patches (0.6%) exceeded these cutoff concentrations for MDA, and only one was positive without concurrent MDMA above the method LOQ.

MDMA was first observed in short-term patches worn from 0-2.5 h after low and high dose administrations. MDA was present in patches worn 0-6 h after dosing. Large intra- and inter-subject variability was observed in duplicate weekly patches applied for seven days. Median weekly MDMA concentrations were 137.5 ng/patch (5.8 - 894.0) and 376.6 ng/patch (14.7–3007.7) following low (n=18) and high (n=23) doses, respectively.

This research is supported by the Intramural Research Program, NIH, National Institute on Drug Abuse.

MDMA, Sweat, GC/MS

K26 A Fatal Case of a Paint Thinner Ingestion: Comparison Between Toxicological and Histological Findings

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The goal of this presentation is to illustrate a fatal case of self-poisoning by ingesting of solvents used to dilute varnishes.

This presentation will impact the forensic science community by evaluating the histopathological findings in liver, kidney, and brain slides with the results reported in scientific literature about pathologic pathways found in animal models exposed to acute solvents.

The authors illustrate a fatal case of self-poisoning by ingesting of solvents used to dilute varnishes.

A 15-year-old Caucasian boy was found in supine position in the garden of his teacher's country-house. Past history indicated that the boy went to confront his teacher about a recent failed examination in his class. He was transported to the local Emergency Room and died shortly afterwards. During the subsequent death investigation, police officers found numerous small bottles of paint thinners. By an order of the legal authorities, an external examination and autopsy were performed two days later at the Institute of Legal Medicine of Palermo.

External examination: The young boy was 175 cm tall and weighed 65 kg. No injuries were found on his body; the external examine showed only a nasal haemorrhage and labial and subungual cyanosis.

Autopsy findings: The forensic autopsy revealed citotoxic wet brain and congestion of cerebral veins. There were no lesions on the scalp or in the galea capitis and no intracerebral haemorrhaging was found. Pulmonary edema, pancreas and kidney congestion were found. The gastric content

consisted of a brownish liquid (300 cc) and its odour suggested the presence of organic volatiles. Nothing else was found during the autopsy.

Histological findings: The microscopic examination showed a multi-visceral congestion. The oesophageal mucous membrane showed multiple lympho-granulocyte infiltrates.

Toxicological analysis: The blood alcohol screening was negative. Additional toxicological analysis revealed the presence of toluene and *ortho*-, *meta*-, *para*- xylene. Analysis was performed by the Headspace/Solid-Phase Microextraction/Gas Chromatography-Mass Spectrometry (HS-SPME-GC/MS) to identify and quantify volatile organic compounds in blood and tissue samples. Experimental condition included headspace sampling at 40°C. Carboxen/PDMS fiber (85 mm) repeatedly tested at various adsorbing and desorbing times in order to obtain the best compromise in term of chromatogram quality and method sensitivity. The capillary column used was SUPELCOWAXTM 10. The quantitative analysis was carried out using toluene-d8 as the internal standard. In order to optimize the GC-MS method, a preliminary study was conducted using a single quadrapole instrument in SIM mode. The first quantitative data on blood were: toluene 60 mg/L, *ortho*- xylene 232 mg/L, *meta*- xylene 160 mg/L, *para*-xylene 65.2 mg/L. Afterwards, the analysis on the other tissue samples (gastric contents, brain, etc.) were performed using a GC-MS equipped with an ion trap mass analyzer and an autosampler, in order to achieve a better reproducibility on data and reduce manual errors. Ions at m/z 91, 106 and m/z 98 (i. std. toluene-d8) were used to quantify the aromatic compounds both in SIM mode using a single quadrapole instrument and, as extracted ions, in SCAN mode using a ITD mass analyzer.

Solvents Ingestion, Self-Poisoning, Organic Volatile Toxic

K27 A Review of Cases Analyzed for 1,1-difluoroethane

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After attending this presentation, attendees will learn the bodily fluid and tissue concentrations of 1,1-difluoroethane and understand the relationship of demographic information to 1,1-difluoroethane abusers.

This presentation will impact the forensic toxicological and pathological communities by presenting data on 1,1-difluoroethane concentrations in human fluids and tissues where there is currently a relative dearth of current information.

1,1-difluoroethane (DFE) is a colorless, odorless gas used as a refrigerant and as an aerosol propellant in many commonly used consumer products and electronic cleaners. Over the past few years it has been recognized as a substance of abuse that can lead to injury or death. In general, inhalation of fluorinated hydrocarbons may result in a feeling of light-headedness and disorientation; however, in higher concentrations abuse may lead to cardiac dysrhythmias and sudden death.

A review of cases from our laboratory database for the past two years revealed 48 cases for which DFE was analyzed. The analysis for these specimens was performed by headspace gas chromatography/mass spectrometry. All but three of the cases found DFE to be present. The specimens in which DFE was detected included blood (n=35) (while most did not identify the source of the blood some were identified as central, chest, iliac, inferior vena cava, femoral or peripheral); lung tissue (n=8), brain tissue (n=2); adipose tissue (n=1); and urine (n=1). The blood concentrations ranged from 0.14 to 300 mcg/mL, average (± SD) 51 ± 78 mcg/mL and median 23 mcg/mL. In most cases, our laboratory did not receive case histories with the accompanying specimens; therefore, it was difficult to determine if the blood tested was an investigation of a death (due to an overdose or an accident), investigation of human performance involving an accident, or probable cause for substance abuse. However, based on the source of the specimen and/or the submitting client, 21 blood specimens were identified as postmortem blood that had DFE concentrations ranging from 0.74 to 300 mcg/mL, average (± SD) 79 ± 91 mcg/mL, and median 45 mcg/mL. The DFE concentration in the lung tissues examined ranged from 0.86 to 59 mcg/g, average (± SD) 20 ± 24 mcg/g, and median 11.3 mcg/g. The two brain tissues had concentrations of 26 and 100 mcg/g. The one adipose tissue and one urine sample had DFE concentrations of 6.8 mcg/g and 0.94 mcg/mL respectively. In three cases where multiple samples were analyzed, the DFE concentrations were blood 65 mcg/mL and brain tissue 100 mcg/g; blood 23 mcg/mL and lung tissue 0.94 mcg/g; and adipose tissue 68 mcg/g and lung tissue 24 mcg/g. It should be noted that DFE is a gaseous substance and may volatilize on handling; therefore, the reported values may be lower than the circulating concentrations.

In 37 of the cases where the gender was identified, 73% (27) were male and 27% (11) were female. The ages of the individuals were given in 35 of the cases and ranged from 15 to 55 years, average (± SD) 27 ± 10 years, and median 25 years. In cases were both gender and age were noted, the average (± SD) age of the males (n=24) was 29 ± 11 years (range 15 – 55 years), median 27.5 years; and the average (± SD) age of the females (n=9) was 22 ± 6.6 years, (range 16 – 31 years), median 18 years. In conclusion, DFE can be found in a variety of bodily fluids and tissues in a forensic toxicological investigation and appears to be predominantly abused by men in their late twenties, but also can be found in women usually of a younger age. With the prevalence of this propellant in commonly used consumer products, the abuse of this substance will likely continue.

1,1-difluorethane, Toxicology, Inhalant Abuse

K28 Evaluation of the Lin-Zhi International Benzodiazepine Enzyme Immunoassay for the Detection of Benzodiazepines and Their Metabolites in Urine

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The goal of this presentation is to inform the toxicology community and others of the performance of the Lin-Zhi International Benzodiazepine Enzyme Immunoassay for the detection of benzodiazepines and their associated metabolites in urine.

An evaluation of the performance of the Lin-Zhi International Benzodiazepine Enzyme Immunoassay will impact the forensic science community by providing the field of toxicology with an alternative choice for the rapid detection of benzodiazepines and their associated metabolites in urine.

An evaluation of a new Benzodiazepine Enzyme Immunoassay [BEI] (Lin-Zhi International, Inc., Sunnyvale, CA) for the detection of benzodiazepines and their major metabolites in urine will be presented. The Lin-Zhi assay is based on competitive antibody binding between benzodiazepines in urine and glucose-6-phospahate dehydrogenase labeled oxazepam. When benzodiazepines and/or their metabolites are present in urine, active unbound enzyme reduces the co-enzyme NAD to NADH that results in an increase of measured absorbance at 340 nm. The assay is calibrated with oxazepam.

The BEI was evaluated by testing 1409 urine specimens collected from pain management patients. All 1097 specimens were tested with the assay in an ADVIA 1200 Chemistry System auto-analyzer (Bayer Health Care, Diagnostics Division, Tarrytown, NY) with calibrators containing 0, 200 (cut-off calibrator) and 600 ng/mL of benzodiazepine. Controls containing 0 ng/mL of oxazepam and -25% (negative control) and +25% (positive control) of the 200 ng/mL cut-off calibrator (Bio-Rad Laboratories, Irvine, CA) were analyzed with each batch of samples. All urines were then analyzed by a GC/MS for alprazolam, hydroxy-alprazolam, diazepam, nordiazepam, lorazepam, oxazepam and temazepam at a cut-off concentration of 75 ng/mL.

Approximately, 30% (315) of the 1097 specimens yielded positive results by the BEI assay. Of these specimens, GC/MS confirmed the presence of Benzodiazepines at 75 ng/mL in 306 specimens, indicating 9 false positive results. However, 36 specimens yielding negative BEI results were found to contain Benzodiazepines above the GC/MS cut-off of 75 ng/mL. Therefore the overall agreement of BEI and GC/MS results was 96%. From the presented study, the sensitivity of the BEI was 0.895 and the selectivity 0.988. Testing at 1,000 mg/mL of other drugs of abuse or their metabolites such amphetamine, benzoylecgonine, morphine and phencyclidine, BEI demonstrated no cross reactivity. The within-run precision of BEI was determined by the absorbance rates of the negative and positive controls was CV=1% (n=16); while the between-run precision of the controls was CV=<6% (n=16). The assay was found linear from –50% to 150% of cut-off concentration. The Lin-Zhi BEI provides a precise, reliable method for the routine detection of benzodiazepines and/or their metabolites in urine specimens.

Enzyme Immunoassay, Benzodiazepines, Urine Drug Testing

K29 Evaluation of the Lin-Zhi International Phencyclidine Enzyme Immunoassay for the Detection of Phencyclidine in Urine

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The goal of this presentation is to inform the toxicology community and others of the performance of the Lin-Zhi International Phencyclidine Enzyme Immunoassay for the detection of Phencyclidine in urine.

An evaluation of the performance of the Lin-Zhi International Phencyclidine Enzyme Immunoassay will impact the forensic science community by providing the field of toxicology with alternative choices for the rapid detection of phencyclidine in urine.

An evaluation of a new Phencyclidine Enzyme Immunoassay [PCPI] (Lin-Zhi International, Inc., Sunnyvale, CA) for the detection of phencyclidine (PCP) in urine will be presented. The Lin-Zhi assay is based on competitive antibody binding between PCP in urine and glucose-6-phospahate dehydrogenase labeled PCP. When PCP is present in urine, active unbound enzyme reduces the co-enzyme NAD to NADH that results in an increase of measured absorbance at 340 nm.

The PCPI was evaluated by testing 412 urine specimens collected from criminal justice clients and substance abuse treatment patients. All 412 specimens were tested with the assay in an ADVIA 1200 Chemistry System auto-analyzer (Bayer Health Care, Diagnostics Division, Tarrytown, NY) with calibrators containing 0 and 25ng (cut-off calibrator) of PCP. Controls containing 0 ng/mL of PCP and -25% (negative control) and +25% (positive control) of the 25 ng/mL cut-off calibrator (Bio-Rad Laboratories, Irvine, CA) were analyzed with each batch of samples. All urines were then analyzed by HPLC-MS/MS for PCP at a cut-off concentration of 5 ng/mL.

Approximately, 29% (118) of the 412 specimens yielded positive results by the PCP assay. Of these specimens, HPLC-MS/MS confirmed the presence of at 5 ng/mL in 118 specimens, indicating no false positive results. Only one specimen yielded a negative result and was found to contain PCP above 25 ng/mL. Therefore, the overall agreement of PCPI and HPLC-MS/MS results was 99.8%. From the presented study, the sensitivity of the PCPI was 0.992 and the selectivity 1.000. Testing at 100 mg/mL of other drugs or their metabolites such as amitriptyline, amphetamine, benzoylecgonine, diphenhydramine, doxepin, doxylamine, imipramine, morphine, and oxycodone PCPI demonstrated no cross reactivity. The within-run precision of PCPI was determined by the absorbance rates of the negative and positive controls was CV=2% (n=12); while the between-run precision of the controls was CV=<6% (n=4). The assay was found linear from –50% to 150% of cut-off concentration. The Lin-Zhi PCPI provides a precise, reliable method for the routine detection of phencyclidine in urine specimens.

Enzyme Immunoassay, Phencyclidine, HPLC/MS/MS

K30 Identification of Product Adulteration With Pesticides Via Direct Analysis in Real Time (DART™) Time-of-Flight Mass Spectrometry (TOF-MS)

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The goal of this presentation is to demonstrate that DART-TOF-MS instrumentation is a beneficial counterpart in the modern forensic laboratory to traditional toxicological examinations.

This presentation will impact the forensic science community by demonstrating how Direct Analysis in Real Time (DART) ionization sources may provide a more rapid and direct analytical route to toxicant identification in adulterated food or beverage specimens.

DART™ stands for "Direct Analysis in Real Time". A new ion source, DART™ allows for the direct detection of chemicals on surfaces, in liquids, and in gases without the need for sample preparation. The ion source is open to the atmosphere, and does not require a vacuum, the use of high voltages or solvent sprays. Samples are simply placed into the ionization stream. The ionization mechanism is based upon the reactions of excited-state species with reagent molecules and polar or non-polar analytes. When coupled with a TOF-MS, accurate mass assignments are generated and analyte identifications are realized.

In many toxicological investigations, the suspected source of the poison may be received in addition to biological specimens such as blood or urine. Often, the most direct route to toxicant identification is primary analysis of suspect source material. However, analysis of seized food, beverage, and other commercial products is typically time consuming and laborious. A DART-TOF-MS instrument offers the forensic examiner a tool for rapidly identifying such adulterations in bulk samples. Such analyses can complement subsequent traditional investigations by immunoassay and chromatography.

Several cases are presented in which beverages or food products were suspected to have been spiked with a commonly available pesticide formulation. Commercially available herbicide formulations often contain a variety of organochlorine, organophosphorus or other compounds. Ingestion of such preparations may cause severe injury or death.

Direct analysis of both the seized food samples and a pesticide exemplar by DART-TOF-MS yielded a rapid and conclusive identification. The analysis provided exact molecular mass, theoretical isotope distribution matching, and characteristic fragmentation patterns to effect the identifications. No sample preparation was required. The pesticides identified were 2,4-D, dicamba, mecoprop, and diethyltoluamide.

DART-TOF-MS, Pesticides, Accurate Mass

K31 National, Regional, and State Trends in Workplace Urine Drug Testing Results From a Medical Review Officer Data Source, 2003-2005

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After attending this presentation, attendees will have an enhanced understanding of the relationships between laboratory reported drug test results and Medical Review Officer (MRO) verified results reported to employers from 2003-2005 for Non-Federally Regulated Workplace Drug Testing. Drug testing results will be evaluated nationally, by census region, and by state. Map displays by state will evidence variation across states. Geographic Information System (GIS) functionality will display spatial distribution of the data.

This presentation will impact the forensic science community by describing how annual positive rates by geographic area for the Non-Regulated Workforce determined from Medical Review Officer (MRO) verified data, which excludes blind quality assurance samples and results reversed through valid medical explanation, may more accurately represent illegal drug use rates and geographical trends to the forensic community.

Records for over 2.1 million Non-Regulated specimens collected during calendar years 2003 through 2005 from more than 8,000 companies and tested by 41 laboratories were obtained from a large MRO data source. The database includes donor demographics, employer information, collection site information, laboratory results, and MRO determinations, but does not include employer blind quality assurance samples. Analysis of the data indicates that, following MRO review, there was a decreasing trend of annual positive rates and an increasing trend of reversal rates in regulated and non-regulated populations during the 36 month period. The table below illustrates the geospatial distribution of MRO verified positive drug testing results for Non-Regulated specimens by U.S. Census regions.

Non Regulated Drug Testing 2003-2005	Total, U.S.	Northeast	South	Midwest	West
MRO Verified Drug Positive Rates, %					
Overall Drug Positive Rate, 2003	3.74%	3.39%	3.56%	4.40%	3.71%
Overall Drug Positive Rate, 2004	3.52%	3.31%	3.52%	3.58%	3.63%
Overall Drug Positive Rate, 2005	3.18%	3.07%	3.21%	3.21%	3.16%
MRO Verified Drug Positive Rates, %					
Overall Drug Positive Rate, 2003-2005	3.46%	3.25%	3.41%	3.70%	3.46%
Amphetamines	0.18%	0.05%	0.14%	0.11%	0.51%
Cocaine	0.61%	0.59%	0.68%	0.63%	0.37%
Marijuana	2.49%	2.44%	2.39%	2.78%	2.44%
Opiates	0.08%	0.07%	0.09%	0.09%	0.08%
Phencyclidine	0.01%	0.03%	0.01%	0.01%	0.01%
Barbiturates	0.06%	0.07%	0.08%	0.04%	0.04%
Benzodiazepines	0.14%	0.09%	0.19%	0.11%	0.11%
# of Specimens Tested, 2003-2005	2,111,528	320,329	999,052	443,807	348,340

The overall MRO verified drug positive rate has decreased nationally as well as in all four regions during the period 2003-2005. The most dramatic decrease was in the Midwest region where it decreased from 4.40% to 3.21%. Looking at drug classes for 2003-2005, the MRO verified positive rate for amphetamines was significantly greater in the West region (0.51%), while the cocaine positive rate in the West (0.37%) was the lowest of all regions. The positive rates for marijuana and opiates were not significantly different among the regions. The positive rates for both barbiturates and benzodiazepines were highest in the South region. The annual positive rate for marijuana has consistently evidenced a downward trend nationally (2.76% to 2.21%) and in all regions during the three year period. Data supports the observation that Workplace Drug Testing may be a deterrent to illicit drug use.

Workplace Drug Testing, Drug Testing Database, Medical Review Officer Verified Results

K32 A Stability Study on Ritalinic Acid in Urine

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The goal of this presentation is to evaluate the short-term stability of ritalinic acid in authentic urine specimens exposed to different storage conditions.

This presentation will impact the forensic science community by identifying adequate storage conditions for urine samples obtained from methylphenidate users; and contribute to proper interpretation of results from delayed analyses or reanalyses by reviewing indications from the assessment of ritalinic acid stability.

The stability of any drug and potential metabolites in biological samples must be considered when justifying the reliability of analytical results. Variation in drug concentrations in biological fluids is possible via thermal, chemical, enzymatic or matrix degradation. Stability studies can improve toxicological quality by identifying optimal storage conditions and time limits for analysis, after sample collection, and reanalysis. The examination of the short-term stability of ritalinic acid, assessed through quantitative results for eight positive ritalinic acid urine samples obtained from pain management patients prescribed methylphenidate, is presented.

Ritalinic acid is the primary metabolite of methylphenidate, a phenethylamine derivative employed in the treatment of attention-deficit hyperactivity disorder (ADHD), childhood hyperkinesis, depression and narcolepsy. Previous research has revealed that methylphenidate spontaneously hydrolyses to ritalinic acid in vitro.[1] The conclusion from that scientific study recommends freezing or refrigeration conditions for specimen storage. Some commercial laboratories refuse analysis of specimens that have not been frozen. The methylphenidate degradation process is minimized at pH 2.9, or by addition of ethylenediaminetetraacetic acid (EDTA), and under "cool" storage.[1] Studies have confirmed the percentage of methylphenidate in urine to be minimal, less than 1% in a twenty four hour void.[2, 3] Consequently, urine methylphenidate concentrations are usually quite low and if conversion to ritalinic acid does occur, it is unlikely that the ritalinic acid content will be significantly increased. There have been no published studies on ritalinic acid stability to date.

The ritalinic acid concentration in three sets of urine aliquots from authentic cases (n=8), stored at room temperature, refrigerated or frozen was quantified by gas chromatography/mass spectrometry (GC/MS), once weekly, over a one-month period. The baseline concentration range of all specimens was 10,945-78,673 ng/mL. Loss of analyte appears to be concentration dependent. Deterioration is more rapid at higher ritalinic acid concentrations. There was a significant decrease in concentration of the target analyte over the twenty nine-day period; mean percentage loss of analyte was 32%, 36%, and 43% for highly concentrated ritalinic acid specimens (46,332-78,673 ng/mL) stored at room temperature, refrigerated and frozen, respectively. No statistically significant difference in the variation of ritalinic acid content among the samples stored under the three conditions was evident. At lower ritalinic acid content (10,945-18,594 ng/mL), change in concentration was insignificant. All statistical analysis was done at the 95 % confidence limit; P= 0.05. The results indicate that ritalinic acid is unstable in urine, particularly at high concentrations, and the concentration will decrease significantly upon storage at room temperature, refrigeration, or freezing.

Stability, Ritalinic Acid, Storage Condition

K33 Methadone Detection in Postmortem Oral Swab Samples

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After attending this presentation, the attendees will have an understanding of the use of oral swab samples obtained after death for the detection of methadone.

The presentation will impact the forensic community and/or humanity by demonstrating how oral swabs may be valuable in establishing methadone use in cases of fatal drug overdose.

Recent studies have shown that oral fluid samples are useful for detecting drug use. The purpose of this study was to evaluate whether a specific drug, methadone, could be detected in oral swab samples obtained after death. At present, methadone is among the most commonly detected drugs in fatal drug overdoses in West Virginia.

Oral swabs were obtained in cases in which the cause of death was suspected to be drug-related. Autopsy technicians collected the samples using standard laboratory cotton-tipped swabs by rubbing the swab along the buccal mucosa. Samples were eluted by vortexing with 1.0 mL of methanol and were centrifuged to remove debris. The supernatant was collected, dried under nitrogen, and reconstituted in 0.10 mL of methanol. GC/MS analyses were performed using an Agilent 6890 gas chromatograph interfaced with a 5973 mass-selective detector.

