D30 The Effect of Microscopic Surface Coatings and Residues on the Size and Shape of Bloodstains

Samira Shiri, EMA 224 Boston, 730 Commonwealth Avenue, Boston, MA 02215; Kenneth F. Martin, MS, PO Box 1363, 30 County Road, Mattapoisett, MA 01776; and James Bird, PhD, Boston University, 110 Cummington Mall, Boston, MA*

After attending this presentation, attendees will be familiar with how the shape of a bloodstain can be significantly altered if the blood were to impact on a microscopic coating, such as the residue oils and lipids from a latent print.

This presentation will impact the forensic science community by providing results from controlled experiments illustrating how nearly imperceptible surface coatings influence bloodstain size and shape, thereby potentially affecting the results of such analysis. This presentation extends the frontier of research in Blood Pattern Analysis (BPA) to account for alterations in bloodstains due to common coatings that may be encountered at a crime scene.

BPA uses the location, size, shape, and distribution of bloodstains to provide information regarding the events occurring at the crime scene. For example, aspects of the stain can provide insight into the speed at which the blood drop originally hit the surface, which can provide information about the cause of the bloodletting event. Furthermore, when estimating the drop trajectory responsible for a bloodstain, methods that account for gravitational and drag effects rely on an accurate estimate for the impact velocity.[1] Previous research has found a relation between the impact velocity and the number of spines radiating from the dried drop or from the stain size if spines are absent.[2,3] These relations tacitly assume that the drop shape and size would be identical on any smooth surface.[4] The hypothesis presently explored is that microscopic coatings, including residue oil from a latent fingerprint, can also have a significant effect on the size and shape of a bloodstain.

This hypothesis was tested using systematic experiments conducted in a laboratory environment. Four different coatings were prepared on glass slides having a polished non-porous surface. The first set of glass slides was cleaned and left uncoated. The second set of slides was coated with a fixed volume of vegetable oil smeared across the surface to create a uniform microscopic film. The third set of slides was coated with natural sweat secretions deposited by a finger rubbing across the slide, and the final set of slides was coated with a thin layer of soot from a flame, as might occur after a fire. Another group of slides was created using a combination of both clean and coated regions. For each type of slide coating, a single blood drop was released from a given height so that it impacted at a particular velocity. Velocity adjustments were made by changing the height at which the blood drops were released. Impact velocities varied from 1m/s to 18m/s, or terminal velocity for small drops. By recording the drop impact using both high-speed and time-lapse photography, the drop dynamics leading to the final stain could be quantified.

The results demonstrated a significant difference between the shape of a bloodstain on the clean surface and that with a microscopic coating. The size of stains formed on clean glass was larger than those on the glass surfaces with an oily residue. In addition, for the oil-smeared surface, several spines with associated satellite droplets were formed, whereas these did not form on clean glass slides under identical drop impact conditions. By contrast, on the glass surface coated with soot, the blood drop completely recoiled from the surface and, thus, did not leave behind a stain at all.

This study illustrates that commonly found microscopic coatings can alter the way a drop of blood spreads and dries on a smooth surface. This affects the final appearance of the bloodstain upon which BPA examination is based. The results indicate that bloodstain analysts may be able to further reduce uncertainty in forensic reconstructions by noting conditions that might indicate the presence of specific microscopic coatings.

Reference(s):

1. Laan, Nick, Karla G. De Bruin, Denise Slenter, Julie Wilhelm, Mark Jermy, and Daniel Bonn. Bloodstain Pattern Analysis: implementation of a fluid dynamic model for position determination of victims. *Scientific Reports.* 5 (2015): 11461.
2. Hulse-Smith, Lee, Navid Z. Mehdizadeh, and Sanjeev Chandra. Deducing drop size and impact velocity from circular bloodstains. *Journal of Forensic Science.* 50, no. 1 (2005): JFS2003224-10.
3. Laan, Nick, Karla G. de Bruin, Denis Bartolo, Christophe Josserand, and Daniel Bonn. Maximum diameter of impacting liquid droplets. *Physical Review Applied.* 2, no. 4 (2014): 044018.
4. Kim, Sungu, Yuan Ma, Prashant Agrawal, and Daniel Attinger. How important is it to consider target properties and hematocrit in bloodstain pattern analysis? *Forensic Science International.* 266 (2016): 178-184.

Surface Coating, Bloodstain, Terminal Velocity

*Presenting Author