A123 GSR Analysis: Correlating Quantities of Trace Metals (Pb, Sb, Ba) by ICP-MS to the Presence of GSR by SEM

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After attending this presentation, attendees will have a better understanding of the trace metal (Pb, Ba, and Sb) quantities identified by the Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) that correlate to the presence of gunshot residue (GSR) and associated particles reported using the Scanning Electron Microscope – Electron Dispersive Spectrometer (SEM-EDS). Attendees will also understand the effect that time and physical activity have on the quantities of trace metals associated with gunshot residue found on a person's hands after shooting a firearm.

This presentation will impact the forensic science community by highlighting the importance and validity of using the ICP-MS as a means to quantify trace metals associated with GSR by demonstrating a correlation between quantities of metals to the presence of GSR by SEM-EDS, thereby allowing the crime lab a greater throughput for GSR cases. The data gathered in this study from the SEM also has the potential to substantiate a timeline that shows the degradation of GSR evidence over time.

Traditionally, the Scanning Electron Microscope (SEM) has been used for the analysis of gunshot residue evidence because of its ability to identify gunshot residue particles elementally and morphologically. Some disadvantages of using only the SEM in gunshot residue analysis include low throughput ability and a lack of quantitative ability. For agencies with a high volume of cases which involve GSR kits, the Inductively Coupled Plasma – Mass Spectrometer (ICP-MS) is a viable response to these disadvantages. The sensitivity, precision, and accuracy make it an ideal candidate for analyzing GSR evidence from the hands of people suspected of having been around a gun when it has been fired. Literature reports the ICP-MS limits of detection for Pb, Ba, and Sb to be 0.1µg/L, 0.02µg/L and 0.05µg/L respectively. The use of both the ICP-MS and the SEM will allow the agency higher throughput and an ability to quantify trace metals on a person's hands while maintaining the ability to conclusively identify GSR particles.

GSR kits, consisting of both SEM particle lifts and swabs, were taken at zero, one, two, four, and six hour intervals post-firearm discharge. All subjects continued their general laboratory and office duties and kept a record of those daily activities. Two sets of data were generated using two different calibers of weapons (a .22 caliber semi-automatic and a .44 caliber revolver) in order to achieve minimum and maximum quantities of gunshot residue. Particle lifts were taken from the right palm, right back of the hand, left palm, and left back of the hand of the participating shooters. These lifts were then followed by sample swabs of 5% nitric acid (two swabs per region of the hand) as well as one set of control swabs taken from a region of skin that should not have come into contact with GSR during a shooting, such as the covered back of the shooter's calf or shoulder.

Quantities of metals from the ICP-MS were calculated from each sample from the GSR kits and these quantities were compared to results obtained from the sample area using the SEM. Quantitation values of the previously mentioned GSR kits were separated by region of hand, as well as element, and then averaged for practical application. In order to provide minimum quantities that correlate to the presence of GSR and related particles, only .22 caliber results were used in the calculations.

SEM confirmed samples were categorized based on the particles found. Four classes were used to distinguish the samples: round Pb-Ba-Sb particles (gunshot residue), non-round Pb-Ba-Sb particles, round lead particles, or negative. Trend lines were then created to display particle behavior as a function of time. A negative correlation was observed between the amounts of GSR or GSR related particles and the length of the time intervals, while negatives had a positive correlation.

ICP-MS, Gunshot Residue, Metals Analysis

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