Saliva collected from non-methadone using donors was used for validation with deuterated methadone as an internal standard. Preliminary experiments demonstrated that an unidentified substance present in the swabs co-eluted with methadone. Several attempts were made to modify GC parameters in order to circumvent this interference. These were unsuccessful in resolving the two compounds; therefore, selected-ion monitoring was employed for analysis of methadone in the swabs. Target and qualifier ions acquired for methadone and deuterated internal standard were: methadone 72, 294, 223; methadone-*d9* 78, 226,178. The analysis had a linear range of 36.5 ng/swab to 365 ng/swab (r^2=0.991) and a limit of detection of 29.2 ng/swab. Precision of the assay was demonstrated with intraday (n=3) and interday (n=3) coefficients of variation of 5.72% and 13.4%, respectively, using a control containing 292 ng/swab. Average methadone recovery was 27.3% when spiked saliva (0.1 mL) was added to the swab.

Cases that were confirmed to be methadone-positive and quantitated in blood were chosen for the study. The average weight of material collected on the swab was 83 mg ± 41 mg.

All calibrators and controls were required to be ± 20% of their intended values. Twenty-six case samples were analyzed with a maximum of five case samples included in each assay. Assays also included four calibrators (36.5, 73.0, 183, 365 ng/swab), two positive controls (54.8, 292 ng/swab), and one negative control (saliva with no methadone added).

Methadone was detected in 17 of the 26 samples, three of which were below the LOQ (< 36.5 ng/swab). The amount of methadone in the samples varied from 38.9 to 333 ng/swab. The methadone metabolite, EDDP, was not studied, but it was noted that methadone was not detected in any of the swab samples from cases for which EDDP in blood was found to be below our limit of detection, 0.01 mg/L.

Methadone, Oral Fluid, Postmortem

K34 Analyzing Cannabiniods by HPLC/MS/MS

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After attending this presentation, attendees will understand how to increase sample throughput using HPLC/MS/MS methodology and how to chose the proper method conditions to obtain reliable, enhanced sensitivity for cannabinoid analysis.

The HPLC methodology discussed will impact the forensic science community by providing an alternate means of analyzing cannabinoids at low concentrations compared to the current GC methodology.

After attending this presentation, attendees will understand how to increase sample throughput using HPLC/MS/MS methodology and how to chose the proper method conditions to obtain reliable, enhanced sensitivity for cannabinoid analysis. The HPLC methodology discussed provides the forensic community with an alternate means of analyzing cannabinoids at low concentrations compared to the current GC methodology.

This study included developing an HPLC/MS/MS method for analyzing cannabinoids. The main psychoactive component in marijuana, Δ^9 – tetrahydrocannabinol (Δ^9–THC), is quickly absorbed and metabolized to 11-hydroxy-Δ^9-tetrahydrocannabinol (hydroxy-THC), an active metabolite. The hydroxy-THC is further metabolized (rapidly) to 11-nor-9-carboxy-Δ^9-tetrahydrocannabinol (carboxy-THC), an inactive metabolite commonly found in urine, blood, hair, and other tissues. GC-MS (Gas Chromatography-Mass Spectrometry) often is used for confirming and quantifying Δ^9–THC and carboxy-THC. However, GC-MS methods require time-consuming steps like derivatization to obtain acceptable chromatography. Using HPLC (High Performance Liqui Chromatography), derivatization is eliminated, saving time without sacrificing sensitivity.

A quantitative method for analyzing underivatized cannabinoids by HPLC tandem mass spectrometry was developed. Goals were threefold in this study; 1) to optimize the column selection, 2) to provide a short analysis time and, 3) to obtain reliable confirmation and quantitation data in the low ng range (< 10ng).

Results showed that choosing a column that produced longer retention allowed for the use of a high organic mobile phase composition. This high organic mobile phase composition increased desolvation efficiency and enhanced sensitivity of the cannabinoids. Detection at the picogram level was obtained. The high organic mobile phase composition also contributed to a short analysis time of 5 minutes. The use of the MS/MS instrumentation produced reliable identification by producing two +MRM transitions.

Based on the work described above, a biphenyl HPLC column coupled to an HPLC MS/MS can quantify low levels of analyte from underivatized sample – and can achieve baseline separation of Δ^9-THC and cannabidiol (which have very similar product ion spectra and +MRM transitions) – in less than 5 minutes.

Mass Spectrometry, HPLC, THC

K35 The Advantages and Limitations of MRM vs. Full Scan MS/MS for Drug Confirmation Utilizing LC/MS/MS

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After attending this presentation, attendees will become familiar with two methods of drug screening using liquid chromatography tandem mass spectrometry (LC/MS/MS) and will understand the pros and cons of using full scan MS/MS versus two multiple reaction monitoring (MRM) transitions for drug confirmation.

This presentation will impact the forensic community by adding data to the debate of what constitutes a confirmation of drug presence in LC/MS/MS.

Introduction and Hypothesis: GC/MS has been the analytical technique of choice for drug confirmation in forensic toxicology labs. However, the use of LC/MS/MS for screening and confirmation has been increasing and this technique continues to be adopted by a rising number of labs. When any new confirmatory technique is implemented, debates arise regarding what constitutes a confirmation. Although it has been established that three ions are necessary for GC/MS SIM confirmation, the criteria for an LC/MS/MS confirmation is still a highly debated topic. In this work, confirmation using two MRM transitions is compared and contrasted with confirmation using full scan MS/MS spectra. The advantages and limitations of both techniques are presented and discussed. The goal of the study was to investigate which LC/MS/MS method was more robust and which had the largest dynamic range for drug confirmation.

Methods: Standards of various drug compounds were spiked into drug free urine and diluted 10x with mobile phase. Analysis was performed on an LC interfaced to a hybrid triple quadrupole/linear ion trap (LIT) mass spectrometer (Applied Biosystems 3200 QTrap). All compounds were analyzed using positive mode electrospray ionization.

For the MRM only method, two MRM transitions per analyte were monitored with the second transition functioning as a qualifier ion. The ratio of the peak areas of the target MRM to the qualifier MRM was calculated. For confirmation, it was required that the ratio be within +/- 20% of the standard.

When full scan MS/MS spectra were used for confirmation, an MRM survey scan was used to detect the presence of an analyte. If an analyte was detected, the system automatically acquired a full scan MS/MS spectrum of the compound using Q3 operating in LIT mode. The resulting spectrum could be searched against a library for identification and confirmation. A purity match of about 70% or higher was required for confirmation.

The precision for the two methods was also compared since it was expected that the full scan method may compromise precision due to switching between MRM and full scan modes.

Preliminary Data: Preliminary results from analysis of amphetamines showed that a full scan spectrum using LIT was more robust in confirmation than using a ratio of two MRM transitions. In 15 samples at 100 ng/mL, amphetamine and methamphetamine passed every time in both methods, MDA failed in both methods, and MDMA passed in the full scan method but failed 13 out of 15 times in the MRM with qualifier method. Also, there was no significant compromise in precision with the full scan MS/MS method: the within run and between day precision was 4.6 and 6.0, respectively, compared to 3.8 and 5.8 for the MRM with two transitions method.

Conclusion: To conclude, initial findings indicate that both the full scan method using a LIT and the MRM with two transitions method are robust and precise in performing amphetamine confirmations. However, the full scan method was more robust at the low end of the dynamic range. This study will be expanded to include drugs from other classes to determine if the initial trends are observed across most compounds and to determine how well each method functions in situations of co-eluting drugs at large concentration ranges.

LC/MS/MS, Drug Screening, Drug Confirmation

K36 Correlation Study Between Blood Concentrations and Vitreous Concentrations: Case of Meprobamate and Some Benzodiazepines (Bromazepam, Nordazepam, Oxazepam)

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The goal of this presentation is to show that, for the studied population, there is a positive correlation between blood and vitreous concentrations of meprobamate. There is no positive correlation for bromazepam, nordazepam and oxazepam. For all the molecules studied, concentrations measured in the vitreous, collected in the right and left eye, are not different.

This presentation will impact the forensic science community by confirming that vitreous concentrations of benzodiazepines cannot be used to extrapolate blood concentrations. For meprobamate, the results of this study show that the vitreous concentrations may be used to calculate blood concentration. The forensic toxicologist can provide a reliable result of quantitative analysis even if only one of the two vitreous is available.

Blood sample is the gold standard for most of the drugs in forensic toxicology. However the blood sample could be damaged or inexistent. In those cases, vitreous could be an alternative sample. It is thus important to know the relationship between blood and vitreous concentrations. This study has been performed on molecules often involved in forensic toxicology: meprobamate and some benzodiazepines (bromazepam, nordazepam, oxazepam).

Blood and vitreous samples were collected during forensic autopsies. Included in this study were the cases where one or many of the studied molecules (bromazepam (n=31), nordazepam (n=58), oxazepam (n=28) and meprobamate (n=43)) were detected in blood or urine during routine toxicology investigations. Benzodiazepines were quantified in blood by HPLC/DAD and in vitreous by Ultra Performance Liquid Chromatography with UV detection (UPLC/DAD). Meprobamate was quantified in blood and vitreous by GC/MS.

No difference has been highlighted, for all the molecules studied, between the vitreous collected in the right and left eye. A significant correlation (r^2=0.86) has been highlighted for the meprobamate. No correlation has been found for bromazepam (r^2=0.32), nordazepam (r^2=0.45), oxazepam (r^2=0.52). The [Blood] / [Vitreous] ratios (± SD) were 4.75 (±4.85), 35.71 (±23.28), 33.18 (±28.78), 1.56 (±0.77) for bromazepam, nordazepam, oxazepam, and meprobamate respectively.

The correlation between blood and vitreous concentrations is positive for the meprobamate in the studied population, which is not the case for the three studied benzodiazepines. The [Blood] / [Vitreous] ratio is much more important for the nordazepam and the oxazepam, than for the bromazepam and the meprobamate. To explain this behavioral difference, further studies are necessary.

Benzodiazepine, Meprobamate, Vitreous

K37 Chemical Warfare Agent Decontamination Reactions in Ionic Liquids (I): Decontamination of Diisopropylfluorophosphate (Simulant for Sarin) and Bis(2-ethylhexyl) Phosphite (Simulant for VX) in DMPITf2N

John S. Wilkes, PhD, Joseph A. Levisky, MS, Adrian Hermosillo, BS, Patrick J. Castle, PhD, Cynthia A. Corley, BS, Sherri-Jean Adams, BS, Keith A. Sanders, BS, Ian S. Tuznik, BS, and Donald M. Bird, PhD, Department of Chemistry, Chemical Research Center, United States Air Force Academy, 2355 Fairchild Drive, Suite 2N225, Colorado Springs, CO 80840*

After attending this presentation, attendees will obtain an understanding of some of the basic research being conducted on decontaminating chemical warfare agents on buildings, vehicles, equipment, and personnel. The attendee will gain a better understanding of the role of ionic liquids as solvents, reactants, and catalysts in organic chemical reactions.

This presentation will impact the forensic sciences by acquainting first responders, medical examiners, coroners, investigators, and morgue attendants with some of the research efforts currently underway to neutralize facilities/equipment that may be exposed to various nerve agents. The impact of this paper is to instill confidence in all personnel that research is being conducted to establish protocols that minimize personal risks of exposure and rapidly return exposed equipment to use.

Because of 9/11, the vulnerability of America to attack became apparent and the threat of chemical attacks from within became real. Shortly after 9/11, major efforts were initiated to prepare for a chemical attack. The efforts involved establishing rapid and reliable decontamination processes for chemical warfare agents. In order for a decontamination process to be effective, it must be rapid, generate non-toxic reaction products, and be compatible with the environment. In studying decontaminating processes of chemical warfare agents, "simulants", in lieu of the actual chemical warfare agent itself, are used. Simulants are chemical compounds that are similar in chemical composition and physical properties to the actual agents, but considerably less toxic. For this study, the simulants, diisopropylfluorophosphate (DFP) and bis(2-ethylhexyl)phosphate (BEHP), were chosen which simulate the nerve agents Sarin and VX, respectively. The ionic liquid selected for study was 1,2-dimethyl-3-propyl imidazolium bistrifluoromethylsulfonyl amide ($DMPITf_2N$). $DMPITf_2N$ was selected because of its favorable hydrophilic/hydrophobic properties.

The objective of studying decontamination reactions in $DMPITf_2N$ as the ionic liquid is threefold: (1) identify those chemical compounds that are reactive with simulants in $DMPITf_2N$, (2) determine the composition of the reaction products, and (3) develop a reaction matrix that isolates the reactants and products from the environment.

In this report we describe the results of the reactions between DFP and BEHP with tetraalkylammonium hydroxide/methanol in DMPITf2N ionic liquid and the reaction between DFP and ethanolamine in $DMPITf_2N$. The reactions with tetraalkylammonium hydroxide/methanol were extremely rapid and produced both hydrolysis and alcoholysis reaction products. The reaction between DFP and ethanolamine resulted in nucleophillic substitution of the P-F bond with formation of isomeric phosphate esters and phosphoramides. A ^1H NMR Mercury 300 NMR was used to monitor the reaction between ethanolamine and DFP.

A liquid chromatograph coupled to an exact mass time-of-flight mass spectrometer (LC/MS-TOF) was used to identify the reaction products. A polar and aromatic reversed phase selectivity ether-linked phenyl with polar endcapping LC column (Synergi^{tm} Polar-RP^{R}) was used. A mobile phase gradient elution with methanol and 5mM ammonium formate from 30 – 95% over 12 minutes at 0.3 mL/minute flow provided good retention and resolution. Electrospray ionization was used as the ionization source. A discussion of the TOF fragmentation patterns of the reaction products is presented. The data presented here are results of ongoing research.

Chemical Warfare Agents, VX, Sarin

K38 Chemical Warfare Agent Decontamination Reactions in Ionic Liquids (II): Decontamination of Chloroethylethyl Sulfide, Simulant for Sulfur Mustard (HD), in DMPITf2N

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After attending this presentation, attendees will obtain a better understanding of some of the basic research associated with chemical warfare agent decontamination processes. The blister agent, chloroethylsulfide commonly referred to as mustard gas (HD), presents challenges to the scientific community in both its decontamination, if used as an offensive agent, as well as its disposal, as mandated by international agreements. The attendees will gain awareness of the chemistry being developed to convert this toxic material into non-toxic products by carrying out oxidation reactions in ionic liquids.

This presentation will impact the forensic sciences by acquainting first responders, medical examiners, coroners, investigators, and morgue attendants with some of the research efforts currently underway to neutralize facilities/equipment that may be exposed to chemical warfare agents. The impact of this paper is to instill confidence in all personnel that research is being conducted to establish protocols that minimize personal risks of exposure and at the same time will result in a rapid return of exposed equipment to use without fear of prolonged contamination or risk of exposure.

Many techniques currently exist, and more are being developed for the detection of toxins in chemical, biological and nuclear attacks. With the attacks of 9/11 and acts of terrorism abroad, the need has arisen for the scientific community to develop techniques centered upon a reactive posture. The end goal is to anticipate and mitigate the adverse effects of an actual chemical attack through a chemical process designed to be effective and rapid.

In this presentation we describe the results of some of the basic research being conducted in developing a reaction medium that: (a) will identify those chemical reagents that react with mustard gas stimulant (CEES) in an ionic liquid, (b) determine the composition of the reaction products, and finally (c) develop a reaction matrix that contains the reactants and products preventing them from entering the environment, i.e. Green Chemistry compatible. The ionic liquid selected for this study was 1,2-dimethyl-3-propylimidazolium bistrifluoromethylsulfonyl amide (DMPITf2N) because of its excellent hydrophillic and hydrophobic properties.

The copper II catalyzed oxidation of CEES with hydrogen peroxide in the DMPITf2N to the corresponding sulfoxide occurred with ease. Copper (II) bistrifluoromethylsulfonyl amide was selected as catalyst because of its compatability and solubility in DMPITf2N. A Mercury 300 NMR (^1H NMR) spectrometer provided a convenient method of monitoring the decrease in concentration of CEES in the ionic liquid. A liquid chromatograph coupled to an exact mass time-of-flight mass spectrometer (LC/MS-TOF) was used to identify the reaction products. A polar and aromatic reversed phase selectivity ether-linked phenyl with polar endcapping column (Synergi^{tm} Polar-RP^{R}) was used. A mobile phase gradient elution with methanol and 5mM ammonium formate from 30 – 95% over 12 minutes at 0.3 mL/minute flow provided good retention and resolution. Electrospray Ionization was used as the ionization source. A Thermo Electron Corporation PolarisQ ion trap GC/MS system was also used to determine the presence of remaining sulfide and sulfoxide and sulfone formation. A discussion of the TOF fragmentation patterns of the reaction products is presented. The data presented here are results of ongoing research.

Chemical Warfare Agents, Mustard Gas Simulant, Ionic Liquids

K39 Determination of Trace Levels of Benzodiazepine in Urine Using Capillary Electrochromatography – Time-of-Flight Mass Spectrometry

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The goal of this presentation is to present the benefit of using a monolith as a stationary phase in separation science and its hyphenation with a mass spectrometry detection.

This presentation will impact the forensic science community by providing information regarding the detection of trace level of benzodiazepines which are common drugs used as tools in drug facilitated sexual assault (DFSA).

Benzodiazepines are substances with a wide range of therapeutic uses; suitable for the treatment of sleeplessness, anxiety, increased muscle tone or epilepsy.

Mainly because they can produce anterograde amnesia, benzodiazepines are common drugs used as tools in drug facilitated sexual assault (DFSA). These drugs are comprised of a 1,4– diazepine ring with a benzene ring fused to carbons 6 and 7 and typically a phenyl group attached to carbon 5. Following an incident of DFSA, benzodiazepines may be present in very low concentrations. A successful analytical method for the analysis of these compounds may require detection limits below 10 ng/mL. Thus a highly sensitive analytical method is required.

This work details a method for the separation and determination of ten benzodiazepines in urine using capillary electrochromatography–time of flight mass spectrometry (CEC–MS(TOF)) and an hexyl acrylate-based porous monolith. The time of flight mass spectrometer proves to be able to determine exact mass of protonated benzodiazepines to three decimal places. This high selectivity along with the CEC separation, provides an effective method for the identification of benzodiazepines. Linearity is satisfactory for all compounds in the concentration range of 25–500 ng/mL for lorazepam and 12.5–500 ng/mL for the others. The relative standard deviations are between 1.4–2.3% for retention times and 1.1–9.2% for relative areas. Using the monolithic stationary phase, a pre-concentration step is achievable and permits a 75–140 fold improvement in sensitivity. This strategy allows the quantification of these drugs down to 1 ng/mL in urine. This method was used for the analysis of benzodiazepines in spiked urine samples.

Benzodiazepine, Electrochromatography, Mass Spectrometry

K40 Excretion of 11-Hydroxy-Δ^9-Tetrahydrocannabinol (11-OH-THC), and 11-nor-Δ^9-Tetrahydrocannabinol-9-Carboxylic Acid (THCCOOH) in Urine From Chronic Cannabis Users During Monitored Abstinence

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After attending this presentation, scientists will understand the urinary excretion of cannabinoids in chronic cannabis users, a population that is rarely studied due to the difficulty and cost of sequestering individuals for extended periods of time.

This presentation will impact the forensic science community by demonstrating how the urinary 11-OH-THC excretion data conducted with heavy chronic daily cannabis users during monitored abstinence clearly indicate that 11-OH-THC in urine cannot be used to indicate recent cannabis use.

Seven healthy participants (aged 20-35, four males & three females), who self-reported an extended history of daily cannabis use, provided written informed consent for this IRB-approved study. Subjects self-reported chronic daily smoking of between one and five cannabis "blunts" prior to entering the closed research unit. During the study, all subjects were under continuous medical surveillance for up to 29 days at the NIDA Intramural Research Program to prevent self-administration of additional drugs. Each urine specimen (n = 259) was collected individually *ad libidum*. Two mL urine specimens were hydrolyzed by a tandem enzyme (*E. coli* β-glucuronidase)/alkaline method, extracted by SPE (Clean Screen® ZSTHC020 extraction columns, United Chemical Technologies, Bristol, PA), and derivatized with BSTFA for 30 min at 85°C. Trimethylsilyl derivatives of 11-hydroxy-Δ^9-tetrahydrocannabinol (11-OH-THC), and 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (THCCOOH) were resolved and quantified in a 2-dimensional/cryofocusing chromatography system (Agilent 6890 GC/5973MSD) operated in electron impact selected ion monitoring (EI/SIM) mode. Limit of quantification (LOQ) was 2.5 ng/mL for both analytes. Accuracy of the method ranged from 87.6% to 102.1%. Intra- and inter-assay precision, as percent relative standard deviation, were less than 8.6% for both analytes.

Time of last detection (> LOQ) of 11-OH-THC for all subjects in urine ranged from 180 – 716 hours (7.5 to 29.8 days). 11-OH-THC maximum concentrations ranged from 25 – 133 ng/mL (mean 79.7 ± 40.1, median 67 ng/mL). Maximum concentrations of THCCOOH ranged from 117 – 766 ng/mL (mean 455.3 ± 208.3, median 482 ng/mL). All participants also had THCCOOH positive urine specimens at the LOQ on the last day of residence between 7.5 to 29.8 days. It also is important to evaluate urinary THCCOOH concentrations at the 15 ng/mL federally mandated cut off utilized by most laboratories. Employing the 15 ng/mL cutoff, THCCOOH urine specimens also were positive throughout residence on the research unit for 7.5 to 29 days.

These data indicate that following chronic cannabis smoking, 11-OH-THC can be measured in urine for up to 29 days, negating its value as a urinary biomarker of recent cannabis use.

Cannabinoids, Urine, GC/MS

K41 Gamma-Hydroxybutyrate (GHB) in Saliva: A GC/MS Method Applicable to Toxicological and Physical Evidence

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The goal of this presentation is to introduce attendees to the potential use of saliva as an alternative biological matrix and as a tool in GHB screening analysis and to establish GC/MS as a sensitive analytical technique for the detection of GHB in saliva.

