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BLOODSTAIN PATTERN ANALYSIS

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Abstract:

Blood is one of the most significant and frequently encountered types of physical evidence associated with the forensic investigation of death and violent crime. The identification and individualization of human blood is cojoined with the discipline of bloodstain pattern analysis (BPA). BPA focuses on the analysis of the size, shape and distribution of bloodstains resulting from bloodshed events as a means of determining the types of activities and mechanisms that produced them. The scientific analysis of bloodstain pattern evidence has proved crucial in numerous cases where the manner of death is questioned and the issue of homicide, suicide, accident, or natural death must be resolved in a criminal or civil litigation or proceeding.

Keywords:

Bloodstain pattern; forensic investigation of death; the issue of homicide; suicide; accident; or natural death.

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The identification and individualization of human blood is cojoined with the discipline of bloodstain pattern analysis (BPA). BPA focuses on the analysis of the size, shape, and distribution of bloodstains resulting from bloodshed events as a means of determining the types of activities and mechanisms that produced them.

This information coupled with DNA individualization and wound interpretation from the autopsy examination of the victim by the forensic pathologist provides a basis for the reconstruction of the bloodshed events.

The scientific analysis of bloodstain pattern evidence has proved crucial in numerous cases where the manner of death is questioned and the issue of homicide, suicide, accident, or natural death must be resolved in a criminal or civil litigation or proceeding.

BPA is a discipline that uses the fields of biology, physics, and mathematics. BPA may be accomplished by direct scene evaluation and/or careful study of scene photographs (preferably color photographs with measuring device in view) in conjunction with detailed examination of clothing, weapons, and other objects regarded as physical evidence. Details of hospital records, postmortem examination, and autopsy photographs also provide useful information and should be included for evaluation and study. In cases where a scene investigation is not possible and photographs must be relied on, detailed sketches, diagrams, reports of crime scene investigators, and laboratory reports should be available for review. [2]

Relative to the reconstruction of a crime scene, BPA may provide information to the investigator in many areas.

- Areas of convergence and origin of the bloodstains;
- Type and direction of impact that produced bloodstains or spatter;
- Mechanisms by which spatter patterns were produced;
- Assistance with the understanding of how bloodstains were deposited onto items of evidence;
- Possible position of victim, assailant, or objects at the scene during bloodshed;
- Possible movement and direction of victim, assailant, or objects at the scene after bloodshed;
- Support or contradiction of statements given by accused and/or witnesses;
- Additional criteria for estimation of postmortem interval;
- Correlation with other laboratory and pathology findings relevant to the investigation.

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The goal of the reconstruction of the crime scene using BPA is to assist the overall forensic investigation with the ultimate questions that must be addressed, which include, but are not limited to, the following:

- What event(s) occurred?
- Where did the event(s) occur?
- When and in what sequence did they occur?
- Who was there during each event?
- Who was not there during each event?
- What did not occur?

The approach to BPA must adhere to the scientific method and rely on the principles of biology, physics, and mathematics. Education in these areas is highly recommended. A combination of training through formal instruction, personal experimentation, and experience with actual casework is necessary before an individual acquires adequate proficiency in the analysis of bloodstain patterns to answer these types of questions [5]. Contemporaneous experiments to duplicate specific patterns should be considered relative to a given case to support an analysis or conclusion. Some conservative speculation is permissible during the initial investigative stages of a case. However, final opinions, contents of a written report, and ultimate court testimony must be based on scientific fact with *no speculation*.

All potential explanations should be explored thoroughly and recognized and acknowledged by the analyst. Analysis of bloodstains should be correlated with postmortem and laboratory findings in an investigation. For example, when an arterial spurt pattern is observed, the autopsy report should indicate a cut or breached artery in the victim. In those cases, where an assailant as well as the victim produces bloodshed or where there are multiple victims, the individualization of the bloodstains by the forensic laboratory is critical. It is important to stay within the realm of that which can be proven scientifically and not to over-interpret bloodstain evidence [4]. This axiom particularly applies when the number of bloodstains is limited because a single or few small bloodstains do not often lend themselves to useful valid analysis. Conclusions based on crime scene photographs should be conservative when the investigator has not had the opportunity to examine the crime scene personally and must rely on the photographic documentation of others.

