



## Pathology Biology Section - 2012

### G66 Elemental Analysis of Gunshot Residue to Differentiate Bullet Type and Firing Distance

*Christine E. Hay, BS\*, 329 Michigan State University, Department of Chemistry, East Lansing, MI 48824; Ruth Waddell Smith, PhD, Michigan State University, School of Criminal Justice, 560 Baker Hall, East Lansing, MI 48824; and Brian C. Hunter, MD, 630 South Saginaw Street, Flint, MI 48502*

After attending this presentation, attendees will be familiar with the elemental analysis of gunshot residue (GSR) using inductively coupled plasma mass spectrometry (ICP-MS).

This work will impact the forensic science community by demonstrating how elemental analysis can be used to identify GSR in various stages of decomposition.

Porcine tissue was shot with jacketed and non-jacketed ammunition at two different firing distances. Samples were collected throughout decomposition and analyzed by ICP-MS to determine element composition of the GSR. Element concentrations were statistically assessed to investigate differentiation of bullet type and firing distance based on chemical concentration of the GSR.

In the fresh state, bullet entrance holes and a characteristic GSR pattern may be readily visible, enabling identification of a gunshot wound. However, due to chemical and biological processes occurring during decomposition, as well as larval activity, the entrance hole and GSR patterns can be obliterated. Thus, the natural decomposition of a gunshot victim in an outdoor setting can hinder the identification of a bullet entrance wound. The ability to detect GSR on corpses that have undergone advanced stages of decomposition would aid pathologists and medical examiners in cause of death determination, while the ability to identify the bullet type would aid law enforcement in narrowing down the suspect pool.

Differentiation of bullet type based on elemental composition of GSR has been demonstrated previously in our laboratory. Porcine tissue was shot with jacketed and non-jacketed ammunition and tissue samples were analyzed by ICP-MS for elements characteristic of GSR (antimony, barium, and lead), as well as elements characteristic of bullet type (copper, iron, and zinc). However, in these previous studies, the jacketed and non-jacketed ammunition contained different smokeless powders, all wounds were shot with a firing distance of 5cm, and only moderate decomposition was investigated.

The objectives of this research were to further investigate differentiation of bullet type based on chemical composition of GSR, as well as to investigate differentiation of firing distance based on GSR composition. Samples were collected throughout full decomposition, to determine if differentiation according to bullet type and firing distance was still possible.

In this study, control (unshot) samples were collected from each of four euthanized pigs. Two pigs were then shot eight times each with jacketed ammunition using a .357 Dan Wesson revolver (blued steel barrel, 1.5 inch in length); one was shot using a firing distance of 5 cm, while the second was shot using a firing distance of 10cm. The remaining two pigs were shot in a similar manner, except using non-jacketed ammunition. All ammunition cartridges were hand loaded with the same smokeless powder to ensure no elemental variation was due to differences in composition of the powder. One tissue sample was collected from each pig immediately after GSR deposition. The pigs were then allowed to decompose naturally and the remaining wounds were collected throughout the decomposition process.

The control samples and tissue samples containing GSR were microwave-digested in nitric acid and then analyzed by ICP-MS. Full mass scans were initially used to identify those elements present at significantly higher concentration in the shot tissue compared to the control tissue, for both bullet types. Once identified, the instrument was calibrated for the elements of interest and the tissue samples were analyzed using selected ion monitoring for those elements. Element concentrations in the fresh tissue were statistically assessed to differentiate tissue shot with jacketed versus non-jacketed bullets, as well as to differentiate tissue shot with a 5 cm firing distance versus a 10cm firing distance. Then, element concentrations were compared for samples collected throughout decomposition, assessing the persistence of GSR and the ability to continue differentiating bullet type and firing distance.

#### **Gunshot Residue, Bullet Type, Firing Distance**