A9 Some Error Rates Associated With Angle of Impact Calculations

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After attending this presentation, attendees will have a better understanding of the effect of impact angle and surface texture on error rates associated with angle of impact (AOI) calculations.

This presentation will impact the forensic science community by increasing the understanding of the accuracy, precision, and reliability of

AOI calculations. This will enhance bloodstain pattern analysis and crime scene reconstruction.

Bloodstain pattern analysis is useful in reconstructing the blood- letting events at a crime scene. The presence of transfer stains, projected stains, passive stains, miscellaneous stains, or impact stains all can act as informative physical evidence. Accurately calculating angle of impact (AOI) of an impact stain can be used to estimate the three-dimensional point in space from which blood originated (the area of origin). However, little experimental data is available concerning the error rates associated with AOI calculations. Further, the effect of surface texture and impact angle on the error rates associated with AOI calculations has received little experimental investigation. Controlled laboratory experiments were conducted to investigate the effect of surface texture and impact angle on the error rates associated with AOI calculations.

Experiments were conducted by intravenously drawing human blood (blood density equaled 1.07 grams per milliliter ± 0.003 grams per milliliter) into vials containing no anticoagulants or preservatives. Blood (30 microliters ± 1 microliter) was dropped from a height of 35 cm onto three different surfaces: ceramic, porcelain, mirror; at three different angles: 10°, 50°, 90° within three minutes (to avoid clotting). Ceramic tile had the greatest amount of texture while mirror tile had the least amount of texture. AOI was calculated using standard protocol and error rates were calculated as standard error of the mean. Four analysts, ranging in expertise from novice to expert, measured the bloodstains for angle of impact calculations. Data did not meet the assumptions set forth for normality and homogeneity of variance. Thus, a comparison of the calculated AOI means was conducted using the Kruskall-Wallis H and Mann-Whitney U statistics.

Surface texture had a significant ($P < 0.05$) effect on AOI calculation at 10° and 50° but not at 90°. Estimates of 10° on mirror were significantly ($P < 0.05$) greater than on porcelain. Estimates of 50° on ceramic were significantly ($P < 0.001$) greater than on mirror and porcelain. Error rates increased as angle of impact increased. Yet, error rates were relatively small, as they all were less than or equal to 1.2°. Yet, despite this precision, only one AOI calculation was accurate (50° on mirror). That is, only one calculation overlapped the actual angle of impact.

Impact stain analysts typically impose an error rate of ± 5° to ± 7°. To achieve 100% accuracy in the current study, an error rate of 3.5° for AOIs of 50° and 90° and an error rate of 1.9° for AOIs of 10° would need to be imposed. Applying reliable, smaller error rates to angle of impact analysis should increase accuracy and precision in determining area of origin, which could be the difference between a self-defense plea and a homicide conviction. It was also determined that a one millimeter division ruler is not sufficiently precise to measure angle of impact for bloodstains with a volume of approximately 30 microliters.

Bloodstain Pattern Analysis, Impact Stain, Reliability

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