H93 "Forens-OMICS": The Application of Omics Sciences to Forensic Investigations

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Learning Overview: After attending this presentation, attendees will understand the potential of "omics" methodologies to estimate Postmortem Interval (PMI). Attendees will be introduced to "Forens-OMICS" as the first global application of several "omics" technologies to forensics and will discuss current state and preliminary findings from omics data.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by introducing an innovative approach to PMI estimation. Combining molecular methods with visual observations may provide more precise and unbiased estimates and help overcome current methodological limitations.

Estimates of time-dependent biological processes (e.g., PMI and age at death) are based primarily on visual observations and require considerable experience and expertise. Moreover, most methods rely on the completeness of remains or presence of certain skeletal elements. This limits the possibility to obtain precise estimates from incomplete remains, a common situation in mass disasters, conflicts, terrorist attacks, and routine casework.

Biomolecules, such as proteins and lipids, are abundant in bone tissue and persist long after death. Consequently, these biomolecules may retain and reveal information about time-dependent biological processes significant to forensic investigations. Proteomics provides information about age at death and PMI, and lipidomic analyses of skeletal muscle and bone marrow are useful for PMI estimation.[1-5] This presentation demonstrates an integrative approach using various sources of omics data to reveal quantitative biomarkers for estimating PMI and age at death from remains in advanced states of decomposition, including skeletonization.

Omics data were obtained from four sources: pig bones, mice bones, human bones, and human skeletal muscle tissue. Liquid Chromatography with Tandem Mass Spectrometry (LC/MS/MS) was used to identify biomarkers on pig (n=4) and mice carcasses (n=96) of prolonged PMIs (up to six months). Proteomic studies identified biomarkers suitable for PMI, as well as age-at-death estimation (e.g., fetuin and biglycan). Lipidomics analyses of human muscle tissue from 16 human bodies at the University of Tennessee Anthropological Research Facility (n=262 samples, Accumulated Degree Days [ADD] 0–2,000) were analyzed via MS/MS. Cell membrane glycerophospholipids, specifically phosphatidylglycerol and phosphatidylethanolamine, showed the highest predictive power of PMI (R-square=0.85). Lipidomic analyses of human trabecular bone from three skeletal sites (calcaneus, proximal tibia, vertebral body) were conducted on 135 individuals. The sample consists of a cross-sectional and longitudinal component: (1) 115 skeletons from the William M. Bass Donated Skeletal Collection (PMI=1–30 years); and (2) 20 individuals placed at the University of Tennessee Anthropological Research Facility in 2018, which are being sampled every six months for two years. Analyses with a high-resolution electrospray ionization lipidomics analytical platform have identified 76 potential N-acyl amino acids; two have been validated via generation of the MS2 product ion for serine (palmitoyl and oleoyl serine).

These preliminary results show that omics data have great potential for transforming current approaches for estimating time-dependent biological processes of forensic import (e.g., PMI and age at death). Further lipid and protein class candidates are being validated with MS/MS, and machine learning algorithms will be used to analyze the combined omics data in addition to other omics results (e.g., DNA methylation data from bones) with the goal of improving predictive power and identifying the most accurate methodology to assess time-dependent forensic parameters.

Reference(s):

1. Procopio N. et al. Intra- and Interskeletal Proteome Variations in Fresh and Buried Bones. *J Proteome Res.* 2017;16(5).
2. Procopio N. et al. Forensic Proteomics for the Evaluation of the Post-Mortem Decay in Bones.. *J Proteomics.* 2018;177.
3. Langley N.R. et al. Forensic Postmortem Interval Estimation from Skeletal Muscle Tissue: A Lipidomics Approach. *Forensic Anthropology.* 2019.
4. Wood P. and Langley N.R. Lipidomics Analysis of Postmortem Interval: Preliminary Evaluation of Human Skeletal Muscle. *Metabolomics.* 2013; 3(3):127.
5. Dudzik B. Postmortem Interval Estimation Using Bone Lipidomics". *Proceedings of the American Academy of Forensic Sciences*, 70th Annual Scientific Meeting, Seattle, WA. 2018.

Omics Technologies, Postmortem Interval, Age Estimation

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