This presentation will impact the forensic science community by describing a proposed method for the rapid, selective and accurate toxicological screening of saliva analysis for forensic purposes. The use of a surrogate standard provides a quantitative measure of extraction and preparation efficiency that is matrix specific. The method described here could be applied to swabs, neat saliva, and possibly physical evidence such as saliva on drink glasses. Current research is focused on the latter application.

GHB and related compounds have been known for years because of their illicit use in drug facilitated sexual assault (DFSA) and to a lesser extent, as party drugs. This problem is exacerbated by GHB's rapid clearance rate and short half life of ~30 min. For this reason, it would be useful to develop a rapid screening analysis from a biological matrix that predictably tracks plasma drug concentrations. Oral fluids, which can be collected non-invasively, are an attractive option. Unfortunately, saliva drug concentrations are generally significantly lower than those in urine, which creates challenges for method development.

A sensitive and specific gas chromatography-mass spectrometer (GC-MS) method has been developed using selective ion monitoring (SIM) for the identification and quantification of gamma-hydroxybutyric acid (GHB) in saliva. In this approach, 1.0 µl of synthetic saliva was spiked with 1.0 µl of GHB-d6 as the internal standard. As an added quality assurance method, 1.0 µl of 1,7-heptanediol is added to all samples as a surrogate spike. The purpose of the surrogate is to track the efficiency of extraction and preparation procedures.

After a silyl-derivatization the sample was injected at a split ratio of 10:1. The following ions were monitoring: GHB 233, 234; GHB-d6: 239, 240, 241; 1,7-heptanediol: 55, 73, 97. No interferent peaks were observed. The LOQ was determined to be 0.5 ppm with a linear dynamic range of 0.5 ppm to 50 ppm. Quality-control samples (5 ppm, 20 ppm, 30 ppm) were prepared for evaluation of analytical precision. Variation was found to be from 1.07 to 9.44% in both intra-day and day-to -day experiments respectively. Surrogate recovery from saliva samples fell in the range of 94.6 to 100% with an average of 98.37% and a corresponding % RSD of 1.2%. Data obtained from validation were compared with results from sample prepared drying saliva before the derivatization process. Blank samples from lab staff were analyzed to estimate endogenous GHB in saliva. Values in the range of 2-3 ppm were typical. These results will be presented.

The success of this method suggests a novel extension to physical evidence. Victims of sexual assault may leave biological evidence such as saliva on surfaces like the exterior of glasses, tissues, and cigarettes. If the saliva was deposited after the illicit drugging occurred, the deposited saliva may provide valuable investigative information and evidence of a drug-facilitated assault. With drugs such as GHB that have rapid clearance rates, the capability to detect elevated GHB in deposited saliva samples could be significant.

In the present work, we utilized the GC/MS method for a screening test for GHB in saliva on objects such as cigarettes, bottles, cups, plastic glasses. Blank saliva was spiked with GHB at different concentrations. 5 µl of those samples were then spread out on the surfaces. At time intervals, saliva samples were extracted from the objects with a swab saturated with methanol. After a centrifugation, the supernatant was dried and reconstituted in 500uL of methanol, of which 1 uL was injected into the instrument. This methodology precludes quantitation, but does afford reliable qualitative results at low concentrations.

Gamma-Hydroxybutyric acid (GHB), GC-MS, Saliva

K42 Methamphetamine Involved MVA Fatalities in Phoenix: A Seven Year Postmortem Study

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After attending this presentation, attendees will learn about the fatality statistics associated with motor vehicle accidents (MVAs) involving operators driving under the influence of methamphetamine in the Phoenix Metropolitan area for the past seven years.

This presentation will impact the forensic community and/or humanity by increasing awareness not only in Arizona but throughout the United States concerning the growing problem of driving under the influence of drugs, in particular methamphetamine.

The Maricopa County Office of the Medical Examiner (OME) provides medicolegal investigations into all deaths in a population of 3.7 million to determine the cause and manner of death. In this study, the 31,274 cases admitted to the office between 2000 and 2006 were examined, and of those cases, 2,449 were ruled MVAs. Of those 2,449 MVAs, 168 of them tested positive for methamphetamine. It was reported by OME Investigators and various law enforcement agencies that the driving behavior of these individuals included speeding (16), running a red light (14), collisions caused by either crossing the center line of traffic (31) or rear-ending another vehicle (10) or other various means (32), single vehicle accidents caused by leaving the roadway (21) and roll-overs (27), as well as other erratic driving behavior (17).

In each case, a blood sample was screened using ELISA for the presence of methamphetamine with a 0.05 mg/L cutoff value. Each sample that screened positive was then extracted by liquid-liquid extraction using d10-amphetamine and d11-methamphetamine as internal standards followed by pentafluoropropionic anhydride derivatization. This extract was then analyzed quantitatively using selected ion monitoring (SIM) mode with gas chromatography/mass selective detection (GC/MSD) using electron impact ionization with a limit of detection of 0.01 mg/L and a limit of quantification of 0.025 mg/L. The methamphetamine results for the 168 methamphetamine involved MVAs ranged from 0.025 mg/L to 11.34 mg/L, with an average of 1.05 mg/L and a median of 0.53 mg/L. Of these cases, 117 of them (70%) were above the suggested therapeutic value of 0.20 mg/L with 19 of those (11%) above 2.5 mg/L. The amphetamine results ranged from 0.025 mg/L to 1.16 mg/L, with an average of 0.11 mg/L and a median of 0.08 mg/L.

When this data is broken down by year, it shows a trend of increasing numbers of methamphetamine involved MVAs each year from 2000-2004, with a plateau since 2004 despite yearly increases in county population, OME admitted cases, and total MVA cases. Because methamphetamine is currently the most frequently encountered clandestinely produced drug in the United States, various federal and state laws have recently been passed that place restrictions on the sale of methamphetamine precursors, and that increase the consequences faced by methamphetamine offenders. In the state of Arizona, there have been various government and private sponsored programs to combat the growing problem of illicit methamphetamine use. There is some hope that these laws and organizations will help to curb the methamphetamine use in Maricopa County; ultimately decreasing the number of methamphetamine involved MVA fatalities the office receives each year.

Data concerning 2007 methamphetamine involved MVAs is currently being collected and will be added to the current data, and presented along with the seven years represented so far.

Methamphetamine, MVA, Fatalities

K43 "Less Than Perfect" DUI Drug Cases: Do You Think They Were Impaired?

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After attending this presentation, attendees will be given the opportunity to discuss the pros and cons of using only limited information to establish suspected Driving Under the Influence of Drugs (DUID).

This presentation will impact the forensic science community by assisting toxicologists who support Drug Recognition Expert (DRE) programs as well as those who regularly testify on Driving Under the Influence of Drugs cases for both the prosecution and defence.

Developing forensic opinions on persons suspected of drug-impaired driving is regularly performed by forensic toxicologists who testify in court. Accomplishing this based solely on records review can be difficult under the best circumstances. The widely used "triad of results" involves: 1) consideration of the nature of any accident and events which led up to it, including observed driving behaviors, 2) field sobriety tests (FST's) and/or drug recognition examinations (DRE's) by law enforcement, and 3) qualitative and quantitative toxicology findings, preferably from a blood sample. But can a valid opinion on impairment be developed with less-than-perfect information? You be the judge!

Part One: The "Hit-and-Run Nanny": The defendant in the first case, a resident alien who had worked for several years as a nanny, was driving to work when she drifted off the road, over a curb and struck and

killed two young children out for a walk with their mother. Afterwards, the suspect fled on foot and was apprehended after two days. Blood collected at the time of her arrest tested negative for drugs and alcohol.

The information available for case review included accounts of the suspect's criminal background, personal history, behavior on the accident day, her witnessed driving pattern prior to the accident and behaviors immediately afterwards, and lastly, the defendant's admissions about her drug consumption before the accident. When the accident occurred, she was driving on a suspended license and had four previous DUI alcohol convictions. She had had marital problems with a recent separation from her husband due to heavy drinking. She had prescriptions for Vicodin® (hydrocodone) and Flexeril® (cyclobenzaprine). She had apparently taken 110 Vicodin pills in the prior 22 days and had prescriptions from several physicians. Neighbors reported seeing her drinking alcohol earlier that afternoon.

Observed driving patterns and behaviors included weaving, jackrabbit starts and stops, sleepy and confused appearance, and driving with her hair covering her face. She admitted ingesting four or more pills of each medication that day. What is your opinion? Was her driving was impaired by drugs and perhaps alcohol when the accident occurred?

Part Two: Can a Positive Urine THC Metabolite (THC-COOH) Be Used to Prove Impairment in a Driving Under the Influence (DUID) - Cannabis Case?: A suspect was stopped for speeding at midnight on Colorado Interstate 70, a section of the interstate with a steep 6% grade. According to the arresting officer the subject "displayed indicators of being under the influence of alcohol or drugs or both". Officer observations included "speech was slow and thick tongued and that he had a brown-green coating on his tongue". The subject admitted taking a Vicodin® pill earlier that day. His hand was in a cast. He agreed to perform standardized field sobriety tests (SFST's) and according to the officer, he failed them. A search of the subject's vehicle revealed an open 24-pack of beer, an open can in the console, and a glass pipe. The subject was arrested at 0020 hours and agreed to take a breath alcohol test (which was <0.05%) and a urine sample was also collected.

The urine screened positive for cannabinoids and confirmed for delta-9-THC-COOH (84 ng/ml). The sample also screened positive for opiates and confirmed for hydrocodone. The subject apparently had spent the day with friends, and reportedly consumed a minimal amount of beer and no other drugs within six hours of being arrested. He reported recent dental surgery and was taking Vicodin received from his dentist for pain.

The officer who conducted the SFST's was not a certified Drug Recognition Expert (DRE). Based upon the low breath alcohol concentration, there was no charge of driving while intoxicated with alcohol.

You decide. Do the positive drug and drug metabolite findings in the subjects urine substantiate, along with his failure to pass the SFST's, that he was impaired by drugs to such a degree at the time of driving that he should be charged with DUID? If so, what was the contribution of cannabinoids? Of hydrocodone? Of alcohol?

Drugs and Driving, Forensic Toxicology, Impairment

K44 Driving Under the Influence of Cannabis: Are Science-Based Concentration Limits for Tetrahydrocannabinol (THC) in Blood Practical to Enforce?

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After attending this presentation, attendees will acquire up-to-date information about various forensic aspects of driving under the influence of cannabis.

This presentation will impact the forensic science community by providing information on the effectiveness of zero tolerance legislation as a practical and pragmatic way to simplify the prosecution of offenders.

Those attending this presentation will acquire up-to-date information about various forensic aspects of driving under the influence of cannabis. The age and gender of offenders are reported in relation to the concentrations of tetrahydrocannabinol (THC) in blood of motorists apprehended over a 10-year period. Results are compared from before and after a zero-tolerance law for driving under the influence of drugs (DUID) was introduced in Sweden. The forensic community in North America will learn about the effectiveness of zero tolerance legislation as a practical and pragmatic way to simplify the prosecution of offenders.

Although cannabis and its various preparations are considered illicit drugs in most countries, these psychoactive substances are widely used for recreational purposes and as such represent a problem for traffic safety. Some countries have a fairly liberal attitude towards possession of cannabis for personal use, whereas in other nations, this constitutes a criminal offence. Accordingly, there is much ambivalence about the danger of cannabis use and abuse in society and re-classification as a scheduled substance is sometimes considered. Indeed, there is increasing discussion and debate among scientists and politicians about the pros and cons of cannabis as a recreational drug and the legal prescribing of cannabinoids for treatment of certain medical conditions.

The pharmacologically active constituent of cannabis, hashish and marijuana is Δ^9-tetrahydrocannabinol (THC), which displays a complex pharmacokinetic profile owing to its high lipid solubility, protein binding and large distribution volume. The forensic evidence necessary to verify that a person has taken cannabis comes from finding THC or its main metabolites (6-hydroxy-THC and carboxy-THC) in blood, urine or other body fluids. Knowledge about the concentration of THC in blood is necessary to permit drawing conclusion about the effects on a person's performance and behavior and the likelihood of drug-related impairment and the risk of a traffic crash. In our laboratory THC is determined in blood samples by gas chromatography-mass spectrometry with deuterium labeled internal standards (d_3-THC). The limit of quantitation (LOQ) of this method in routine use is 0.0003 mg/L (0.3 ng/mL).

Enforcement of laws pertaining to driving under the influence of drugs (DUID) other than alcohol are either structured around measuring drug-related effects on the individual concerned or some threshold concentration in blood is set by statute, above which a person is liable to prosecution. The creation of zero-.tolerance laws is increasingly favored in European nations for illicit drugs so that any measurable amount in a specimen of blood constitutes an offence of impaired driving. The presence of such a drug or its metabolites in urine but not in blood does not motivate charging a person with DUID in European nations.

Considerable interest exists in trying to establish so-called "science based" concentration limits for driving under the influence of cannabis. The scientific background for this stems from measurement of cognitive and psychomotor impairment after smoking marijuana, clinical correlates of THC concentrations in blood, epidemiological surveys of cannabis-related traffic crashes and also a limited number of on-the-road driving performance tests. Roadside surveys of the risk of a crash as a function of the blood alcohol concentration exist (e.g., the Grand Rapids study) but equivalent studies for cannabis are lacking. The threshold concentration limit of THC in blood under such a *per se* statute has not yet decided but this will most likely be set fairly high at 0.002-0.003 mg/L (2-3 ng/mL) or even higher.

Over a 10-year period between 18% and 30% of all DUID suspects apprehended in Sweden had measurable amounts of THC in their blood (> 0.0003 mg/L) either alone or together with other drugs. The mean age (± SD) of cannabis users was 32.6 ± 9.4 y (range 15-66 y) with a strong predominance of men (94%). The frequency distribution of the concentrations of THC in blood (N = 8,803) was markedly skewed to the right with mean, median and highest values of 0.0021 mg/L, 0.0010 mg/L and 0.067 mg/L, respectively. The concentrations of THC were less than 0.001 mg/L in 42% of cases and below 0.002 mg/L in 60% of cases. No statistically significant correlation existed between the concentration of THC in blood and the person's age (r = -0.027). THC concentrations in blood were higher when this was the only psychoactive substances present (N = 1,281); mean 0.0036 mg/L, median 0.002 mg/L and 26% were below 0.001 mg/L and 40%

were now less than 0.002 mg/L. The concentrations of THC in blood were similar in a population of users of illicit drugs (non-traffic cases). Based on studies from Sweden it can be shown that at least 40% of drivers abusing cannabis would evade prosecution if the THC limit in blood was set at 0.002 mg/L (2 ng/mL).

The complex kinetics of THC means that the concentrations in blood at the time of driving are likely to be considerably greater than at the time of sampling blood, which occurs about 30-90 min afterwards, owing to movement of the active substance (THC) from the central blood into peripheral tissues and lipid compartments. The notion of establishing a science-based concentration limit for THC in blood (e.g., 0.002-0.003 mg/L) or higher, as being discussed by some investigators, would mean that many individuals who had smoked marijuana before driving would evade prosecution. Zero-tolerance or LOQ laws are a much more pragmatic way to enforce DUID legislation.

Cannabis, Drugs, Driving

K45 Instances of Marijuana, Driving, Blood Concentrations, Field Sobriety Tests, and Prediction Models

Joseph J. Saady, PhD,and Terri H. Woods, BS, Virginia Department of Forensic Science, 700 North 5th Street, Richmond, VA 23219*

After attending this presentation, attendees will understand some of the difficulties in the correlation of driving related behaviors and blood concentrations of marijuana.

This presentation will impact the forensic community by analyzing various aspects of marijuana and driving, to include the blood concentration, Field Sobriety Test results, the analytical analysis and the timing and manner of the last smoke.

One of the very difficult court testimonies for a forensic toxicologist pertains to marijuana, which is the most frequently encountered drug in the Virginia DUID program, with the exception of ethanol. Some of the issues for consideration in the interpretation of results involve the time of last smoke, the rapid elimination of tetrahydrocannabinol (THC) from the blood, the blood collection time following the incident, the analytical testing and the duration of storage of the blood sample, and physiological effects as close to the time of a suspected driving incident as possible.

The authors will review Virginia DUID cases where there was some reasonable suspicion that smoking occurred close to or at the time of the police stop, as noted by law enforcement personnel. The collection of the blood specimen occurred from one to four hours after the stop. The laboratory typically receives the blood specimen by mail within one week of collection, and stores it refrigerated until analysis. Samples are analyzed by a modified Kemp et.al. method, usually within six weeks of receipt. Briefly, two mL of blood is mixed with THC-d3 and THCA-d3 internal standards, vortexed while adding cold acetonitrile and refrigerated until the phases separate. Acetonitrile is back extracted with 0.2 N NaOH into hexane:ethyl acetate (9:1), evaporated under nitrogen and derivatized with trifluoroacetic acid anhydride., heated, evaporated and reconstituted with heptane, transferred to an autosampler vial for gas chromatography mass spectrometry (GC/MS) for THC selected ion monitoring (SIM) quantitation. The saved NaOH fraction is acidified with 1 N HCl, extracted with hexane:ethyl acetate (9:1), evaporated under nitrogen and derivatized with BSTFA with 1% TMCS, transferred to an autosampler vial for gas chromatography mass spectrometry (GC/MS) for tetrahydrocannabinol carboxylic acid (THCA) selected ion monitoring (SIM) quantitation.

Field sobriety tests (FST) generally consisted of recitation of some portion of the alphabet or counting, Horizontal Gaze Nystagmus (HGN), Walk and Turn and One Leg Stand. Most cases showed a number of errors at nearly all concentrations.

Based on statements by law enforcement, predictive modeling (Huestis Model II) produced reasonable estimates of the smoking time using the average, in most of the cases. In some instances the trooper saw the disposal of the cigarette, or could see smoke in the vehicle. In other instances, statements by the suspect led to the conclusion that smoking occurred recently (e.g., "I smoked marijuana at a friends house 15 or 20 minutes ago").

In conclusion, blood THC concentrations ranged from 1 to 27.5 ng/mL, while (THCA) ranged from 2 to 343.5 ng/mL. There was a relatively poor correlation between THC concentrations and FST errors. However, there was a good correlation between errors on the FST and the presence of THC in the blood. Using information provided by law enforcement concerning the time of last smoking, Model II produced reasonable estimates.

Marijuana, DUID, Concentrations

K46 Plasma Cannabinoid Concentrations in Daily Cannabis Users During Seven Days of Monitored Abstinence

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After attending this presentation, attendees will learn that Δ^9-tetrahydrocannabinol (THC) plasma concentrations can exceed 0.25 ng/mL for more than seven days during monitored cannabis abstinence in daily cannabis users.

This presentation will impact the forensic community by influencing interpretation of plasma THC concentrations from daily cannabis users.

In the presence of corroborating evidence, detection of THC in whole blood at ≥ 2 ng/mL is commonly considered consistent with recent cannabis use in driving under the influence of drugs (DUID) cases and other forensic investigations. This laboratory has previously reported detectable THC in plasma (≥ 0.5 ng/mL) 3 to 27 hr after smoking a single 1.75 or 3.55% THC cigarette, while the inactive metabolite, 11-nor-Δ^9-tetrahydrocannabinol-9-carboxylic acid (THCCOOH) was detected at 0.5 ng/mL for 48 to > 168 hr. Few data are available on analyte detection in plasma of daily cannabis users during periods of monitored abstinence.

Twenty-eight, self-reported daily cannabis users (ages 19-36, 46.4% male, 85.7% African American) provided written informed consent for this IRB-approved study, where they resided in a closed clinical research unit for 7 days. Plasma specimens were collected upon admission and once every 24 hr thereafter. Cannabinoids were extracted by solid phase extraction (SPE) using ZSTHC020 columns (United Chemical Technologies, Inc., Bristol, PA) and derivatized with *N*,*O*-bis-(trimethylsilyl)trifluoroacetamide + 1% trimethyl-chlorosilane (BSTFA + 1% TMCS). Derivatized extracts were injected into an Agilent 6890 gas chromatograph (GC)/5973 mass selective detector (MSD) system operated in electron impact (EI)/selected ion monitoring (SIM) mode. A two dimensional GC method with cryofocusing was developed and validated for the quantification of THC, 11-OH-THC, and THCCOOH. Split calibration curves (low, 0.125 – 25 and high, 25 – 100 ng/mL) were constructed with $r^2 > 0.99$. Limits of quantification (LOQ) were 0.25 ng/mL for all analytes.

After more than 16 hr of monitored abstinence, 92.6% of participant plasma specimens (N = 27) were positive for THC (≥ 0.25 ng/mL). On Days 3, 4, 5, 6, and 7, 84.6 (N = 26), 79.2 (N = 24), 70.8 (N = 24), 66.7 (N = 24), and 76.0% (N = 25) of participant plasma specimens contained detectable THC, respectively. Not all participants had adequate specimen volume on all days.

Of the 19 participants' plasma specimens testing positive for THC on day 7 (≥ 0.25 ng/mL), 9 tested positive with an LOQ of 1 ng/mL, while 4 were positive using a 2 ng/mL LOQ.

Sixteen participants' plasma specimens had detectable THC on days 2, 4, and 7; median concentrations were 1.6 (range 0.8 - 7.3), 1.4 (range 0.5 - 7.5), and 1.2 (range 0.3 - 5.5) ng/mL, respectively. Fewer specimens were positive for 11-OH-THC; median concentrations were 2.4 (N = 3, range 2.1 – 3.3), 1.2 (N = 2, range 0.73 – 1.75) ng/mL, and not detected (N = 16) on

days 2, 4, and 7, respectively. Median THCCOOH concentrations in these 16 participants' specimens were 25.9 (range 7.2 – 189.4), 19.4 (range 4.3 – 88.3), and 11.5 (range 2.8 – 45.6) ng/mL, on days 2, 4 and 7, respectively.

