B126 The Calculation of Calibrated Likelihood Ratios (LRs) for Glass Using a Multivariate Kernel Density Model: Introducing a User-Friendly Graphical User Interface (GUI)

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Learning Overview: The goals of this presentation are to demonstrate the calculation of LRs for glass using a GUI and the interpretation of evidence using numerical values.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by illustrating how this software will help forensic scientists calculate LRs easily for casework glass using this GUI.

Laser Ablation-Inductively Coupled Plasma/Mass Spectrometry (LA-ICP/MS) for the quantitative elemental analysis of small fragments of glass evidence is considered the "gold standard" in the forensic analysis and comparison of glass.[1] The Organization of Scientific Area Committees (OSAC) -approved American Society for Testing and Materials (ASTM) E30 standard test method of analysis measures the concentrations of 17 elements and describes the comparison of glass samples collected from a victim or suspect to a known source. If the ASTM method results in no significant difference between the elemental concentrations of the recovered and the known source, a likelihood ratio can be calculated to better report the weight of the "match" between the glass samples. It has been previously reported that the use of a Multivariate Kernel (MVK) density 2-level model can be calibrated using Pool Adjacent Violators (PAV) that result in very low Rates Of Misleading Evidence (ROME), less than ~1% false exclusions and less than ~1% false inclusion rates.[2,3] Three glass databases were used to evaluate the performance of the LR; the first database includes 420 automotive windshield samples of known (authenticated) sources, the second database includes 385 glass samples from casework (the Federal Criminal Police Office of Germany [in German: Bundeskriminalamt, BKA]), and the third is a combination of the two. In addition to low ROME rates, the calibrated LRs limited the magnitude of the misleading evidence, providing only weak support for the incorrect hypothesis. Finally, most of the pairs found to be "falsely included" were explained by similarity of manufacturer of the glass source.

This presentation will focus on the simplification of the application of the previously developed R code for routine calculation of the LR in casework. One of the disadvantages in utilizing R programming is that it requires considerable knowledge in using the R software. The aim of the current effort is to develop a GUI to access the in-house written R code to calculate LRs to interpret the forensic glass evidence. The current R code has five main sections including: (1) installing and loading the required R-packages; (2) loading the background database (any glass database with the $\log_{10}$[elemental concentrations of glass]); (3) calculation of LRs for the samples in the background database (same source and different source) using the combination MVK+PAV calibration model; (4) load the casework data to be considered; and (5) calculate and calibrate the LRs obtained for casework data. All of the above steps within the process will be presented as graphical widgets within the GUI interface. The calculated LRs will be displayed in the "output" interface and the data will be saved as a ".csv" file. This presentation will include instructions on how to access the original R code, the simplified GUI interface with detailed instructions, and also make the background databases available.

The goal of this effort is to reduce the computational barriers to calculate LRs using the previously published MVK+PAV calibration model so that forensic practitioners can routinely use a quantitative and objective method for reporting glass evidence comparisons using an LR and couple verbal statements with a numerical interpretation of the casework evidence.

Reference(s):

1. ASTM E2927-16, Standard Test Method for Determination of Trace Elements in Soda-Lime Glass Samples Using Laser Ablation Inductively Coupled Plasma Mass Spectrometry for Forensic Comparisons. *ASTM International*, West Conshohocken, PA, 2016, www.astm.org.
2. Ruthmara Corzo, Tricia Hoffman, Peter Weis, Javier Franco-Pedroso, Daniel Ramos, Jose Almirall. The use of LA-ICP-MS databases to calculate likelihood ratios for the forensic analysis of glass evidence. *Talanta*, 186, 2018, 655-661.
3. Tricia Hoffman, Ruthmara Corzo, Peter Weis, Edward Pollock, Andrew van Es, Wim Wiarda, Aleksandra Stryjnik, Hendrik Dorn, Alex Heydon, Eva Hoise, Sandrine Le Franc, Xie Huifang, Begonia Pena, Thomas Scholz, Jhanis Gonzalez, Jose Almirall. An inter-laboratory evaluation of LA-ICP-MS analysis of glass and the use of a database for the interpretation of glass evidence. *Forensic Chemistry*, 11, 2018, 65-76.

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