The conventional method of classifying bloodstains was based on the correlation between the velocity of the force influencing the blood source or drop that governed the characteristics and size or diameters of the resulting bloodstains [1].

Three basic categories of stain groups were used based on the concept that the size of the bloodstain being inversely proportional to the force applied to the static blood.

Low-Velocity Impact Blood Spatter

Low-velocity impact spatters (LVIS) are bloodstains created when the source of blood is subjected to a force with a velocity up to 5 ft/sec. Primary stains measure generally 4 mm in diameter or greater.

Medium-Velocity Impact Blood Spatter

Medium-velocity impact spatters (MVIS) are bloodstains created when the source of blood is subjected to a force with a velocity in the range of 5 to 25 ft/sec. The diameters of the resulting stains are in the size range of 1 to 3 mm, although smaller and larger stains may be present. Stains in this category were usually associated with beatings and stabbings.

High-Velocity Impact Blood Spatter

High-velocity impact spatters (HVIS) are bloodstains created when the source of blood is subjected to a force with a velocity of greater than 100 ft/sec. The diameters of the spatters are predominately less than 1 mm, although smaller and larger stains are often observed within the pattern. Stains in this category were usually associated with gunshot injuries.

Other mechanisms that produced stains within the size range of the conventional medium and high-velocity categories such as satellite spatter and expiratory bloodstains were not appreciated to the extent that misinterpretations could and did occur.

Many bloodstain analysts have chosen to discontinue this conventional terminology and classification for a more holistic approach to bloodstain classification [3]. The issues that kindled the rethinking of the conventional classification of low-medium-high velocity were the overlapping of stain sizes between the medium- and high-velocity categories and the realization that mechanisms other than beatings, stabbings, and gunshots frequently produced stains with size ranges within these categories. The bloodstains and patterns are classified based on their physical features of size, shape, location, concentration, and distribution into *passive stains*, *spatter stains*, or *altered stains*.

They are further classified relative to mechanisms that may produce stains with those characteristics with reference to pertinent scene, medical

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and case related facts, and history of the evidence. The analyst may then be able to establish the specific mechanism(s) by which the pattern was created.

The bloodstain pattern analyst should realize that regardless of who is requesting an analysis of the bloodstain patterns, the person requesting the analysis will have their own theory of the case as well as a predisposition to one side. The analyst must maintain a totally objective thought process beginning with their first conversation with the individual requesting services.

Prior to the commencement of the examination of evidence, photographs, or the crime scene, one must determine whether the request is within the realm of knowledge and expertise of the bloodstain pattern analyst [2]. Routinely, we are asked questions that are ultimately being referred to a forensic pathologist or a serologist. The bloodstain pattern analyst should not render opinions outside of the bloodstain pattern analysis discipline, unless the analyst has a previously acquired expertise in an additional discipline.

The following should be requested prior to the reconstruction of a bloodstain pattern case:

1. Brief background information
2. Examination of the actual crime scene
3. Examination of physical evidence
4. Photographs of the crime scene
5. Photographs of the physical evidence
6. Photographs of the autopsy
7. Autopsy report
8. Serology report
9. Crime scene diagram(s)
10. Crime scene investigator's notes or reports
11. Responding officer's notes
12. Emergency medical technicians' (EMTs) notes or depositions
13. Additional forensic reports
- Fingerprint (bloody prints)
- Shoe print (bloody prints)
- Firearms (blood on weapon)
- Other forensic evidence

Obviously, every case will not have each of the items listed. Although, if the information provided is too scant, vague, or poor quality, there is absolutely nothing wrong with the bloodstain analyst discontinuing

his or her investigation by stating insufficient information exists to render a meaningful opinion in this matter. [5]

Once this information has been received, a sequence for extracting the pertinent information needs to be established. Often the bloodstain analyst is only retained after all other investigative leads have been exhausted.

The objective is to strengthen the scientific process of BPA in actual casework through the ultimate test in the legal process and the courts. The variable level taxonomic classification is not complex but addresses the issue of the mechanisms that produce overlapping patterns with respect to the size of the stains. The structure of the categories will permit the analyst to begin with the primary bloodstain pattern categories—namely, passive, spatter, and altered—and proceed to specific subcategories based on case-driven facts.

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