Interpretation of plasma and whole blood cannabinoid concentrations is important in DUID and other forensic cases. For the first time, we present evidence of the presence of THC in plasma for multiple days during monitored abstinence, suggesting that its detection in plasma may not indicate recent use in individuals consuming cannabis on a daily basis. Bioaccumulation of THC in deep tissue compartments and gradual release from tissue stores into the bloodstream during cannabis abstinence may explain this prolonged seven day THC detection window.

THC, Plasma, Cannabis

K47 The Z Drugs: An Update for Forensic Toxicologists in Light of DUID Cases

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After attending this presentation participants will have a greater understanding of the Z drugs, how they produce the effects commonly seen in DUID cases and metabolism and excretion profiles that affect the forensic toxicologist abilities to detect the drug or metabolites. In addition, recent pharmacological research will be summarized concerning such issues as sleep driving and other aberrant behavior.

This presentation will influence the forensic science community who support suspected DUID and drug facilitated sexual assault cases by enhancing their understanding of the drug mechanisms and current challenges to interpretive issues.

The "Z-drugs" are non-benzodiazepine sedative hypnotic available in standard release and extended release formulations. Zolpidem (Ambien) has consistently finished in the "Top 20" of the 200 most prescribed medications over the last seven years. Zolpidem is commonly prescribed for treatment of insomnia. Lunesta (Eszopiclone) has been approved by the U.S. Food and Drug Administration for long term treatment of insomnia since 2004. Eszopiclone is a nonbenzodiazepine hypnotic that is a pyrrolopyrazine derivative and is a steroisomer of zopiclone (Imovane, Noctitrex, Ximovane, Zimovane), which is not currently available in the U.S. Zaleplon (Sonata) is also a nonbenzodiazepine hypnotic from the pyrazolopyrimidine class. Zaleplon interacts with the GABA receptor complex and shares some of the pharmacological properties of the benzodiazepines. Although not a benzodiazepine, zaleplon can cause similar effects: anterograde amnesia (forgetting the period during the effects) as the most common side effect.

Multiple cases will be presented highlighting some of the analytical and interpretation challenges presented by the "Z-drugs". Zolpidem blood concentrations in a few selected cases ranged from 190 to greater than 4,000 ng/mL. Clearly some of these drivers' blood concentrations dramatically exceed those expected from single oral dosing for night time hypnotic effect. A typical case of Zolpidem impaired driving is presented: A law enforcement officer observed a subject crash into the rear of a parked car. The officer also noted "bizarre driving" with the subject driving in reverse for one block, then stopping in the line of traffic for one minute (one vehicle had to swerve to avoid crash). The officer pulled up behind & activated emergency lights; however the subject didn't notice the officer and started driving forward. Eventually the subject stopped. The subject was wearing a fur lined winter cap over a baseball cap and sunglasses over the top of prescription eyeglasses even though it was night time at the time of the incident. The subject exhibited delayed responses to the officer's questions, slow slurred speech and seemed confused. The subject was unsteady and needed to brace on the car to attempt Standardize Field Sobriety Tests (SFST). The subject exhibited multiple clues on all 4 SFSTs. The subject was arrested and taken in for a blood sample. Throughout the examination the subject was unable to recall any of the recent incidents. The subject stated: "I'm confused, lost and out of it". Toxicological analysis of the blood revealed zolpidem at 500 ng/mL and less than 50 ng/mL of citalopram.

As this case report demonstrates, "Z-drugs" have the potential to significantly impair the driving abilities of an individual. Dissemination of toxicological findings for cases such as these will assist forensic toxicologists in their own case interpretations.

DUID, Zolpidem, Zaleplon and Zopiclone

K48 Medical Devices and Their Impact on Death Investigations

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After attending these presentations participants will understand how medical devices such as blood glucose monitors, insulin pumps, patient controlled analgesia, intrathecal pumps, and defibrillators can impact death investigation by providing information about the events surrounding a death.

The presentation will impact the forensic community by providing information about medical devices, their evaluation, and assignment of cause and manner of death.

Introduction: There are a variety of medical conditions in which medical devices including blood glucose monitors, insulin pumps, patient controlled analgesia, intrathecal pumps, and defibrillators are employed and these devices are encountered with increasing frequency in forensic death investigations. Questions concerning the proper operation and potential tampering of these devices as well as historical information contained in them is of concern to a variety of forensic professionals.

Topics Covered: This special session will cover regulatory, pathological, toxicological, and safety issues related to medical devices.

A historical overview of these devices, their in vitro diagnostic evaluation and safety by the Food and Drug Administrations Center for Devices and Radiological Health (CDRH) as well as basic information on device regulation will be discussed. More than 20,000 companies worldwide produce over 80,000 brands and models of medical devices for the U.S. market. These devices rang from contact lenses and blood sugar monitors to implanted hip joints and heart valves. The CDRH makes sure that new medical devices are safe and effective before they are marketed. The center is also responsible for monitoring these devices throughout the product life cycle, collecting, analyzing, and acting on information about injuries and other experiences in the use of medical devices and radiation-emitting electronic products, setting and enforcing good manufacturing practice regulations and performance standards for medical devices, monitoring compliance and surveillance programs for medical devices.

A synopsis of techniques that might be used during autopsy when encountering an in vitro device as well as case studies in which the interaction of pathology and these devices played a role in the death will be included. Special procedures used during and following an autopsy can help with a diagnosis of device performance. These procedures can help when deciding on a cause and manner of death.

Toxicological case studies focused mainly on chronic pain treatment involving fentanyl patches and continuous analgesia infusion devices will be discussed. Aggressive treatment of chronic pain in recent years has lead to an increase in the frequency of cases in which analgesic devices such as fentanyl patches and intrathecal pumps are encountered by forensic professionals. Investigations into the performance of these devices are often requested and the toxicology laboratory is faced with the task of testing the

devices and interpreting the results. The case studies will be used to illustrate salient points such as proper storage of the devices, sampling and caution in interpretation.

Finally the session will conclude with a discussion of medical devices related specifically to the treatment of diabetes mellitus and case studies in which these devices played a role in deciding the cause and manner of death. In postmortem death investigation of deaths involving diabetes mellitus, having a record of recent blood glucose measurements can help in determining the level of control the decedent had prior to death and whether or not there were recent difficulties such as abnormally low or high blood glucoses. Diabetic deaths to nonketotic hyperosmolar coma and diabetic ketoacidosis can be diagnosed by high vitreous glucose, disturbances in vitreous electrolytes and the presence of acetone. However, deaths due to insulin overdose are usually a diagnosis of exclusion as methods for measuring postmortem insulin concentrations are not readily available or even reliable. Both traditional blood glucose devices and the new continuous blood glucose monitors can be accessed to provide historical information to aid in this diagnosis. Many insulin pumps also keep a continuous record documenting 7-14 days worth of blood glucose levels, insulin boluses (insulin given in response to a meal, snack or correction of high blood glucose), and total insulin use per day. Instruction on how to access the data these devices contain will be provided.

Medical Devices, Safety, Evaluation

K49 Methadone Disposition in Human Breastmilk and Plasma in the Immediate Perinatal Period

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After attending this presentation, attendees will learn about the methadone content in human breastmilk in the immediate postnatal period, its relationship to maternal methadone dose and maternal and infant plasma concentrations, and the variability in breastmilk methadone concentrations in fore- and hindmilk.

This presentation will impact the forensic science community by demonstrating how the findings that maternal methadone dose was unrelated to plasma and breast milk methadone concentrations and that infant methadone exposure from breastmilk was low, support the recommendation that methadone-maintained women be permitted to breastfeed their infants if appropriate and desired.

Methadone maintenance is the only recognized pharmacologic treatment for opiate dependency during pregnancy in the U.S. It is well established that breastfeeding is the optimal way to nourish an infant. Breastmilk confers known advantages to mother and infant and could be beneficial for methadone-exposed infants at risk for morbidity in the perinatal period. However, lactation among methadone-maintained women is frequently challenged due to lack of knowledge about this practice. 2,257 women enrolled in a comprehensive substance abuse treatment program for pregnant and post-partum drug dependent women were screened for participation. Any woman considered intoxicated or having a positive urine test was excluded from further participation. Eight methadone-maintained (dose range 50–105 mg/day), lactating women provided blood and breastmilk specimens on days 1, 2, 3, 4, 14, and 30 after delivery at the times of trough (just before methadone dose) and peak (3 hours after dosing) maternal methadone levels. Paired specimens of foremilk and hindmilk were obtained at each sampling time. Eight matched formula-feeding subjects had blood drawn the same days. Infant blood for both groups was obtained on day 14 concurrent with a heelstick for routine pediatric care. All infants underwent neurobehavioral testing using the NICU Network Neurobehavioral Scale on days 3, 14, and 30.

Breast milk was collected in polypropylene storage vials and stored at -20°C until time of analysis. Specimens were analyzed using a validated liquid chromatography atmospheric pressure chemical ionization tandem mass spectrometry method. Breastmilk, 0.5 mL was analyzed following protein precipitation and solid phase extraction. The limit of quantification (LOQ) was 10 ng/mL with a linear dynamic range of 10 – 500 ng/mL. Extraction efficiency was greater than 97% with inter- and intra-day imprecision < 20%. Blood was collected in heparinized tubes, centrifuged, and plasma separated and stored at -20°C until time of analysis. Plasma specimens were analyzed by gas chromatography mass spectrometry following solid phase extraction. LOQ for methadone was 5.0 ng/mL and range of linearity was 5 – 2000 ng/mL. Intra- and inter-day imprecision was <20%.

Repeated measures linear regression was used to determine whether there was a significant change over time days 1 through 30 in breastmilk methadone concentrations for each sampling time (trough prefeed, trough postfeed, peak prefeed, peak postfeed) and whether there was an effect of breastfeeding (yes/no), time (day 3, 14, 30) or breastfeeding by time interaction for neurobehavioral outcomes. Statistical significance was set at $P < 0.05$ for all analyses.

Methadone doses among subjects and controls varied little in the postpartum period and were (median (range): 70 mg (50 – 105 mg) at delivery, and days 14 and 30. Concentrations of methadone in breastmilk were low (range 21.0–462.0 ng/mL) and not related to maternal dose. There was a significant increase in methadone concentrations in breastmilk over time, and concentrations increased from pre- to postfeed in all cases aside from the first collection (colostrum). There were no significant effects of breastfeeding on neurobehavioral outcomes. Fewer infants in the breastfed group required pharmacotherapy for neonatal abstinence syndrome, but this was not a statistically significant finding. Infant plasma methadone concentrations obtained on day 14 of life were low, uniformly detected among all samples, and were unrelated to maternal methadone dose, maternal plasma methadone concentrations, and breastfeeding. Further, infant plasma methadone concentration was not related to the infant's need for pharmacotherapy for NAS or NAS scores. This research demonstrated that concentrations of methadone in breastmilk, even at peak maternal plasma methadone levels, are low in the perinatal period.

Methadone; Plasma, Breast Milk

K50 Disposition of Buprenorphine and Norbuprenorphine in Human Meconium

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This presentation will provide attendees with the first data on concentrations, ratios and extent of glucuronidation of buprenorphine and norbuprenorphine in meconium following controlled buprenorphine administration to a cohort of pregnant women.

This presentation will impact the forensic community by providing the first data on buprenorphine and norbuprenorphine excretion in meconium following controlled drug administration to a cohort of pregnant women. These data provide valuable information on buprenorphine and norbuprenorphine concentrations and the extent to which these analytes may be conjugated in meconium. Additionally, these data allow for correlations to be examined between maternal dose and meconium concentrations and between meconium concentrations and neonatal outcomes, providing critical information for clinicians.

Buprenorphine is currently being investigated in the United States as a pharmacotherapy for treating opioid dependence in pregnant women. The disposition of buprenorphine and norbuprenorphine was evaluated in meconium from infants born to nine women participating in a study approved by the Johns Hopkins Bayview Medical Center and National Institute on Drug Abuse Institutional Review Boards comparing methadone and buprenorphine for the treatment of opioid dependence during gestation.

Women were treated with 14-24 mg/day buprenorphine for the last 12-22 weeks of pregnancy. Meconium specimens (N=10, one set of twins) were analyzed using the first validated liquid chromatography-tandem mass spectrometry with atmospheric pressure chemical ionization method. Two aliquots (0.25 ± 0.1 g) of each specimen were analyzed, one with and one without enzyme hydrolysis. Hydrolysis efficiency was evaluated in each analytical run using hydrolysis controls that quantified within 7.2% of target. Analyte recovery from meconium was at least 77% with buffer extraction followed by solid phase extraction. The assay was linear from the method's limit of quantification of 20 ng/g to 2000 ng/g for buprenorphine and norbuprenorphine. Accuracy was >86% and precision >84% with no interference from 69 tested licit and illicit drugs and metabolites.

Total buprenorphine concentrations ranged from 24-297 ng/g with a mean (±SE) of 131 ± 27 ng/g and a median concentration of 110 ng/g. Free buprenorphine ranged from 24-240 ng/g (mean = 93 ± 23; median = 60 ng/g). One specimen, which contained 24 ng/g total buprenorphine, had free buprenorphine concentrations below the method's limit of quantification. The percent free buprenorphine was 35-82%, with an average of 64 ± 6%, indicating inter-subject variation in glucuronide conjugation. Matched-pair t-test of total and free analysis indicated a statistically significant higher concentration of total buprenorphine than free (mean difference = 49 ± 10 ng/g, n=9 pairs, t=4.788, 8df, p=0.001). Specimens contained higher concentrations of total and free norbuprenorphine, 324-1880 (mean = 754 ± 136 ng/g; median = 660 ng/g) and 331-1229 ng/g (mean = 610 ± 88 ng/g; median = 501 ng/g), respectively. Four specimens had >99% free norbuprenorphine. Three of these actually had lower total than free drug concentrations, but results were within ± 20%, the imprecision of the analysis. Another possibility could be the difficulty in completely homogenizing meconium. The remaining specimens (N=6) ranged from 53-89% free norbuprenorphine (mean 71 ± 6%). There was no statistically significant difference between the concentration of total norbuprenorphine and the concentration of free drug (mean difference = 143 ± 78 ng/g, t=1.840, 9df, p=0.099).

The free buprenorphine to free norbuprenorphine ratio was 0.14 ± 0.02 ng/g (range: 0.07-0.20 ng/g; median = 0.14) and the total buprenorphine to total norbuprenorphine ratio was 0.18 ± 0.03 ng/g (range: 0.05-0.33 ng/g; median = 0.16.). There is no statistically significant difference between these two ratios (p=0.37).

These findings impact the forensic community by providing the first data on buprenorphine and norbuprenorphine excretion in meconium following controlled drug administration to a cohort of pregnant women. These data provide valuable information on buprenorphine and norbuprenorphine concentrations and the extent to which these analytes may be conjugated in meconium. Additionally, these data allow for correlations to be examined between maternal dose and meconium concentrations and between meconium concentrations and neonatal outcomes, providing critical information for clinicians.

Buprenorphine, Meconium, Pregnancy

K51 Disposition of Nicotine and Metabolites in Human Meconium Following In Utero Tobacco Exposure

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After attending this presentation, attendees will learn the disposition of nicotine, cotinine, 3'-trans-hydroxycotinine, nornicotine and norcotinine in human meconium after in utero tobacco exposure, including relative analyte concentrations, metabolite ratios, and degree of glucuronidation.

This presentation will impact the forensic community, as this is the first quantification of nicotine and metabolites in meconium, the first data on the percentages of total and free nicotine and metabolites in meconium and the first report of the importance of nicotine as a biomarker of in utero tobacco exposure in meconium. These data will aid in the identification of prenatally tobacco exposed infants.

Approximately one-quarter of pregnant women smoke tobacco despite nicotine's known effects on fetal growth, lung and nervous system development, and increased risk of nicotine dependence in adulthood. Detection of cotinine in meconium by immunoassay is the primary means of monitoring *in utero* nicotine exposure. Recently, the first chromatographic assay for nicotine and metabolites in human meconium was developed and validated in our laboratory. Liquid chromatography-atmospheric pressure chemical ionization-tandem mass spectrometry in positive ion mode was employed to simultaneously quantify nicotine and metabolites, cotinine, OH-cotinine, norcotinine and nornicotine in meconium from 125 neonates.

Meconium (0.5 g) was homogenized with 3 mL of acidified methanol. After sonication, centrifugation, reconstitution in buffer and *E. coli* β-glucuronidase hydrolysis for 18 h at 37°C, solid phase extraction using a mixed-mode cation exchange column was performed. Limits of quantification (LOQ) were 1.25 ng/g for OH-cotinine, cotinine, and norcotinine and 5 ng/g for nicotine and nornicotine. Specimens were analyzed with and without β-glucuronidase enzymatic hydrolysis to determine total and free concentrations.

Fifty-nine specimens (47.0%) were positive for at least one free drug, with nicotine being the primary analyte detected (43.2%), followed by OH-cotinine (37.6%), cotinine (34.4%), nornicotine (12.0%) and norcotinine (9.6%). The highest percentage of specimens (20.0%) contained nicotine, cotinine and OH-cotinine, 8.8% were positive for all five analytes, and 8.8%, 0.8% and 2.4% for nicotine, cotinine and OH-cotinine only, respectively. No specimen was positive for only nornicotine or norcotinine. Average free drug concentrations of positive specimens (±SD) were 72.6 (±92.2) ng/g OH-cotinine, 69.9 (±70.3) ng/g cotinine, 59.6 (±76.3) ng/g nicotine, 4.5 (±3.7) ng/g norcotinine, and 11.8 (±6.2) ng/g nornicotine. Average total drug concentrations of positive specimens (±SD) were 99.2 (±118.2) ng/g OH-cotinine, 80.3 (±78.5) ng/g cotinine, 60.0 (±73.3) ng/g nicotine, 4.2 (±3.9) ng/g norcotinine, and 11.8 (±5.1) ng/g nornicotine. Two specimens had OH-cotinine concentrations greater than the 500 ng/g upper limit of quantification, but could not be reanalyzed due to lack of additional specimen. Statistically significant differences were shown between total and free OH-cotinine and cotinine using a paired t-test ($P<0.05$). Amongst positive specimens, the average percentage (±SD, range) of total OH-cotinine, cotinine, and nicotine present as glucuronide conjugates were 29.4 (±21.1, -19.4-73.3), 15.7 (±16.2, -18.6-54.5), and 4.2 (±12.4, -36.2-30.6), respectively. Free drug concentrations greater than total drug concentrations can be attributed to analytical imprecision and lack of homogeneity in the matrix despite extensive mixing prior to sampling. OH-cotinine total drug and glucuronidation results should be interpreted with caution, as hydrolysis efficiency of authenticated OH-cotinine-O-glucuronide was determined to be 15% during method validation. Possibly, the high degree of OH-cotinine

glucuronidation observed could be due to the presence of di-glucuronide or N-glucuronide species in addition to the O-glucuronide control that was tested for hydrolysis efficiency. Hydrolysis efficiencies for nicotine- and cotinine-N-glucuronide were greater than 80%. Average free drug metabolite ratios (±SD) were: OH-cotinine/nicotine 1.75 (±1.74) [median (range), 1.37 (0.055-8.67)], cotinine/nicotine 1.44 (±1.28) [1.00 (0.31-5.90)], norcotinine/nicotine 0.058 (±0.080) [0.028 (0.009-0.288)], nornicotine/nicotine 0.11 (±0.11) [0.08 (0.04-0.46)], OH-cotinine/cotinine 1.41 (±0.98) [1.18 (0.15-3.94)], and norcotinine/cotinine 0.08 (±0.03) [0.08 (.04-0.13)].

Meconium, Nicotine, Cotinine, In Utero

K52 MDMA, HMMA, MDA, and HMA Plasma Pharmacokinetics in Humans Following Controlled MDMA Administration

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Attendees of this presentation will be informed about the plasma pharmacokinetics of 3,4-methylenedioxymethamphetamine (MDMA or ecstasy), 4-hydroxy-3-methoxymethamphetamine (HMMA), 3,4-methylenedioxyamphetamine (MDA), and 4-hydroxy-3-methoxyamphetamine (HMA).

This presentation will impact the forensic science community by presenting data to improve the interpretation of MDMA and metabolite plasma concentrations.

The pharmacokinetics of MDMA after controlled oral dosing will be presented. These results are part of a larger investigation of the effect of MDMA on human brain activity and cognitive performance and the relationship of effects to plasma MDMA and metabolite concentrations.

Seventeen young adults, ages 18-27, volunteered for this Institutional Review Board-approved study. Eight African-American males, six African-American females, two Caucasian males, and one Caucasian female provided written informed consent. Volunteers received three doses of MDMA, 0 (placebo), 1.0 (low) and 1.6 (high) mg/kg MDMA, in a double-blind, within-subject, randomized and balanced design. 150 mg was the upper limit of dosing for safety purposes. Dosing was separated by a minimum of one week. Participants resided on a closed research unit and plasma was collected for 47-167 h after MDMA administration. A fully validated 2D GC/MS method simultaneously quantified MDMA, HMMA, MDA, and HMA in human plasma. Calibration curves were MDA, 1-100 ng/mL; HMA, 2.5-100 ng/mL; and MDMA and HMMA, 2.5-400 ng/mL. The lowest calibrator concentration was equal to the limit of quantification. WinNonlin was used to determine pharmacokinetic parameters. Paired t- and Wilcoxon Signed Rank tests were performed using SPSS v 14.0. $p < 0.05$ (two-tailed) was considered significant. Data are presented as mean ± standard deviation (SD).

In general, participants were positive for MDMA and HMMA by 30 min post-dose; MDA was quantifiable in all subjects by 1.25 h. HMA had a variable first detection time, ranging from 1.25-9 h. Mean maximum plasma concentrations (C_{max}) of 162.9±39.8 and 171.9±79.5 ng/mL were observed for MDMA and HMMA, respectively, after the low dose. After the high dose, mean MDMA C_{max} increased to 291.8±76.5 ng/mL, while mean HMMA C_{max} was relatively unchanged at 173.5±66.3 ng/mL. High inter-subject variability in C_{max} was observed. The highest individual C_{max} were 465.3 (MDMA) and 318.1 (HMMA) ng/mL. Mean MDA C_{max} were 8.4±2.1 (low) and 13.8±3.8 (high) ng/mL. HMA C_{max} were lower at 3.5±0.4 and 3.9±0.9 ng/mL after the low and high dose, respectively. C_{max} of all analytes except HMMA were significantly higher after the high dose. A comparison of MDMA and HMMA C_{max} revealed a significant difference after the high dose only (n=17, p=0.001), indicating non-linear HMMA pharmacokinetics. Mean time to maximum concentrations (T_{max}) after the low dose were MDMA, 2.4±0.6 h; HMMA, 1.8±0.7 h; MDA, 7.5±1.7 h; and HMA, 10.6±2.6 h. T_{max} did not significantly differ between dose for any analyte. 100% of participants were positive for MDMA, HMMA and MDA at 23 h after both doses. Similar patterns of detection were noted for MDMA and MDA; 48 h after the low dose, <25% of subjects were positive, while after the high dose, positivity increased to >80%. >90% were HMMA positive 48 h after the low and high doses; HMMA had the longest window of detection of up to 95 h, while HMA was not measurable beyond 47 h. Mean half lives ($t_{1/2}$) of MDMA were 6.9±3.4 h (range: 4.1-18.3) and 8.1±2.1 h (range: 4.7-13.3) after the low and high dose, respectively. HMMA mean $t_{1/2}$ was 11.5±5.5 h after the low and 13.5±2.7 h after the high dose. MDA $t_{1/2}$ were shorter than previous reports, at 10.6±4.3 (low) and 12.3±3.7 (high) h. HMA $t_{1/2}$ showed high variability due to low concentrations. Half-lives of all analytes except HMA were significantly longer after the high dose. Mean MDMA volume of distribution was 5.5 L/kg after both doses; clearance was significantly higher after the low (0.62±0.19 L/h/kg), as compared to the high (0.48±0.11 L/h/kg) dose (n=17, p=0.004).

Extended plasma collection, large sample size, and multiple doses permitted a comprehensive evaluation of MDMA, HMMA, MDA, and HMA pharmacokinetics. These data will impact the forensic science community by improving the interpretation of MDMA and metabolite plasma concentrations.

MDMA, Ecstasy, Pharmacokinetics

K53 Comparison of Various Liquid Chromatography–Mass Spectrometry Technologies for the Analysis of Forensic Toxicology Samples for Commonly Encountered Drugs

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After attending this presentation participants will have a greater understanding of how a variety of mass spectral technologies may be applicable to particular analytical challenges.

This presentation will impact the forensic science community conducting analysis of "drugs" by providing comparative data from a variety of mass spectral techniques on the same samples.

Introduction: A wide array of mass spectral and hyphenated mass spectral technologies is currently available for analysis of small molecules. It has become increasingly confusing for investigators to understand which technologies may be best for particular analytical applications. Specifically, this presentation will provide an overview of LC/QqQ (triple quad), LC/QTOF (time of flight), LC/TOF, LC/MS (single quad), LC/MS ion trap and DART-TOF (Direct Analysis in Real Time, Time of Flight MS) technologies. These technologies will be applied to the same samples to allow for the comparison of what types of technologies are advantageous for which types of applications. Samples will include postmortem specimens and DUID specimens.

Method: Typical forensic samples, blood from death and DUID cases, were prepared in sufficient amounts such that the same extracts could be analyzed on the various fragmentation and detection instruments. Samples were extracted in a manner appropriate for the matrix and suitable for the various ionization methods. For DART analysis, blood samples were introduced without sample preparation and with the same sample preparation as

for LC/MS. Samples were run on an AccuTOF-DART system located at RTI International and on LC/MS systems located at the University of Miami forensic toxicology laboratory and at various Agilent application laboratories.

Results: Representative chromatograms and mass spectra will be presented. The various strengths and limitations of quadrupole-based technologies for quantification and SRM/MRM identification will be compared with identification of compounds using accurate mass and MSn techniques. The presentation will also discuss how individual technologies can accommodate both identification and quantification. Specifically, the different mass spectrometers will be discussed in light of each instrument's strengths and weaknesses for providing forensically-acceptable, highly sensitive screening and identification results.

Conclusions: These comparative MS/MS data provide examples appropriate to the challenges faced in forensic toxicology and demonstrate what various instruments are able to achieve. This presentation will provide examples from a variety of mass spectral technologies from at least two manufacturers and will hopefully provide the groundwork for further comparative studies to include upcoming technologies and more manufacturers.

Analytical Toxicology, Postmortem Toxicology, LC/MS

K54 New Strategies to Apply LC/MS/MS for the Quantitation and Confirmation of Hundreds of Substances Relevant in Forensic Toxicology

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The goal of this presentation is to present the comparison of different LC/MS/MS technologies used for screening and followed by library searching to detect drugs of abuse and pharmaceuticals.

This presentation will impact the forensic science community by demonstrating how LC/MS/MS will replace LC/UV screening methods.

Introduction: With about 5% of the population between the ages of 15 and 64 (~200 million people) using illicit drugs, and thousands of drug intoxications per year in the western world alone, fast screening methods for drugs and pharmaceuticals are necessary for the detection of xenobiotics in forensic intoxication cases. Screening methods usually include immunoassay tests, available only for a small number of substance classes, Gas Chromatography (GC) especially with Mass Spectrometric (MS) detection, or Liquid Chromatography (LC) with Ultraviolet (UV) detection. While GC requires typically extensive clean-up steps with derivatization, LC is ideally suited for polar compounds but UV detection lacks the necessary specificity and methods require long run times to minimize the potential for co-elution. Since 1999, screening for drugs with LC/MS and LC/MS/MS has made progress with mass spectral library searching to confirm detected drugs.

Experimental and Results: This presentation compares LC/MS(/MS) screening strategies using different mass spectrometric detection techniques such as Time of Flight (TOF), Single and Triple Quadrupole, Ion Trap and Hybrid Triple Quadrupole Linear Ion Trap. These MS technologies are compared regarding their ability to screen for a large number of compounds, sensitivity, selectivity, and the possibility of using mass spectral libraries to confirm the presence of detected analytes. Additionally the possibility of transferring once generated libraries to other instruments is discussed. A mass spectral library with more than 1200 substances was generated by injection of standard solutions using standardized Collision Energies (CE) of 20, 35, and 50. In addition a CE of 35V with a Collision Energy Spread (CES) of 15V was used. Data presented were acquired on different mass spectrometers including API 3200™, 3200 Q TRAP® and QSTAR® LC/MS/MS systems in different quadrupole, TOF, and ion trap scan modes. Electrospray Ionization (ESI) was used to ionize all investigated compounds including drugs of abuse, pharmaceuticals, and metabolites. A Shimadzu Prominence HPLC with reversed phase column was used with a standard eluent of water and acetonitrile with a buffer of formic acid and ammonium formate.

Comparative analysis of 300 compounds and extracts of urine and blood sample were used to investigate different MS technologies and their advantages and disadvantages when used for the screening in forensic toxicology.

Conclusion: It was found that the combination of highly selective and sensitive Multiple Reaction Monitoring and fast and sensitive Enhanced Product Ion Scan on a Hybrid Triple Quadrupole Linear Ion Trap is the most powerful LC/MS/MS technique to screen for a large number of unknown compounds and confirm their presence by library searching in forensic samples.

LC/MS/MS, Screening, Library Searching

K55 Whole Blood/Plasma Cannabinoid Ratios in Daily Cannabis Users After Multiple Years of Frozen Storage

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After this presentation, attendees will be informed of whole blood/plasma cannabinoid ratios in authentic specimens (N = 187 pairs) stored frozen for multiple years, and will learn of the first data on intra-subject whole blood/plasma Δ9-tetrahydrocannabinol (THC) and 11-nor-9-carboxy-THC (THCCOOH) ratio variability.

This presentation will impact the forensic science community by providing the first reference of cannabinoid whole blood/plasma ratios from aged authentic specimens and the first data on intra-subject whole blood/plasma THC and THCCOOH ratio variability.

After this presentation, attendees will be informed of whole blood/plasma cannabinoid ratios in authentic specimens (*N* = 187 pairs) stored frozen for multiple years, and will learn of the first data on intra-subject whole blood/plasma Δ9-tetrahydrocannabinol (THC) and 11-nor-9-carboxy-THC (THCCOOH) ratio variability. THC, 11-hydroxy-THC (11-OH-THC) and THCCOOH whole blood/plasma ratios are approximately 0.5, due to high affinity for albumin and/or lipoproteins. Few studies report whole blood/plasma cannabinoid ratios determined from direct comparison between simultaneously collected authentic specimens. In only one report were ratios determined from aged specimens and none report intra-subject ratio variability. Here, whole blood/plasma cannabinoid ratios in authentic specimens collected during a clinical study and stored in polypropylene at -20ºC for 2.9 to 5.6 years are investigated. Also reported are the intra-subject THC and THCCOOH whole blood/plasma ratio variability in 13 participants by direct comparison of specimens collected simultaneously during one week of cannabis excretion.

Thirty-two daily cannabis users (aged 19 - 38, 50% male, 84% African American) provided written informed consent for this IRB-approved study, and resided on a closed clinical research unit for seven days of monitored drug abstinence. Whole blood and plasma were collected simultaneously upon unit admission and every 24 h thereafter. Specimens were collected into Vacutainer tubes containing anticoagulant and transferred to polypropylene cryotubes for long term (-20ºC) storage. Cannabinoids were extracted by SPE (Clean Screen® ZSTHC020 extraction columns, United Chemical Technologies) and derivatized with BSTFA + 1% TMCS. Extracts were injected on an Agilent 6890 GC/5973MSD (operated in EI/SIM mode) retrofitted with a Dean's switch and cryotrap. Two calibration curves (low,

0.125 – 25 and high, 25 – 100 ng/mL) were constructed with $r^2 > 0.99$. Plasma limits of quantification (LOQ) were 0.25 ng/mL for THC and THC-COOH and 0.5 ng/mL for 11-OH-THC. Whole blood LOQ were 0.25 ng/mL for all analytes.

Overall mean ± SD whole blood/plasma ratios were 0.39 ± 0.17 (N = 75, median 0.39, range 0.08 – 0.77), 0.55 ± 0.22 (N = 17, median 0.56, range 0.22 – 0.90) and 0.45 ± 0.29 (N = 187, median 0.37, range 0.11 – 1.53) for THC, 11-OH-THC, and THCCOOH respectively. Mean whole blood/plasma ratios for THC and THCCOOH were determined for 13 subjects that had a least three paired specimens with THC and THCCOOH greater than LOQ (Table 1). A paired samples t test (α = 0.05) including only the 13 participants' paired THC and THCCOOH ratios revealed that the mean whole blood/plasma THC ratio was significantly lower than the corresponding mean THCCOOH ratio ($p < 0.01$). Four of 13 participants mean THCCOOH ratios (N = 7 each) were > 0.8. Removing these potential outliers yielded a non-significant difference ($p = 0.087$) between THC and THCCOOH mean ratios of 0.36 ± 0.10 and 0.46 ±, 0.13, respectively.

Table 1: Average of intra-subject mean (N = 3 – 7) whole blood/plasma THC and THCCOOH ratios from 13 participants over one week.

	N	Mean ± SD	Median	Range
THC	13	0.40 ± 0.11	0.40	0.13 – 0.56
THCCOOH	13	0.63 ± 0.28	0.56	0.28 – 1.15

These data impact the forensic community by providing the first reference of cannabinoid whole blood/plasma ratios from aged authentic specimens and the first data on intra-subject whole blood/plasma THC and THCCOOH ratio variability. The overall mean whole blood/plasma THC ratio was lower than previously reported, which may be explained by cannabinoid binding to whole blood proteins and/or container surfaces during storage. Mean intra-subject whole blood/plasma THC ratio was significantly lower than the corresponding mean THCCOOH ratio; however, further research may be necessary because data may be skewed by mean ratios >0.8 in four participants.

Cannabinoids, Ratio, Whole Blood

K56 A One-Year Study of Cocaine and Heroin in Waste Water Plants in Florence, Italy

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The goal of this presentation is to present data on a one-year study of cocaine and herion concentrations in waste water plants in Florence, Italy.

This study will impact the forensic science community by proving once again the potential of the analysis of drugs and metabolites in waste water as a tool in monitoring drug abuse and, especially, in the identification of trends in consumption habits.

Determination of drugs and metabolites in wastewater collecting plants (WWP) is a newly and efficiently developed strategy in the assessment of substance use and abuse in several different countries. In particular, in the last years, determination of cocaine and other drugs in wastewater was proposed to estimate *per capita* consumption with better reliability than traditional markers (as epidemiological studies, drug confiscations, crime statistics). Although an inter-laboratory validation of methods of analysis and data elaboration (especially in relating water concentration with population) is needed before this can be used as a widespread monitoring tool, the analysis of wastewater from a specific collection site by a validated method over a certain period of time can be helpful in the identification of trends in drugs use.

The amount of cocaine was determined (measured as the sum of cocaine and benzoylecgonine) and heroin (measured as morphine) over one year (July 2006-June2007) in wastewater of the City of Florence. Analytical results were used to evaluate a trend in the use of these drugs and to speculate on the impact of tourist flow on cocaine/heroin consumption in the city of Florence.

Wastewater was collected every month at two different WWPs located on opposite sides of the Arno River before any treatment. Three liters of water were analyzed by solid phase extraction (on Bond Elute LRC Certify, Varian Inc. Lake Forest, CA, according to the manufacturer's instructions for basic drugs with minor modifications), followed by N-Methyl-N-trimethylsilyltrifluoroacetamide derivatization and gas chromatography-mass spectrometry (GC-MS). Cocaine (COC), benzoylecgonine (BE) and morphine (MOR) were identified in selected ion monitoring mode (ions 82, 182, 272, 303 for COC, 82, 240, 346, 361 for BE, and 324, 401, 414, 429 for MOR). Four-point calibration curves were prepared (from 25 to 200 ng/L for COC and BE and from 22 to 212 ng/L for MOR) and accuracy and precision were calculated by repeatedly injecting three quality control (QC) points (25, 50, 150 ng/L for COC and BE, 22, 37, 153 for MOR). The analytical method was found to be linear for all substances in the range of interest (COC: slope: 44.72 ± 2.20, intercept: 2.39 ± 5.63, R^2: 0.9920 ± 0.008; BE: slope: 320.96 ± 39.36, intercept: 17.55, R^2: 0.9853 ± 0.016; MOR: slope: 515.54 ± 28.93, intercept: 3.8 ±7.49, R^2: 0.9975 ± 0.002). For the three substances, accuracy and precision results were better than 18.4% bias and 14.2% relative standard deviation at the lower QC and better than 10.2% bias and 14.8% relative standard deviation at low and high QC.

Cocaine (calculated as COC + BE equivalents) was assessed to be used in the city of Florence in the range between 42.84 and 82.54 g/day (mean: 59.05 g/day, median: 55.55 g/day), with the highest amounts in August (82.54 g/day), December (78.24 g/day), and March (78.79 g/day). The lowest quantities were retrieved in September (42.84 g/day), October (43.70 g/day), and January (44.69 g/day). Heroin (calculated as morphine equivalents) use was estimated to be used between 2.92 and 17.17 g/day (mean: 9.80, median: 10.56 g/day). The highest amounts were observed in January, March, and April (14.78, 15.58, and 17.17 g/day, respectively) and the lowest in July, September, and October (2.92, 3.93, and 3.84 g/day, respectively). The analysis of cocaine and heroin in surface water over a 12-month period is, to our knowledge, unprecedented and, on the basis of these preliminary data, it is possible to: (i) recognize an increment in the use of heroin in the period taken into consideration (with an average of 4.7 g/day in the first trimester and 12.8 in the last one), (ii) speculate that cocaine use seems higher when the tourist flow is more intense (August and December, in particular), and (iii) assume that heroin does not appear to be influenced in this way (highest amount from January to April).

This study proves once again the potential of the analysis of drugs and metabolites in wastewater as a tool in monitoring drug abuse and, especially, in the identification of trends in consumption habits. Finally, the project is still ongoing and is being extended toward more substances and metabolites.

Waste Water Plants, Cocaine, Florence

K57 Analysis of Antipsychotic and Antidepressants in Whole Blood by LC/MS/MS

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After attending this presentation, attendees should have a more thorough understanding of the capabilities of screening for antipsychotic and antidepressants in whole blood by LC/MS/MS.

This presentation will impact the forensic science community by providing analytical information to members of the medical examiner toxicologist community and to individuals that may take an interest in the analysis of these types of compounds to determine their concentrations in whole blood.

The objective of this research was to develop an LC/MS/MS method for screening and confirmation of various antidepressant and antipsychotic drugs in whole blood. These types of compounds are consistently among the most commonly prescribed medications and as such can be routinely encountered in the performance of therapeutic drug monitoring or medical examiner toxicological examinations. The analysis of these types of drugs may be hampered by laborious extraction procedures, extended analytical analysis times, and even the need for multiple analyses. A generalized sample preparation and analysis method by HPLC tandem MS is presented.

This method describes the simultaneous analysis of more than ten antipsychotic, antidepressant, and structurally similar medications. Whole blood is subjected to protein precipitation. The corresponding supernatant was subsequently analyzed using reversed-phase HPLC with MS/MS detection. The column used was an Allure PFP Propyl from Restek Corporation. The mobile phase consisted of a binary mixture for a gradient. Mobile phase A was aqueous 1.0 mM ammonium acetate with 0.05% acetic acid. Mobile phase B was 95% Acetonitrile and 5% water with 1.0 mM ammonium acetate and 0.05% acetic acid. Detection was by single reaction monitoring for each compound. Confirmation was by multiple reaction monitoring of two transitions for each compound.

All of the analyzed antipsychotics, antidepressants and structural analogs were analyzed in a single method. The analytical run time was complete within 15 minutes. Detection limits of the individual drugs and their observed linear ranges are presented. Linear ranges for the drugs generally covered at least two orders of magnitude. The limits of detections for many the compounds allow for application of the method to monitoring therapeutic concentrations.

The method provides an accurate and reliable means for detection and confirmation of various antipsychotic and antidepressant drugs in a whole blood matrix. The use of a precipitation as a means of sample preparation is less laborious and more time effective than classical liquid-liquid or solid phase extraction. In addition the versatility associated with HPLC and tandem mass spectrometry makes it likely that addition drugs could be added to expand the scope of the analysis with few modifications.

Antipsychotics, Whole Blood, LC/MS/MS

K58 Analysis of Postmortem Blood and Tissue by AccuTOF™ DART™

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After attending this presentation, the attendees will understand the potential strengths and weaknesses of the application of the AccuTOF™ DART™ system to screening of postmortem blood and tissue specimens.

The presentation will impact the forensic community by providing information about a novel technology applied to screening of postmortem blood and tissue samples.

Introduction: The innovative use of direct analysis real time (DART) coupled with time-of-flight (TOF) mass spectrometry has the potential to be of great value in the area of postmortem blood and tissue analysis. Generally, the technology applied by the AccuTOF-DART™system allows for the analysis of many samples without the need for sample preparation or solvents. Additional benefits of TOF-DART include: (1) use of limited sample size, (2) simultaneous screening and identification of a myriad of drug classes, and (3) minimal time for analysis. This system was used to analyze blood and tissue samples collected from various medical examiners' offices (Maricopa County Office of the Chief Medical Examiner, North Carolina Office of the Chief Medical Examiner, Washington State Toxicology Laboratory). The purpose of this study is to evaluate the AccuTOF-DART™system as a novel approach to expeditiously screen postmortem toxicology samples.

Methods: More than 23 blood and tissue specimen cases were analyzed both with and without minimal sample preparation and extraction. These samples were previously analyzed by traditional postmortem techniques and collection of samples contained 32 different drugs based on the previously reported results from traditional postmortem analysis. All tissue specimens were homogenized in deionized water (1:4). Initially, blood and liver samples were extracted in n-butyl chloride, evaporated, and reconstituted in butyl acetate. As an alternative extraction and sample preparation, the samples were extracted in acetonitrile, evaporated and reconstituted in acetonitrile. Samples were analyzed, for the corresponding M + H ion, by AccuTOF-DART™ mass spectrometry in positive mode. TOF-DART results were compared with the results reported from previous analysis of the cases by their respective toxicology laboratory.

Results: Initial attempts with directly introducing blood and tissue specimens resulted in no detection of corresponding M+H ions from drugs of interest. It was apparent that a sample extraction or minimally a precipitation of proteins was necessary for detection of compounds. With TOF-DART analysis of the representative samples, the results for the solvent-extracted blood and tissues and the protein-precipitated postmortem samples were comparable. In many instances, TOF-DART analysis of a sample produced expected M+H ions for a particular drug of interest, but not for another drug, previously detected using traditional postmortem analysis. For example, amitriptyline previously quantitated at 23 mg/kg in the liver homogenate, was detected by TOF-DART; however, metaprolol and nortriptyline (reported at 25 mg/kg and 35 mg/kg, respectively) were not detected. For example methadone, was consistently detected as low at 0.18 mg/L in aortic blood and 2.1 mg/kg in liver from the same case. In contrast, benzoylecgonine, like other drugs, was undetectable by TOF-DART when it was detected by traditional methods as low as at 6.9 mg/L. This unpredictability was found to occur in both blood and tissue samples.

Conclusions: Although the AccuTOF-DART™system has the ability to detect the presence of analytes by direct analysis, current indications show that drugs are not detected in postmortem samples without extraction or protein precipitation. Even with extraction and some concentration, many

drug were not detected at high or low levels in both blood and tissue samples. It has been previously reported detection of many of the drugs, such as cocaine, at lower levels when drugs spiked into blank blood or urine, but these same drugs in the more complex matrix of postmortem blood and tissue were not as readily detectable. The samples analyzed in this study are archived postmortem samples and the stability of the drugs in these particular samples was not confirmed by traditional postmortem methods after TOF-DART. The AccuTOF-DART™system is a novel approach in the analysis of compounds; however, due to the nature of many postmortem specimens it does not have the sensitivity to detect the presence of many drugs.

AccuTOF™ DART™, Postmortem, Toxicology Screening

K59 Statistical Interpretation of Meprobamate Concentrations in Bone Marrow, Vitreous, and Bile

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Upon completion of this presentation, participants will have some tools to interpret postmortem meprobamate concentration in bone marrow, vitreous and bile. The proposed methodology could be applied to interpret the concentrations measured in other biologic matrices.

In numerous cases of toxic death investigations, the interpretation of blood concentrations is difficult (postmortem redistribution, putrefied bodies) or impossible (lack of blood sample). This presentation will impact the forensic community by enabling an interpretation of meprobamate concentrations measured in sample types other than blood sample.

The interpretation of concentrations in samples other than blood is complex due to the lack of reference ranges. The presented statistical methodology enables the decision of an intoxication or a therapeutic case with a quantified risk of error, which is very important when discussing the results in court.

The presented study is based on 116 forensic cases. On the basis of blood concentration, 70 cases were classified as therapeutic blood concentrations and 46 as toxic blood concentrations. For each case, at least one of the following sample types was collected during the autopsy: bile (n=107), right vitreous (n=40), left vitreous (n=43), and bone marrow (n=51). Meprobamate was quantified by GC/MS. For each sample type, the average concentration and the standard deviation showed that the meprobamate concentrations between the toxic and therapeutic populations were statistically significantly different.

Modeling of the toxic and therapeutic populations allowed the definition of a toxic threshold with less than 5% false positives. Multivariate analysis, such as Principal Components Analysis (PCA) and Partial Last Square Data Analysis (PLSDA) showed that it was possible to distinguish therapeutic cases and the toxic cases by simultaneous use of the concentrations measured in the 4 alternative matrices.

Practical applications of these results on some cases will be presented, as well as cases previously published in the international literature.

Meprobamate, Bone Marrow, Forensic Toxicology

K60 Rapid Determination of N_2O in Postmortem Biological Samples: A Case of Serial Fatal Poisoning

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After attending this presentation, attendees will be briefed on eight cases of fatal poisoning which occurred during general anesthesia.

This presentation will impact the forensic community and/or humanity by demonstrating the presence of N_2O in forensic biological samples by headspace- gas chromatography analysis using ECD detector (HS-GC/ECD).

Case History: In a public hospital during anesthesia, eight accidental deaths occurred due to an erroneous replacement of O_2 with N_2O. Four were females and four were males with a mean age of 77.75 years (range 67-85). Five of the decedents showed cardiovascular diseases, two had lung disease and one had gastrointestinal disease. During anesthesia, all were exposed to N_2O for a mean period of 58,25 min (range 25-125 min) until they expired.

Goal: It is known that Nitrous oxide (N_2O) is an asphyxiant at high concentrations [ACGIH 1991]. Determination of the cause of death in gaseous asphyxiation cases is very difficult due to the variation in circumstances during the event. To clarify the cause of death and identify the factors involved in asphyxia, gases from different lines were characterized and N_2O concentrations in postmortem biological samples (air and tissue samples), collected after 19 days postmortem (range 6 – 31) were analyzed.

Methods: Analyses, carried out on the gas samples both from the O_2 and the N_2O lines in the surgery room, confirmed the incorrect connection of the lines. In fact, gas samples from O_2 lines showed the presence of pure N_2O, while in those collected from the air lines there was pure O_2 with a low percentage of N_2O (less then 0.1%). Analysis of gas samples from the lines supplying each bed, produced the same results.

The analyses performed on the postmortem biological samples, showed an abnormal concentration of N_2O. Particularly, air samples collected from the stomach of all patients during autopsy revealed concentrations from 0.12 mM to 1.9 mM N_2O corresponding to 0.30 % and 4.55%, respectively. All samples were collected in duplicate and stored in 100 ml syringes until analysis. Calibration was carried out using air samples with a known amount of N_2O.

The presence of high levels of N_2O was found in urine, blood, kidney and liver. Results showed a variation in the distribution of the gas consistent with its solubility in the different tissues.

Results confirmed that the air supply lines were indeed switched. The data also indicate that N_2O could be detected in biological samples 31 days postmortem due to the high exposure concentrations.

Therefore, this report presents valuable findings for the correct diagnosis of the cause of death and helps to clarify the true nature of the cause of death.

Nitrous Oxide, Anesthesia, Accidental Death

K61 Deaths Attributed to Intravenous Use and Nasal Inhalation of Oxycodone

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After attending this presentation, attendees will understand the routes of oxycodone administration, understand issues in cases of atypical routes of drug administration, and understand some factors that could affect oxycodone toxicity.

This presentation will impact the forensic science community by providing forensic toxicologists and pathologists additional factors to consider in interpreting oxycodone drug levels following non-oral routes of administration.

Oxycodone is a semisynthetic narcotic analgesic derived by chemical modification from codeine. It produces potent euphoria, analgesic and sedative effects, and has a dependence liability similar to morphine. Two cases of death from oxycodone are presented: one by intravenous and one by nasal insufflation.

The first case was a 50-year-old Caucasian male who was pronounced dead in hospital. A full autopsy was performed < 24 h after death. Autopsy findings included extensive systemic foreign body granulomatosis consistent with IV drug use. The second case was a 28-year-old male found deceased at a friend's home. A friend at the scene reported that the decedent "snorted" the drug. A full autopsy was performed <24 hours after death. Autopsy findings included pulmonary oedema and moderate diffuse cerebral swelling. Blood and urine specimens were collected at autopsy for toxicological analysis.

Blood and urine specimens were subjected to a thorough qualitative analysis. Screening was performed for illicit drugs including opiates, cocaine, barbiturates, benzodiazepines, amphetamines, phenycyclidine, and cannabinoids by immunoassay. Acidic and neutral drugs were screened for by liquid-liquid extraction followed by GC-MS electron impact detection. Volatile alcohols were assayed by GC-FID. Qualitative analysis in urine identified oxycodone and cannabinoids in both cases. Quantitation of oxycodone and 11-Nor-Delta^{9}Tetrahydrocannabinol-9-CarboxylicAcid (THC-COOH) in urine and oxycodone in blood were performed by GC-MS. Oxycodone and its deuterated internal standard were extracted at pH 6.0 using solid phase extraction techniques. The eluant is evaporated, and the resulting residue is dissolved in pyridine. Acetyl derivatives of oxycodone are then formed by adding acetic anhydride and heating the mixture for 30 minutes at 50°C, then dried under nitrogen. The resulting residue is reconstituted in ethyl acetate and subsequently analyzed by gas chromatography/mass spectrometry using single ion monitoring; Oxycodone - 357, 314, 358 m/z; and Oxycodone-d_3 - 360, 317, 361 m/z.

The concentrations of oxycodone found in blood and urine for cases #1 were 0.518 mg/L and 21.7 mg/L respectively. The THC-COOH was 0.020 mg/L in urine. The concentrations of oxycodone found in blood and urine for cases #2 were 0.050 mg/L and 6.58 mg/L respectively. The THC-COOH was 0.081 mg/L in urine.

The usual adult oral dose is 2.5-5 mg every 6 hours, although patients with moderately severe pain may take 10-30 mg every 4 hours. Published pharmacokinetic studies involving oxycodone show that plasma concentrations are generally less than 0.100 mg/L. For example, the peak plasma concentrations in 12 patients receiving a 10 mg oral dose averaged 0.030 mg/L. There is little reported on the lethal levels of oxycodone in blood when administered intravenously or by nasal inhalation. For oral oxycodone alone, a minimum lethal level of 5.0 mg/L has been suggested, and fatal concentrations involving oxycodone and at least one other depressant drug have been reported at 0.60 mg/L. Although the concentration of oxycodone in these cases was lower, it is well known that for other opiates the minimum lethal level can be considerably lower when administered intravenously or by insufflation than when orally administered.

Based on autopsy findings, investigation at the scene, patient history, and toxicology findings, the cause of death in case #1 was ascribed to oxycodone administered by intravenous route; case #2 was ascribed to oxycodone administered by nasal inhalation; and the manner of death in both cases was determined to be accidental.

Oxycodone, Intravenous, Nasal Inhalation

K62 The Controversy of Death Involving Drugs of Abuse and TASERs®

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The goal of this presentation is to present the case history and toxicological findings of a fatality involving the use of a TASER® stun gun on an individual confirmed to have used cocaine. After attending this presentation, attendees will gain insight into the use of incapacitating devices by law enforcement personnel, the detection of illicit drugs in body fluids, and the contribution of each in rendering an opinion in a death investigation.

This presentation will impact the forensic community and/or humanity by reviewing a multi-jurisdictional death investigation involving an electrical weapon with the concurrent use of a drug of abuse. This combination continues to be prevalent in North America and controversial in regards to cause and manner of death.

The authors present the case history and toxicological findings of a fatality involving the use of a TASER® stun gun on an individual confirmed to have used cocaine. After attending this presentation, attendees will gain insight into the use of incapacitating devices by law enforcement personnel, the detection of illicit drugs in body fluids, and the contribution of each in rendering an opinion in a death investigation.

Numerous accounts of law enforcement personnel using TASER® stun guns to subdue suspects in the field and in custody have been reported. The prevalence of abstracts presented at recent AAFS meetings regarding the use of TASERs® attests to the continuing debate as to whether they are lethal weapons, non-lethal weapons, or something in-between.

A 36-year-old male was confronted by officers from a local township police department responding to reports of a suspicious person in the area pounding on doors and windows. The combative male resisted arrest and was subdued with at least five "drive stuns" (without probes) in the small of the back. (Note: one of the officers was shocked twice by his own TASER® during the confrontation). The male subject was also shocked in the abdominal region by another officer with the TASER® probes attached. The male subsequently fell into an Oriental pond containing approximately 2.5 feet of water. The officers promptly removed him from the water. He became unresponsive and was immediately transported to the nearest medical center where he was pronounced dead approximately 30 minutes later. An autopsy was performed and specimens were collected for toxicology testing (blood, bile, gastric and vitreous humor).

Routine toxicological analyses of postmortem blood and vitreous humor were conducted to aid in the determination of cause and manner of death. Thorough examination of the decedent was performed so as to ascertain whether the death was attributable to the use of TASER® stun guns or to the presence of illicit and/or prescription drugs or some other cause or combination of causes. The analytical procedures employed included immunoassays, spot tests, and gas chromatographic methods utilizing flame ionization, nitrogen-phosphorus, and mass spectrometric detection. The presence of cocaine/metabolites was indicated in the vitreous humor via immunoassay. Identification and quantitation of cocaine/metabolites was performed in the femoral blood revealing the following concentrations: 1465 ng/ml cocaine, 3036 ng/ml benzoylecgonine, positive ecgonine methyl ester. The presence of alcohol or other drugs of significance were not detected. The cause of death in this case was determined to be excited delirium due to cocaine intoxication and the manner of death accidental.

Use of incapacitating devices was temporarily suspended by the police department pending an investigation by the county sheriff's office. Each of the police department's 16 TASERs® was examined to ensure proper operation. Reporting of this incident prompted a number of law enforcement agencies in the region to conduct reviews of their respective TASER® policies. According to the manufacturer, TASER International, TASERs® are deployed as a non-lethal alternative to deadly force. However, other groups such as Amnesty International and the American Civil Liberties Union believe that TASERs® pose a serious health risk and should be considered as a contributing factor in TASER® related deaths.

TASER®, Cocaine, Death

K63 Morbidity Involving the Hallucinogenic Designer Amine 2C-I: Case Report

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After attending this presentation, attendees will be familiar with a new class of hallucinogenic synthetic amines and a severe complication that occurred in one case involving 2C-I.

This presentation will impact the forensic community and/or humanity by familiarizing attendees with a new class of hallucinogenic drugs and one possible adverse effect of these drugs. It will also describe a successful method for detecting these designer amines.

The 2C* family of designer amines are derivatives of the natural compound b-phenethylamine. They contain methoxy groups in positions 2 and 5 and a hydrophobic 4-substituent (iodine in 2C-I, bromine in 2C-B, etc). The name "2C" comes from the two carbon atoms that separate the amine from the phenyl ring. The 2C* drugs have hallucinogenic properties and are sometimes incorrectly sold as MDMA. Little is known about the pharmacological and toxicological properties of the 2C* drugs, but it is known that they show affinity to type-2 serotonin (5-HT_2) receptors, acting as agonists or antagonists similarly to other hallucinogenic drugs.

In an adverse event involving one of the 2C* drugs, a 39-year-old woman presented to the emergency department on New Years day after a night of partying with diminishing mental status, agitation, hypothermia, hypertension, vasoconstriction, and hemorrhagic stroke. She was unresponsive and had extensor posturing. Her friends provided a history of MDMA (ecstacy) and 2C-I ingestion, the latter of which the patient reportedly synthesized at home using a recipe from the internet. A high performance liquid chromatography (HPLC) rapid UV scanning method (BioRad REMEDi) could not detect MDMA or MDA due to an interfering substance. However, a method using liquid chromatography tandem mass spectrometry (LC-MS/MS; Applied Biosystems 3200 QTrap) with selected reaction monitoring followed by a linear ion trap full scan was able to detect and identify both MDA and 2C-I in the patient's urine. MDA is a minor metabolite of MDMA and also an independently used drug. The absence of MDMA suggests that the patient ingested MDA alone and not MDMA, as was stated in the history. A head CT scan revealed that the patient had a congenital cerebrovascular abnormality (Moyamoya) that put her at a higher risk for stroke. Hypertension and stroke following MDMA ingestion has been well described. Similar reports are not available for MDA and 2C-I, perhaps because such exposures are less common and/or less often identified. The patient had an extended stay in the ICU, and six months later could follow commands but not speak. Despite these modest improvements in mental status, the patient remains severely disabled and requires total care.

In conclusion, associating clinical syndromes with use of illicit drugs by relying solely on self reporting or that of family members or involved bystanders may not be reliable, nor is laboratory analysis that does not address a broad spectrum of designer amines. This is potentially the first adverse event reported for 2C-I, though the possibility of 2C-I being coincident to MDA toxicity will also be discussed.

2C-I, MDA, LCMS

K64 Fentanyl in Blood and Head Hair From Postmortem Cases

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The goal of this presentation is to assess the prevalence of fentanyl in blood and corresponding head hair specimens in postmortem cases.

Routine testing methodologies in hair and blood analysis may not include fentanyl. With the use of transdermal delivery systems and potential lacing of street drugs with fentanyl, a need to develop a rapid and sensitive assay for this drug became apparent.

Specimens: Biological Specimens were obtained during the medicolegal death investigation process at The Office of the Cuyahoga County Coroner, Cleveland. Cases were included if there was a history of heroin and/or (transdermal) fentanyl use or fentanyl was detected in any routine assay, such as the basic drug screen.

***Methods* - Blood:** Biological Fluid testing was performed at The Office of the Cuyahoga County Coroner, Cleveland. Blood (heart or femoral) were assayed by solid phase extraction followed by gas chromatography/mass spectrometric analysis in the selected ion monitoring mode. Norfentanyl, fentanyl, alfentanil and sufentanil were included in the assay. Matrix matched calibrators were assayed at 1, 2, 5, 15, and 25 ng/mL with deuterated (d_5) fentanyl and norfentanyl as internal standards. A negative and positive control at 10 ng/mL fentanyl were assayed with each batch. The coefficient of determinations (r^2) were typically >0.99. The linear range of the assay was 1-50 ng/mL. Within (n=13) and between (n=5) day precision for fentanyl at 15 ng/mL was 4.28%CV and 6.52% CV, respectively. Accuracy at 5 ng/mL was 93.2% (n=5).

HAIR: Hair testing was performed at Immunalysis Corporation, Pomona, CA. A screening procedure for the detection of several medications using ELISA included washing 10 mg specimens briefly with acetone and air drying. Following cutting, 0.025M phosphate buffer (1.5 mL) was added. The samples were sonicated at 75°C for three hours, 0.2 mL of supernatant was removed and 0.8 mL of bovine serum albumin (BSA) added to dilute the sample 1:5. A specific aliquot of the extract was used for the ELISA analysis depending on the drug. Presumptively positive samples were re-aliquoted, washed, cut and sonicated in 0.025M-phosphate buffer (pH 2.7; 1.5 mL) for two hours at 75°C with corresponding internal standard. The buffer was removed, and 0.1M sodium phosphate buffer (pH 6.0; 1 mL) added; the samples were subjected to solid-phase extraction. Confirmation was achieved using two techniques. For 2-dimensional GC/MS, the extracts were reconstituted in ethyl acetate (40 µL) and transferred into auto sampler vials. The ions monitored were 250.2 and 151.1 for deuterated (d5) fentanyl; 245.2, 146.1 and 189.1 for fentanyl with a dwell time of 70 ms. The system was operated in electron impact mode. Alternatively, for LC/MS/MS analysis, the instrument was operated in atmospheric pressure chemical ionization positive mode and the collision gas was nitrogen. Two transitions were monitored (337.4 to 188.3; 337.4 to 105.3) and a ratio calculated so as to increase confidence in the result. Both procedures had a limit of quantitation of 10 pg/mg.

Results: 23 cases were identified for inclusion in the study. The majority of decedents were white (83%) and the sexes were evenly divided (52% male). The age range was 30-94 years with a mean±SD of 58.7±18.0, and a median of 51 years. Twelve individuals had a history of transdermal patch use, 9, a history of heroin use, 1 individual both and one with no history. Fentanyl was detected in the blood of 14 cases (n=21) in a concentration range of 1-33 ng/mL (8.78±9.25, 5.50 ng/mL). All cases with a history of patch use were positive for fentanyl (1-33 ng/mL). The corresponding hair specimens screened positive for 12/13 of these cases with fentanyl levels ranging 55-5120 pg/mg.

Only two individuals with a heroin use history were positive in the blood for fentanyl (7, 24 ng/mL). The corresponding hair was positive at 36 and 1295 pg/mg. The hair of one individual with a heroin use history was

positive for fentanyl at 31 pg/mg but the corresponding blood was negative. 6-Acetylmorphine, codeine, morphine, ethanol and cocaine metabolites were identified in blood.

Conclusion: Although the highest concentration of fentanyl in hair and blood occurred in cases with the highest patch dose, there did not appear to be a relationship between blood and corresponding hair concentrations or the dose. The data demonstrated that fentanyl is detectable in hair and may be a useful adjunct to routine specimens in postmortem toxicological analysis.

Fentanyl, Blood, Hair

K65 Postmortem Pediatric Toxicology

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After attending this presentation, attendees will understand the impact of certain toxicological agents in death determination of pediatric patients. There will be imparted many of the reasons why children are not small adults. Through discussion, all attendees will better discern how to interpret toxicological findings in this population.

This presentation will impact the forensic science community by assisting pathologists and toxicologists to integrate pharmaco-/toxicokinetic and pharmaco-/toxicodynamic principles with pathological principles in respect to death determination of children.

In this 9th 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.

This years presentations will be:

1. Dr. Kenneth Snell, Interim Chief State Medical Examiner, Alabama Dept. of Forensic Sciences, will be discussing the impact of verapamil in a pediatric fatality. Verapamil is a calcium channel blocking agent not generally indicated in children less than 1-year-old. In the current case, a 1 y/o male was found to have verapamil, a non-prescribed medication, in his blood. The i mplication of this finding in the face of a potential inborn error of metabolism will be discussed and presented for audience consult.
2. Dr. Phil Kemp, Chief Toxicologist, OCME, Okalahoma City, OK, will discuss the potential role of methamphetamine on fetal and/or neonatal deaths. Methamphetamine, labeled as the modern day catastrophic drug of abuse, is highly prevalent in the world of drug abuse. Fetal exposure is generally through maternal abuse of the substance. Young children are often exposed through the living environment. Such exposures will be highlighted through case experience where methamphetamine may have been a contributing factor in the determination of death.
3. Dr. Carl Schmidt, Chief Medical Examiner, Wayne County, MI, will review cases of "accidental" fentanyl exposure to young children. A common route of exposure of young children to fentanyl is through manipulation of fentanyl patches. These patches contain specific directives against various forms of manipulation due to exposure to the patch contents. As a drug with a narrow therapeutic index, such exposure is potentially fatal, as will be demonstrated through case history.

Pediatric, Postmortem, Toxicology

K66 Determination of Guanfacine (Tenex) in a Case of Munchhausen by Proxy

Carl E. Wolf II, PhD, and K. Scott Whitlow, MD, Medical College of Virginia, PO Box 980401, Richmond, VA 23298-0165; and Alphonse Poklis, PhD, Medical College of Virginia, Box 98-165, Virginia Commonwealth University/Medical College of Virginia Hospitals Station, Richmond, VA 23298*

The goal of this presentation is to present a methodology for the determination of Guanfacine (Tenex) and to alert the forensic community that the drug may be used and found in cases of Munchhausen by Proxy.

This presentation will impact the forensic science community by demonstrating the possible treatment of children diagnosed with attention deficit hyperactivity disorder (ADHD) with guanfacine demonstrates the need for a reliable method to detect the drug in cases where Munchhausen by Proxy could be a source of toxicity or unsuspected death.

Guanfacine is a derivative of the nucleic acid guanidine, and is used to treat high blood pressure. Only one published method is available for the quantitation of guanfacine, but the method does not provide for positive qualitative identification. Recently, guanfacine alone or in combination with clonidine has been indicated as a possible treatment for children diagnosed with attention deficit hyperactivity disorder (ADHD).

A four-year-old male child was transferred to an academic tertiary care center for evaluation of a 3-day history of intermittent hyper-somnolence. The child had similar episodes in the past, involving prior hospitalization in the community, an extensive neurological work-up, and follow up with a pediatric neurologist for one year. The child was being treated with valproic acid for possible absence seizures (not seen on prior EEG), and clonidine for sleep. Neurological as well as clinical laboratory testing were all normal, with the exception of a mildly elevated ammonia concentration was resolved without intervention. No drugs were detected on an initial comprehensive drug screen. The child remained hyper-somnolence with intermittent bradycardia without hypotension, while additional neurological studies were negative. Review of the nursing notes revealed that the bradycardic episodes coincided with the somnolent episodes. The child was placed on a three day continuous EEG and camera monitoring. A thorough review of the family history revealed that a sibling was being prescribed guanfacine. Therefore, urine obtained upon admission as well as five other urine specimens were analyzed for guanfacine.

Due to the lack of available mass spectral data, the identification of guanfacine was determined from elicitation of fragmentation ions and pattern. Using a modification of our meperidine/normeperidine urine method, guanfacine was identified and semi-quantified in urine by GC/MS. The pH of 1 ml aliquots of urine calibrators and specimens was adjusted with 0.5 ml of saturated carbonate:bicarbonate solution and extracted using n-butyl chloride with rotate mixing for two minutes, then centrifuged. The upper n-butyl chloride was transferred to a clean test tube, and the guanfacine and the internal standard were derivatized using 50 mL of heptaflurobutyric anhydride (HFBA) at 75 °C for a minimum of 30 minutes. The n-butyl chloride:HFBA solution was evaporated under nitrogen and reconstituted with ethyl acetate and injected into the GC/MS. Guanfacine was analyzed on a Shimadzu QP-2010 GC/MS system operated in SIM mode, with a DB-5 column (30m x 0.25 mm x 0.33 mm) and a 5 m guard column. The GC oven temperature was programmed from 160 °C, 0.1 min hold, to 280 °C at 20 °C/min. The ions monitored for guanfacine and protriptyline (internal standard) were: *m/z* 86, 272, 274, 159, 161 and 191, 189, respectively. The urine guanfacine concentrations upon initial admission 2, 5, 7 (am), 7 (pm), and 11 days post admission were 3.8, 6.4, 17.9, 3.3, 1.6 mg/L and None Detected, respectively.

The fluctuations in the child's urine guanfacine concentrations correlated with the symptomatic and asymptomatic episodes the child experienced. Upon follow up police interrogation and video, the mother elicited a complete confession. The child dramatically improved, and was eventually discharged.

Guanfacine, GC/MS, Munchhausen by Proxy

K67 Prevalence of Cocaine on Urban and Suburban Elementary Student Desks

Frederick P. Smith, PhD, University of New Haven, Forensic Science Department, 300 Boston Post Road, West Haven, CT 06516; and David A. Kidwell, PhD, and Janelle C. Baldwin, BS, U.S. Naval Research Laboratory, Code 6170, Washington, DC 20375*

From this presentation, attendees will understand drug contamination in an environment previously unreported in the scientific literature, in this case elementary student desks. Forensic toxicologists, medical review officers, and other forensic investigators will understand contamination factors which may affect their interpretation of drug test results from external matrices. Concerning the learning environments of children, educators tasked with quality improvement will understand issues of drug contamination in public schools and potential problems if widespread drug testing of students were implemented.

This presentation will impact the forensic science community by demonstrating how the limited body of knowledge on which forensic investigators rely when examining surfaces in the workplace and elsewhere, then ascribing evidence of illicit drug use to such results, is supplemented by these findings.

This research tests the hypothesis that surfaces contacted by potentially unsuspecting individuals may be contaminated with significant amounts of cocaine and that this contamination may spread to other areas where drugs are not being used. These findings will supplement the limited body of knowledge on which forensic investigators rely when examining surfaces in the workplace and elsewhere and interpret the significance of the presence of drugs on these surfaces.

Two public schools in the Washington, D.C. area with differing geographic and socioeconomic profiles were chosen for this study. The prevalence of cocaine-related substances in these environments was compared. Researchers obtained permission from the school administrators to swab each student desk in three classrooms per school. Classrooms were at the first, second and fourth grade levels corresponding to student ages of approximately six, seven, and nine-years-old. The entire desk top was swabbed using disposable latex gloves and individually packaged, and sterile, isopropyl alcohol wipes. Negative control swabs were collected from latex gloves before swabbing. Pre-analysis storage temperature was -20°C. In the laboratory, other negative controls were included as additional tests for laboratory contamination. After deuterated internal standards were added to swabs, they were air dried. Analytes were removed from specimens using 0.1 N hydrochloric acid, and then the drugs were extracted using solid phase (SPE) columns. All extracts were analyzed by ion trap CI-GC/MS.

Of 115 inner-city elementary school desks, cocaine was detected on every desk (mean = 150 ng, σ = 140 ng, LOD = 12 ng). In contrast, only two suburban elementary school desks revealed cocaine levels above the LOD (n = 96, mean = 11 ng, σ = 15 ng). All results, including those below the LOD, were included in the statistics. Similarly, the most common cocaine breakdown product, benzoylecgonine, was more prevalent on urban desks (n = 115, mean = 147 ng, σ = 138 ng, LOD = 2 ng) than desks from a suburban school (n = 96, mean = 0.87 ng, σ = 3.3 ng). The ratio of BE to cocaine had no predictive value.

These data reveal quantities of cocaine substances (ng/swab extract) exceeding the limits of detection and limits of quantitation for analyses of other external surface matrices such as hair (expressed in ng/mg) and sweat (expressed in ng/mL extract), as well as inanimate objects, for which there is no mandated standard practice or cutoff for reporting a surface as "positive" for a drug. Because drug use is unlikely in the elementary school environment and by this young age group population, these results support the conclusion that drugs in a real-life environment can transfer from at least one object to human skin and then to another object a distance from the first. These results suggest caution should be exercised when ascribing drug use conclusions based on surface testing when contamination cannot be excluded. BE does not appear to be a good indicator of cocaine use because BE is a congener in street cocaine, because cocaine decomposes to BE in the environment, and because residues containing BE from the sweat of drug users can transfer repeatedly.

Cocaine, Contamination, Children

LW1 Absinthe: The Green Fairy – Myth, Mystery, or Reality?

William T. Lichon, DDS, 4028 State Street, Suite A, Saginaw, MI 48603*

The goal of this presentation is to familiarize the audience with the myth and reality of the herbal liqueur called "Absinthe."

This presentation will impact the forensic community and/or humanity by traversing the shaky history of Absinthe from its composition and recipes and its present legal considerations.

Absinthe is an alcoholic drink made from an abstract of Wormwood (Artemisia Absinthium). Its color is emerald green and its taste is very bitter (due to the presence of Absinthium). Absinthe is a potent herbal liquor historically ranging from 55-75 percent (up to 150 proof) in alcoholic strength. Its infamous green tint traditionally resulted from the presence of chlorophyll.

At the center of the mystery surrounding absinthe is the compound "thujone." It is classified as a monoterpene, which is found in the essences of various plants and flowers. Thujone has been shown in vitro lab studies that it may affect certain elements of brain chemistry. This theory was based on the similarities in molecular structure between thujone and THC, the active component of marijuana. Despite this similarity, a study in 1977 by Meschler, Marsh, and Howlett debunked this theory proving that thujone does not bind with cannabinoid receptors. Relevant or not, commercial absinthes of today rarely contain more than ten milligrams of thujone in accordance with the European beverage laws.

Absinthe was invented in 1797 by Dr. Pierre Ordinaire. Later, Henri-Louis Pernod opened the first absinthe distillery in Switzerland, then in France in 1805. By the 1850s it had become the favorite drink of the upper class and was quite expensive. Originally wine based, blight in the 1870s on the vineyards forced the manufacturers to base it with grain alcohol. Absinthe was then distilled from Common Wormwood, Star Anise, Fennel Seed, Angelica, Hyssop, and other herbs. The selection and amounts of each are important parts of the distiller's secret recipe.

With the cost down, everyone could now afford it. The bohemian lifestyle embraced it. The "Green Fairy" (la fee verte) as it became known, was most popular in France but later spread to other parts of Europe and the United States. Most days started with a drink and ended with the "green hour" (l'heure verte).

The consumption of absinthe is like no other liqueur. The Green Fairy is a demanding task mistress, having her very own ritual of preparation. The usual protocol is a measure of absinthe is poured into a special absinthe glass. A perforated spoon is then placed over the rim of the glass and a cube of sugar is placed on the spoon. Cold water is then poured over the sugar into the glass to reach a 1:4 or 1:5 mixtures. The drink then turns into an opaque white mixture as the essential oils precipitate out of the alcoholic solution (louche). Drinking absinthe straight can cause gratuitous tears and choking from its intense taste.

Absinthe was once popular among artists and writers. It was consumed by Van Gogh, Verlaine, Degas, Toulouse-Lautrec, Picasso, Oscar Wilde, and Hemingway to name a few.

It appears to have been believed to stimulate creativity. However, in the 1850's, there began to be concern about the results of chronic use. Chronic use of absinthe was believed to produce a syndrome call absinthism which was characterized by addiction, hyper excitability, and hallucinations.

In 1905, Jean Lanfray who was very intoxicated from other types of alcohol, murdered his pregnant wife, and two children then failed to kill himself. He supposedly only had one to two glasses of absinthe but none the less his trial became known as the "Absinthe Murder." Soon an outraged citizenry responded by petitioning to ban absinthe in Switzerland. The ban was then enacted in 1910. In France, the wine industry, which was financially hurting, joined with the Temperance League to ban absinthe in 1915.

In the United States absinthe's association with the bohemian lifestyle also worked to compound fears about effects, much as happened with marijuana. The law banishing absinthe was passed in 1912, preceding prohibition of all alcoholic beverages by several years. The "Green Fairy" had fled, but not forever.

In summary, thujone and absinthe were unjustly maligned and demonized for a combination of commercial and ideological (even religious) reasons. Forensic GC-MS testing in 2005 Emmert et al has proven that absinthe contains 0-4.3 mg/L of thujone, far below perceived amounts. These results match earlier findings showing a vintage 1900's bottle contained 6 mg/L. GC-MS testing is important in this capacity because gas chromatography alone may record an abnormally high reading of thujone due to other chemicals being present. Through these tests it has become evident absinthe contains very little thujone.

Absinthe, Wormwood, Thujone

LW2 The Salem Witch Trials: Sociopolitical Hysteria, Systematic Persecution of Women, or Ergot Poisoning?

David M. Benjamin, PhD, 77 Florence Street, Suite 107, North, Chestnut Hill, MA 02467-1918*

The goals of this presentation are to review the sociopolitical environment which led to the Salem Witch Trials; to describe symptoms exhibited by those who were burned as witches; to identify the symptoms of ergot poisoning; and to formulate a reasonable explanation of what actually occurred.

The Salem Witch Trials have been the subject of debate among social historians, religious theologians, political pundits, and toxicologists for centuries. This presentation will impact the forensic science community and or humanity by discussing the factors which led to the Witch Trials and examine the possible role of ergot poisoning in the etiology of the "strange behavior" in those accused of being witches.

In 1692 in the Massachusetts village of Salem (now known as Danvers), seventeen women and seven men were either hanged, stoned to death, or allowed to die in prison for practicing witchcraft, demonic possession, or affiliating with Satan. The origins of this outrageous spectacle of death have been the subject of debate among social historians, religious theologians, political pundits, and toxicologists for centuries. The purpose of this paper is to review the factors which led to the Witch Trials and examine the possible role of ergot poisoning in the etiology of the "strange behavior" in those accused of being witches.

In 1692, Puritans and their clergy expressed a profound belief in Satan, and witchcraft was one of the strongest forms of proof of the existence of the devil. Salem had been founded by the Puritans, who attended a Protestant Church. However, a charter in 1691allowed previously disenfranchised religious groups such as the Quakers and the Anglicans to proliferate and usurp political power from followers of the traditional Protestant Church. In this framework of social upheaval, stress, and dissention, witchcraft provided a convenient explanation for the dissolution of the status quo, the potential decline of the Puritans, and the emergence of dissidents, insurgents, and sociopolitical flux. Sounds a lot like 2007 as well!

Salem Town experienced new growth in commerce. Some people reaped large profits. A new class of wealthy merchants emerged who dominated local politics to the detriment of the farmers. Many disputes

between the farmers and the merchants over tax revenue and control of the diminishing land space emerged. Such disputes gave rise to the farmers' fight for their right to build their own meeting house and obtain funds for their own minister. In 1689, Samuel Parris moved to Salem from Barbados to become the Preacher in the newly-founded Village Church, which would distinguish the "villagers" from Salem Town's people. With him, Reverend Parris brought his 10 year old daughter, Betty.

Betty Parris and her cousin, Abagail Williams, were among the first young girls to "succumb" to the stigmata of witchcraft, which consisted of: seeing visions, hearing voices, changes in the color and appearance of the skin, and screaming out in pain. William Griggs, MD, physician to the family examined the girls and conjectured that the "afflictions" were not known in medicine. Mary Sibley, a neighbor of the Parris' suggested that a "witch-cake" containing Betty's urine be baked by the Parris' Barbadian slave, Tituba. Ultimately, Tituba confessed to being a witch, and named four others as witches. All were tried. This set off a sequence of warrants and indictments so numerous that Sir William Phips, governor of Massachusetts created a special court of "Oyer and Terminer" to speed the disposition of the cases.

A search of Pub Med for "Salem Witch Trials and Ergotism" yields 111 responses. Ergot alkaloids comprise a group of LSD-like biologically active agents produced by fungi. Since the Middle Ages, historians have reported outbreaks of convulsive ergotism, involving hearing voices, severe burning in the digits, and hallucinations. These outbreaks were sometimes called the *ignis sacer*, or "Holy Fire" because of the intense burning pain and the belief that it was brought upon an individual for wicked acts. In 1093, a religious order to help those afflicted with this condition was founded in southern France, and soon the syndrome of insanity, hallucinations, pain and gangrene in the digits, became known as St. Anthony's Fire, named after St. Anthony, the patron saint of the suffering. St. Anthony's Fire was known to be associated with a fungus, *claviceps purpurea,* which developed on barley, wheat, and especially rye grain. An infected grain produced a pink or purple spur about the size of a grain of rye. This grain came to be called "mad grain" and "drunken rye" and produced the LSD that caused local outbreaks of madness. In 1692, Salem was not the only town to experience "the fungus among us"... the weather had been damp and cool and the mold had proliferated causing eruptions of ergotism in Essex County Massachusetts and Fairfax County, CT. Those afflicted were primarily young women, and the symptoms they displayed were hallucinations, hearing voices, and strange behavior. The similarity between ergotism and the behavior attributed to those who were burned as witches will be discussed, as well as opposing views.

Salem Witch Trials, St. Anthony's Fire, Ergotism

LW3 The Introduction of "Anesthesia" to Surgery & Strange Case of Dr. Jekyll and Mr. Hyde

Robert J. Koolkin, DDS, 300 Avenue A, Turners Falls, MA 01376*

The goal of this presentation is to demonstrate how events in the history of medicine have impacted literature and culture.

This presentation will impact the forensic community and or humanity by serving as a reminder that iconic historical figures were also 'flesh-and-blood' human beings.

Although laughing gas parties and 'ether frolics' were regular events in 19th Century America, no one had thought to use inhaled gases or vapors to avoid the pain of surgery. The Victorian mind still perceived pain as the "Will of God."

Every first year dental student is taught that the great Boston dentist Dr. William T.G. Morton introduced ether anesthesia in the amphitheatre of Massachusetts General Hospital. They might know the date (it was the 16th of October 1846) but they likely would not know that Morton was a semi-literate scoundrel whose discovery led to his ruin.

Morton had made the acquaintance of Dr. Horace Wells. Wells, a prominent Hartford dentist, was exceedingly clever and had received several U.S. patents. One of Well's inventions, a type of gold platework, struck Morton as especially promising and within a year Morton and Wells began a business partnership to promote Wells' platework.

In the second week of December 1844, Dr. Wells took his wife out for an evening of scientific entertainment at Gardner Q. Colton's "Grand Exhibition of the Effects Produced by Inhaling Nitrous Oxide" Throughout the evening Wells pondered what he had observed. After the show was over he approached Gardner Colton with an idea: As Wells himself had been suffering with a nagging toothache, it occurred to him to gas himself senseless prior to having his partner extract the offending molar. The next day's experiment was an unqualified success.

Wells contacted his former partner William Morton who arranged a meeting with Dr. John C. Warren, head of surgery at Massachusetts General Hospital. He authorized Wells to administer the gas to a patient in need of a dental extraction. Numerous students and faculty came to observe. With only a month and half of experience with the gas, Wells extracted the tooth. Unfortunately, during the procedure the patient emitted a noise; some called it a groan, others described it as sort of a weak bleat. The audience perceived the demonstration as an abysmal failure despite the fact that the patient reported experiencing almost no pain. Wells was subjected to a chorus of "humbugs" and slinked out of town at daybreak. *"The excitement of this adventure,"* Wells said later, *"brought on an illness from which I did not recover for many months."* The reality was that the humiliation he suffered precipitated his first nervous breakdown.

Months later, William Morton claimed to have had an epiphany while listening to an assistant describe the ether frolics staged at his old school. Morton had no great yearning to ease the suffering of mankind but he did know that painless dental extractions would be a boon to his dental plate business. Morton realized that ether could serve as the painkiller that he sought to boost his business.

Not only did Morton have a patient all lined up to be etherized for an extraction; he also had a newspaperman there to report it. The extraction proceeded painlessly under the effects of four whiffs of sulfuric ether administered from a handkerchief. The *Boston Transcript* ran a story entitled 'A New & Valuable Discovery' which ended by stating quite correctly that: *"The discovery is destined to make a great revolution in the arts of surgery and surgical dentistry."* Morton however had decided to keep the identity of the mysterious agent a secret.

The very next day William Morton consulted with a lawyer regarding the possibility of obtaining a patent on ether. No one had ever patented a truly important medical discovery before. Morton continued to experiment. He etherized his dog, his goldfish, and himself on several occasions. He also learned that by adding oil of orange to the ether he might partially disguise its signature scent. The addition of the orange oil also gave him the right to assert that the secret liquid, which he dubbed 'Letheon', was not merely one substance but a compound.

It was a Friday October 16th 1846 when William T.G. Morton strode into the operating theater at Mass General Hospital; he was almost thirty minutes late for his appointment with destiny. He had always delivered the ether via a handkerchief but now felt that he needed to fashion an apparatus for use in the public demonstration. Morton was trying to turn a discovery into an invention. The glass retort that he had had fashioned into an ether inhaler had literally just been completed and he had yet to experiment or practice with it in any fashion. On what would become known as Ether Day, Morton administered the Letheon to Dr. Warren's patient Gilbert Abbott. Mr. Abbott fully expected to have a large growth cut from the side of his neck while feeling every slice of the blade. Instead, he had his tumor carefully dissected while he was totally insensible – nothing like it had ever been performed publicly. Upon completing his operation, Dr. Warren pronounced to the gallery: "Gentlemen-*this* is no humbug." Less than two years after Horace Wells had made a laughing stock of himself with the nitrous oxide gas, Ether Day had finally arrived.

With all his shortcomings, Morton's strong suit was in knowing when and where to seek sound advice. Within weeks Morton wrote to Oliver

Wendell Holmes –Sr. (father of the Supreme Court justice) requesting his input on what to call this unconscious state provided by the Letheon. Holmes- physician, writer, and nationally recognized poet wrote the following to Morton:

> *"Everybody wants to have a hand in a great discovery. All I will do is to give you a hint or two as to names—or the name—to be applied to the state produced and the agent. The state should, I think, be called 'Anaesthesia' [from the Greek word anaisthsia, "lack of sensation"]. This signifies insensibility…. The adjective will be 'Anaesthetic.' Thus we might say the state of Anaesthesia, or the anaesthetic state.*

Morton spent the remainder of his life (another twenty years) and squandered his savings unsuccessfully lobbying the U.S. Congress for financial compensation.

In the interim Dr. Wells had become convinced of the superiority of chloroform and devoted himself to experimenting with it. In a matter of months Wells was deep in the grip of chloroform addiction. His behavior became more and more erratic until he found himself jailed in the Tombs of New York. accused in several incidents of having thrown sulfuric acid onto the clothes and faces of Broadway prostitutes. Wells then proceeded to anesthetize himself from a vial of smuggled chloroform. Using his own razor he sliced his femoral artery and bled to death alone in his cell. It was January 24th 1848, just three days past his thirty-third birthday. A mere fifteen months had passed since ether day. Widely reported at the time, the demise of Horace Wells is believed to have been the inspiration for Robert Louis Stevenson's "Strange Case of Dr. Jekyll and Mr. Hyde."

Ether, W.T.G. Morton, Horace Wells

LW4 Lincoln's Duel with Broadswords: Shields, Sabers, and Bloody Island

David Weinberg, JD, JuryGroup, 3 Taliar Ridge Road, Guilford, CT 06437*

After attending this presentation attendees will understand (a) the jurisdictional advantages of dueling on sandbars, (b) how Lt. Robert E. Lee of the Army Corp of Engineers preserved the port of St. Louis in 1838, (c) why Abraham Lincoln chose cavalry "broadswords" as his dueling weapon, and (d) the lessons and outcome of this historic duel.

This presentation will impact the forensic scientist community and or humanity by describing how the intersection of engineering, jurisprudence, government, and human behavior shapes historical events.

On September 22, 1842, Illinois State Auditor James Shields, a Democrat, and State Representative Abraham Lincoln, a Whig, rowed separate boats to Bloody Island to engage in a duel of honor. Nearly forgotten now, the event became so infamous at the time that Lincoln feared it would be the only thing for which he was remembered. When an army officer questioned Lincoln in the White House about the affair, Lincoln replied, "I do not deny it, but if you desire my friendship, you will never mention it again."

Bloody Island was a sandbar in the Mississippi which first appeared off the port of St. Louis, Missouri about 1800. A short time later, Aaron Burr challenged Rufus Easton to a duel there. Easton declined and went on to found Alton, Illinois across the river from St. Louis. Others were not so prudent as Easton, and lawyers, politicians, bankers and military officers went on to soak the sandbar with blood. The presentation will explain how four years before Shields and Lincoln met there on the field of honor, a young Army engineer, Lieutenant Robert E. Lee, transformed the geography of Bloody Island forever.

James Shields, a fiery immigrant from Ireland's County Tyrone, initiated the duel. Outraged by a series of satirical letters published in the local *Sangamo Journal*, Shields demanded that Lincoln retract the letters or face the consequences. Lincoln had written one of the letters, but chivalrously concealed the fact that the most offensive and personal had been written by Lincoln's friend Mary Todd, who had also been courted by Shields. Lincoln accepted Shield's challenge, but dictated "cavalry broadswords of the largest size" as weapons. The presentation will examine Lincoln's choice the weapon known as "The Old Wristbreaker," his unusual but strategic terms of engagement and the final outcome of the contest,

The presentation will also explain James Shield's unique place in U.S. history. Shield's duels continue posthumously. The presentation will discuss Shields current affair of honor with the late President Ronald Reagan.

Dueling, Engineering, Swords

LW5 "Strangulatus Pro Republica:" How the Assassination of President James Garfield Spawned "Firsts" of Medicine, Technology, and Law

Jennie Meade, JD, MLS, The George Washington University Law Library, 716 20th Street, NW, Washington, Washington, DC 20052*

After attending this presentation attendees will learn which new medical techniques, technologies, and laws and legal theories were triggered by the assassination of President James A. Garfield in 1881, and understand how these advances formed the basis for further development and refinement throughout the twentieth century.

This presentation will impact on the forensic community and/or humanity by bringing attention to the medical, technological, and legal developments which were occasioned by the assassination of President Garfield, and how these developments were important to the twentieth century.

"Tortured for the Republic." These words, written by the wounded American President James Garfield in the summer of 1881 on a fragment of paper beneath his autograph, reveal not only Garfield's comprehension of his apparently imminent death, but convey the message that he would die in the name of his country. Though he undoubtedly intended his expression of martyrdom to be understood on a grander scale, Garfield could not anticipate that the circumstances of his shooting and death would precipitate numerous positive advances which, while not providing the grand executive sweep he perhaps contemplated, left significant improvements on a human level which made his brief six-and-a-half month presidency ultimately a productive and valuable one.

Garfield the person is little remembered today, yet he was a man eminently suited to be President. He was the last of the "log-cabin" Presidents, an Ohio native born in poverty who graduated from Williams College as a classics scholar. His presidency of Hiram College, admission to the Ohio bar, service as a Union general in the Civil War, and subsequent election to Congress gave him sound preparation to execute the duties of the Presidency.

Post-election, the White House corridors were filled with office-seekers attempting to lobby the President for government positions, among them Charles Guiteau, a mentally-unbalanced lawyer who was Garfield's opposite in every way. Habitually one step ahead of his creditors, he had been involved with a fringe religious sect and was a wife abuser. He was ubiquitous at Garfield's White House, pleading repeatedly for assignment to the Paris consulate. Rebuffed in these attempts, Guiteau planned and executed the July 2, 1881, shooting of the President at the Baltimore and Potomac Railroad Station in Washington, DC, located on the current site of the National Gallery of Art.

The wounded Garfield lingered for over two and a half months, during which time efforts to locate the bullet lodged in his body occasioned his examination by many doctors, all of whom inserted their unwashed fingers into the bullet wound, thus introducing the infection which eventually killed the President. Although antiseptic method had been developed by Joseph Lister during the 1860s, Garfield's doctors remained skeptical, and stood by

their old habits. Upon Garfield's death, this episode in medical history helped focus the medical profession on the importance of surgical antisepsis which became *de rigueur* by the late 1880s.

When a fragment of fibrous material issued from the President's wound in a torrent of pus, one of the doctors examined the fragment under a microscope. Reportedly this was the first forensic science examination performed microscopically, and it confirmed that the fragment belonged to Garfield's cotton shirt.

Efforts to assist in the President's recovery resulted in new technologies. Attempts to locate the bullet spurred Alexander Graham Bell to devise an "induction balance," a rudimentary metal detector, the first of its kind, which he used on the President. In order to keep the President cool in the miasmic Washington summer, Navy engineers constructed the first air conditioner by forcing cooled air through cotton filters, which then was vented into the President's room. All were to no avail.

The trial of Guiteau in Washington, DC, became one of the most notable nineteenth-century insanity trials in America, and focused attention on the then-controversial insanity defense and its legitimacy.

Garfield's assassination elevated his status to martyr, giving him in 1881 a luster his short tenure as President could not have conferred. The aftermath of the President's shooting and death produced a focus by the nation, first on Garfield's well-being, then on the issues produced by the assassination, which resulted in a series of positive developments for the American nation which extended well past the nineteenth century. Legally, the Pendleton Civil Service Reform Act (1883) resulted in the dismantling of the "spoils system" of awarding government offices which had attracted Guiteau to the White House, and the establishment of the Civil Service Commission to administer a system based on merit rather than political connections.

Garfield, Assassination, Guiteau

LW6 Sickles the Incredible and the Origin of the Defense of Temporary Insanity

Jerry D. Spencer, MD, JD, Office of the Armed Forces Medical Examiner, 668 Pinewood Drive, Annapolis, MD 21401*

The goal of this presentation is to learn information about the history of the United States and the defense of temporary insanity.

This presentation will impact the forensic science community and or humanity by providing knowledge of the history of the United States. Its intended impact is information and entertainment of the audience of the Last Word Society.

On February 27, 1859 one of the most notorious and sensational murders in Washington, D.C. took place across the street from Lafayette Park, near the White House. Congressman Daniel Sickles shot down an unarmed Philip Barton Key in front of more than a dozen witnesses. Sickles was a well-known lawyer and congressman from New York who was a good friend of James Buchanan, then President of the United States. Key was also a well-known public figure. He had served as the U.S. Attorney for the District of Columbia under President Franklin Pearce, and had been re-appointed to that position by President Buchanan. His uncle, Roger B. Taney, was the Chief Justice of the U.S. Supreme Court. He was also the son of the late Francis Scott Key, a former U.S. Attorney for the District of Columbia, and well-known as the author of the patriotic song, "The Star Spangled Banner."

Two days before the murder, Sickles had learned that his young wife Teresa had been carrying on an affair with Philip Barton Key for several months. He obtained a written confession from her with details of the affair, including the fact that Key had waved a white handkerchief from across the street from the Sickles residence as a signal that he was "free" for a rendezvous. The next day, Sickles was on the 2nd floor of his home when he looked out a window and saw Key waving a white handkerchief. Enraged, Sickles grabbed some pistols in his residence, went outside, and ran over to where Key was walking, and shot him several times in front of witnesses. Key was carried into a nearby house, and died a few minutes later.

The sensational story of the murder and even the transcript of his wife's confession were carried by newspapers throughout the United States, London, and Paris. For the trial, Sickles assembled a top-notch defense team including Edwin Stanton, later to be the Secretary of War for President Lincoln during the Civil War. Two months later, with his defense team using the "temporary insanity" defense for the first time in this country, Congressman Sickles was acquitted of the murder of Mr. Key.

The circumstances surrounding the homicide and the use of the defense of temporary insanity in the trial will be examined. In addition, the subsequent career of "Sickles the Incredible" will be briefly reviewed (including how his right leg came to be on display at the National Museum of Health and Medicine).

History, Homicide, Temporary Insanity

LW7 The Dollhouse and the Death Investigator: The Nutshell Studies of Crime

Katherine Ramsland, PhD, DeSales University, 2755 Station Avenue, Center Valley, PA 18034*

After attending this presentation, attendees will learn about a unique contribution in the history of forensic science and will be reminded of the importance of observing all clues before making a judgment about manner of death.

Frances Glessner Lee was one of the first women to make a significant contribution to forensic science and she serves as a role model to other young women. This presentation will impact the forensic science community by demonstrating how her crime scene dioramas serve as a reminder for all death investigators to beware of tunnel vision and to remember that the smallest clues can turn an investigation into a new direction.

On display at the medical examiner's office at the Baltimore city morgue is a series of dollhouse dioramas, the work of philanthropist Frances Glessner Lee. One of the Academy's earliest members, she had these miniature crime scene scenarios constructed during the 1940s to teach police officers about different types of death scenes and to encourage them to use careful observation before devising a hypothesis.

Born into a wealthy family on March 25, 1878, in Chicago, "Fanny" was exposed to great minds but tutored in private. She hoped to go into law, but her father forbade her from attending a university. She met a friend of her brother's, George Burgess Magrath, who taught her about legal medicine. After he became the medical examiner for Suffolk County, Massachusetts he confided to Lee the need for better training for death investigators. This inspired her, as did Conan Doyle's stories about Sherlock Holmes, to establish and support a department at Harvard for the teaching of legal medicine.

She became so well versed in crime that in 1943, Lee received an honorary appointment as a captain of the New Hampshire state police - the first woman to hold such a position - and in 1949 she was the first woman to be invited to the initial meetings of the American Academy of Forensic Sciences. In addition, she became the first female invited to join the International Association Chiefs of Police.

As she learned about the field, Lee noticed that police officers often made mistakes when trying to determine whether a death was the result of an accident, a natural event, a suicide, or a homicide. Often, they simply missed clues. She envisioned a series of crime tableaux as teaching devices, made to scale and inclusive of all the items found in actual crime scenes. Then she set about to get them professionally made. To create each diorama, she blended several stories, sometimes going with police officers to crime scenes or the morgue, sometimes reading reports in the newspapers, sometimes interviewing witnesses, and sometimes utilizing fiction.

Lee employed carpenters for the houses and made each doll by hand herself, using a cloth body stuffed with cotton BB gun pellets and bisque heads. Once the dolls were ready, Lee would decide just how each should "die," and proceed to stick knives in them, paint signs of decomposition on their pale skin, or tie nooses around their necks and hang them up. In the end, she made nineteen scenarios and sponsored week-long teaching seminars twice a year for selected police officers. By 1949, some 2,000 doctors and 4,000 lawyers had been educated at the Harvard Department of Legal Medicine, and several thousand state troopers, city detectives, coroners and district attorneys had attended the seminars.

Frances Glessner Lee, Nutshell Studies, Death Investigation

LW8 Where Death Delights: Who First Said It? Part II

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 discover highlights from the history of pathology, as related to the origin of the Latin motto that translates as "Where death delights to serve the living"; will become familiar with forgotten heroes and characters out of the history of forensic pathology; will understand the role that dissection and anatomy theaters played in the scientific and medical world at the end of the 18th century; and will know more about the role and the limitations of the Internet in research (usegroups, digital research, search engines), as used by a research expert to follow this quotation toward its source.

This presentation will impact the forensic science community by allowing the forensic community to discover the identity of the actual author of a beloved quotation used in forensic circles worldwide and offering comprehension into the uses and limitations of the Internet in doing research.

> "Let conversation cease. Let laughter flee. This is the
> place where death delights to serve the living."
> Or, in Latin, "Taceant colloquia. Effugiat risus.
> Hic locus est ubi mors gaudet succurrere vitae."

Where did this quotation come from? In Latin or in English it adorns the doors and Web sites and badges of medical examiner offices and coroners all over the United States. It can be found in autopsy theaters and forensic sites across the world. Yet no one has been able to give it an accurate attribution – until now.

In 1994 on the day I started my forensic pathology fellowship I first saw this quote emblazoned in bronze letters on the marble wall of the lobby of the Office of the Chief Medical Examiner of the City of New York. It was placed there in 1960 by Dr. Milton Helpern, the giant of forensic pathology who founded and built the Manhattan medical examiner's office. From him, wittingly or unwittingly, every forensic expert in the United States has derived it. But where did Dr. Helpern get it?

In his memoirs he wrote, "Its origin is lost in the mists of time." But is it? That question began a seven year journey for me and my research team on an Internet research odyssey to find out who the mists of time were obscuring. We presented the initial fruits of our research at a Last Word session of the American Academy of Forensic Sciences meeting in 2002.

At that time we were able to show that the quotation consisted of two parts with different histories, which had been incorrectly spliced together by someone unaware of the rules of Latin poetry (dactylic hexameter). We developed a good guess as to where the spliced version came from, and we were able to disprove a dozen guesses as to who the author might have been. We came to understand why the quote cannot date to the ancients, but must have been written in the centuries between Vesalius and Dr. Helpern. As we left the ancients behind, returning to our own century, we moved the earliest known citation back in time, over and over. Eventually we started to narrow the search to the 19th century classically trained physician in Paris or Italy, who must have been the first to use the phrase; and beyond that to the modern Latin poet in the end of the 18th century who first came up with it.

Although we never determined the author of the paragraph that was excerpted to provide the first half of the quote, we were able to trace the second half back to anatomy theaters all over Europe in the nineteenth century. The twists and turns of our detective story took us through great figures of medicine in those decades, including men as famous in their time as Dr. Helpern is in our time; men who have been nearly forgotten except by experts – a note that foreshadowed our eventual discovery.

By 2001 we had traced the second half of the quote as far back as the lintel of an anatomy and dissection theatre in Paris in 1833, and there we foundered. We remained stuck there for five and a half years, patiently chewing away at the question whenever opportunity offered. But while we waited, ancient texts were being digitized by projects across the world; more and more treatises became available to a search across the Internet. In 2007we were rewarded with the breakthrough discovery which led us to the actual author of the second half of the quote – a man so famous in his day for Latin poetry that it would have completely astonished him to find himself not only forgotten except by experts two hundred years later, but quoted without attribution daily all over the world. And we discovered what kind of role dissection and anatomy theaters played in the scientific imagination and civic life of the day, which explains why a Latin poet would be asked to compose an epigraph so resoundingly appropriate for the dedication of such a place.

This historical detective story, researched only through the Internet, highlights what kind of investigative tool the Internet is in expert hands, and where it still falls short. What can the Internet do to help a pathologist or a historian answer unanswerable questions? And when is it likely to prove as great a distraction as it is a help?

The mists of time that baffled Dr. Helpern are parting in the face of Internet research, and they reveal the origin of at least the latter half of the great motto of our field, "Taceant colloquia. Effugiat risus. Hic locus est ubi mors gaudet succurrere vitae: Where death delights to serve the living."

Where Death Delights, History of Pathology, Author Attribution

LW9 Fusen Bakudan: The Intercontinental Balloon Bombs of WW II

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After attending this presentation, atendees will have learned about the Japanese balloon bombs of WWII, their purpose and construction, and the forensic challenges of determining their origins.

This presentation will impact the forensic science community and or humanity by exploring this early chapter in intercontinental missile warfare.

At 0500 hours on the morning of November 3, 1944, Japan released the first of more than 9,000 "fusen bakudan", or balloon bombs. The releases continued until April 1945. The winds of the winter Jet Stream, at altitudes over 5 miles, carried these balloons from Japan to North America in three days at an average speed of 70 mph. Approximately 10% of the balloon bombs reached North American shores.

The balloons were designed for a lifting capacity, at sea level, of one thousand pounds. This required a hydrogen filled balloon with a diameter of 30 feet. Experiments with rubberized silk balloons were promising. However, due to the weight of the material and the criticality of the components to the Japanese war effort, the final design used traditional Japanese tissue paper made from fibers of the mulberry tree. To increase the strength and reduce the diffusion of the lifting gas through the envelope, several layers of this paper were laminated to form a composite using a cellulose paste made from the Japanese konnyaku potato.

During the three-day journey, the hydrogen gas would expand during the warmth of the day, and contract during the colder nights, causing the balloon's altitude to rise and fall. To prevent the balloon bomb assembly from dropping below the jet stream, or even losing so much altitude that it dropped into the ocean, each balloon bomb assembly contained a number of ballast sand bags. The sand bags were rigged with fuses triggered by a signal

from an altitude-sensing aneroid barometer. When the balloon dropped below a preset altitude, a ballast bag was released, lightening the load and allowing the balloon to rise.

A typical balloon payload consisted of a bomb and thermite incendiary devices. After releasing the payload, the balloons were set to catch on fire and self-destruct. As the sighting of these balloons increased, the U.S. government directed the resources of the defense department to determining the mysterious origins of the attack. The government did not believe that the balloons could come from as far as Japan and instead speculated that they were launched either from submarines or from North American beaches by landing parties. These weapons were designed to start fires and cause loss of life through aerial bombardment. However, an arguably more powerful weapon was the potential for psychological warfare, especially if large numbers of the balloons began to arrive. The Office of Censorship directed the media not to mention the balloons to prevent panic and to avoid encouraging whoever was producing them to send more.

The Military Geology Unit of the U.S. Geological Survey investigated ballast sand that had been recovered from various balloon crash sites. Microscopic examination showed the sand contained shell fragments, indicating that the ballast sand came from a beach, but compositional analysis ruled out North American beaches as a source. The skeletons of microscopic diatoms present in the sand had only been previously described in published Japanese geological studies of beaches on the eastern shore of Honshu. Based on that information, and with the aid of reconnaissance photographs, allied bombers located and destroyed the hydrogen production plants. Lacking hydrogen and without any information to verify that the balloon bombs were reaching North America, the Japanese government had already canceled the project.

In total, 285 balloons were observed to reach North America. The majority of these caused no property damage or injuries. The lone exception was a woman and five children who were killed in Oregon when they discovered and disturbed a grounded balloon with unexploded payload.

Fusen Bakudan, Balloon Bombs, Geology

LW10 Citizens Confront James-Younger Gang: The Northfield Raid of 1876

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The goal of this presentation is to familiarize the forensic community with the historic attempted bank robbery in Northfield, Minnesota on September 7, 1876 by analyzing the firearms used during the raid. It will examine how the citizens, who used rifles and shotguns, defeated the James-Younger Gang, who were armed with revolvers, in the attempted bank robbery that became known as the Northfield Raid of 1876.

This presentation will impact the forensic community and/or humanity by discussing the firearms used in the historic attempted bank robbery in Northfield Minnesota in a way that will enlighten those who study historical cases involving the discharge of firearms.

Were the citizens of Northfield at the time skilled marksmen or were the gang members unprepared for the firearms that the citizens used against them? In this incident the locals fought back with rifles and a shotgun against the infamous James –Younger Gang who were brandishing revolvers. The citizens' heroic actions resulted in the demise of the gang.

The plan to rob the Minnesota bank is believed to have originated somewhere on the Osage River in Missouri. One of the robbers, Bill Stiles, had lived in Minnesota and was familiar with some of the towns and roads. He convinced Jesse James that Minnesota had substantial amounts of money in its banks. James was initially against the robbery because Minnesota was an unfamiliar territory but Stiles convinced him he had complete knowledge of the area and friends throughout the state who would provide assistance if needed. After their meeting, James visited Bob Younger in a Kansas hotel and convinced him to join the gang in the Minnesota robbery. In late August, Jesse and Frank James, Cole, Jim, and Bob Younger; along with Clell Miller; Charlie Pitts, and William Stiles traveled to Minnesota by train from their Clay County home in Missouri.

After arriving in Minnesota, the gang divided into groups in search of some possible towns to carry out a robbery. Subsequent to visiting several towns, the gang traveled toward Northfield, a mill town of approximately 2000 people located on the Cannon River in Rice County. The First National Bank of Northfield was located downtown south of the Cannon River in the Scriver building on Division Street. On September 7, 1876, the gang set out on horseback for Northfield. They dressed in linen dusters, a type of outfit generally worn by cattlemen, to conceal their revolvers.

As soon as they rode into town, the town's people were suspicious of the strangers. The gang split into three groups: the robbers, a group to guard the bank entrance and a group to provide an escape route. Frank James, Bob Younger, and Charlie Pitts entered the bank and confronted Alonzo Bunker, a bank teller, Joseph Lee Heywood, the bookkeeper, and Frank J. Wilcox, the assistant bookkeeper. With pistols drawn, they went behind the counter and demanded that the safe be opened. The safe was located in the vault and the vault door was open. Unknown to the robbers the safe was unlocked but its doors were closed giving the appearance of being locked. Although there were numerous threats and even a blow to Heywood's head with the barrel of a revolver, the bank employees resisted giving any money to the robbers.

During the attempted robbery, Alonzo Bunker escaped by running out the backdoor. Pitts chased him and fired a shot which struck Bunker in the shoulder but Bunker got away. The robbers found a cashier's till on the counter and put its contents into a grain bag. It was less than $100 in nickels, pennies and some silver, yet, when the robbers fled the bank they left the sack behind on the floor. On exiting the bank, it is believed that Frank James looked back, aiming his revolver at Heywood's head and fired. Heywood fell to the floor mortally wounded.

After Dr. H.M Wheeler saw three strangers enter the bank and two others remain out front, he walked down to the bank while the attempted robbery was in progress. As he approached the bank, he saw Clell Miller grab a local hardware dealer, J.S. Allen, by his coat collar. Miller drew his revolver and began firing in the air. Allen broke free, ran around the corner and yelled that the bank was being robbed and for people to get their guns. Gunfire erupted.

Clell Miller was mounting his horse when Elias Stacy approached him and shot him in the face with a shotgun. The blast of birdshot knocked him off the horse but he remounted. Dr. Wheeler ran to the Dampier Hotel where he borrowed Dr. Dampier's single shot .50 caliber Smith carbine that hung on the wall. Positioned on the 2nd floor of the Dampier Hotel, Wheeler mortally wounded Miller.

The remaining robbers rode up and down Division Street and warned the citizens to stay inside. They fired their pistols in the air and at store front windows when they observed spectators looking out. A Swedish immigrant, Nicolaus Gustavson, who did not understand warnings shouted in English, was shot and killed. Another round from Wheeler's carbine struck Bob Younger's right elbow. A.R. Manning took a single shot Winchester to the corner of the street and fired at the robbers. One shot hit Cole Younger in the hip. Manning then took careful aim at William Stiles who was about 80 feet away and mortally wounded him.

After the attempted robbery, the James brothers, Young brothers, and Charlie Pitts fled the town. The James brothers escaped but the Younger brothers and Charlie Pitts faced a posse at Madelia, Minnesota. In this confrontation, Pitts was shot five times and killed. During both the attempted bank robbery and the shootout in Madelia, Cole Younger received eleven wounds. One ball lodged in his right eye. Jim Younger received five wounds, one of which was in his mouth.

The attempted Northfield bank robbery led to the demise of the infamous James-Younger Gang. The bank robbers armed with revolvers were no match for the citizens armed with rifles and a shotgun.

Bank Robbery, James-Younger Gang, Northfield Raid of 1876

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