OSAC 2022-S-0030
Standard Methodology in Bloodstain Pattern Analysis

Bloodstain Pattern Analysis Subcommittee
Physics/Pattern Interpretation Scientific Area Committee (SAC)
Organization of Scientific Area Committees (OSAC) for Forensic Science

OSAC Proposed Standard

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Prepared by
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Version No.	Issue Date	Section	Reason
2.0	July 5, 2023	--	Added to the OSAC Registry and publicly announced.
2.1	December 29, 2023	All	Format and font updates only. No content changes made.

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Standard Methodology in Bloodstain Pattern Analysis

Introduction

This document uses the following verbal forms: "*shall*" indicates a requirement, "*should*" indicates a recommendation, "*may*" indicates permission, and "*can*" indicates a possibility or capability.

1 Scope

This document covers methodology for bloodstain pattern analysis. It does not address specific methods but rather the systemic approach for bloodstain pattern analysis casework. For instance, it addresses when to classify but not how to classify patterns. This methodology defines the six overall standardized and chronologically ordered steps to perform bloodstain pattern analysis. Each step provides direction for the development of data supported interpretations. Specifically, this methodology involves the examination of bloodstains and bloodstain patterns to determine the significance of their presence or absence, what potential forces or mechanisms could result in those bloodstains or bloodstain patterns, and the significance of those determinations in regard to the scope or reason for the examination.

To limit the role of contextual bias and improve bloodstain pattern analysis decision making, a linear sequential unmasking-expanded [1] approach is incorporated in this methodology to manage exposure to task-irrelevant data by optimizing the order of information processing.

This document does not address documentation, preservation, or collection at the scene or on items of evidence.

2 Normative References

There are no normative reference documents.

3 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1
analyst
An individual who has successfully completed the prescribed course of study (BPA).

3.2
assumption
Something supposed as true, without adequate supporting evidence or certain knowledge.

3.3
cognitive bias
A set of influences that may affect the reliability and validity of one's observations and conclusions.

3.4
event segment
Time snapshot depicted by moments of activity.

3.5
examination
The act or process of observing, searching, detecting, recording, prioritizing, collecting, analyzing, measuring, comparing, and/or interpreting.

3.6
interpretation
Explanation for the observations, data, and calculations.

3.7
mechanism
The action of event process resulting in a bloodstain or bloodstain pattern.

3.8
methodology
The analytical processes and procedures used to support bloodstain pattern analysis.

3.9
overserved data
Observable features within a bloodstain or bloodstain pattern.

3.10
opinion
View, judgement, or belief that takes into consideration other information in addition to observations, data, calculations, and interpretations.

3.11
post-incident artifact
Any post-occurrence altercation to a bloodstain or bloodstain pattern resulting from the actions of first responders, medical personnel, or an individual.

3.12
task-irrelevant information
Information that is not necessary for making interpretations about the propositions in question, or that it assists only in making interpretations from something other than the physical evidence designated for testing or assists only in drawing conclusions by some means other than an appropriate analytic method.

3.13
task-relevant information
Information that is necessary for making interpretations about the propositions in question, from the physical evidence that has been designated for examination, or through the correct application of an accepted analytic method by a competent analyst.

3.14
utility
The usefulness of a bloodstain or bloodstain pattern for a further step in the analysis.

4 Requirements

Analysts will be exposed to various sources and types of information throughout their analysis which may be task-relevant or task-irrelevant.[1] When considering how this information can influence their decision-making, they shall consider and document the potential for cognitive bias. Where possible, this methodology should follow linear sequential unmasking – expanded.[2] The analyst shall access information in the following order prescribed by the methodology. If information is accessed out of order, it shall be documented and explained.

Prior to the start of analysis, the information available to be utilized shall be defined and a list of these source materials created. If a customer has made a request regarding the purpose and focus of the analysis, this request shall be included in the case documentation.

A request for analysis may be undefined, where much is unknown. In these cases, the analyst shall render opinions based upon the quality and quantity of the information available for analysis.

If the request is to evaluate a statement involving specific positions or actions, the analysis shall be completed prior to learning the focus of that statement. Once analysis is complete, the opinions rendered can be compared to support or refute the statements made.

4.1 Observation and Data Collection

[1] National Commission on Forensic Science, *Ensuring the forensic analysis is based upon task-relevant information.* It is available at https://www.justice.gov/archives/ncfs/page/file/641676/download

[2] Dror, Itiel E, and Jeff Kukucka. "Linear Sequential Unmasking-*Expanded* (LSU-*E*): A general approach for improving decision making as well as minimizing noise and bias." *Forensic science international. Synergy* vol. 3 100161. 13 Aug. 2021. It is available at https://doi.org/10.1016/J.FSISYN.2021.100161.

The analyst shall utilize imaging (e.g., photographs, 3D-laser scanning) and notes to document observations of bloodstained items and bloodstained areas to characterize stain and pattern size, shape, distribution, appearance, and location. Sketches or diagrams may also be utilized to aid documentation. It is understood that imaging may be provided to the analyst and/or produced by the analyst.

4.1.1 Locate all areas where blood is present.

4.1.2 Locate all areas where blood is notably absent.

4.1.3 Characterize stain and pattern sizes.

4.1.3.1 If measuring individual stains, measurements shall be in metric.

4.1.3.2 For spatter stains, sizes of stains refer to the widths.

4.1.3.3 For non-spatter stains, sizes refer to overall dimensions.

4.1.3.4 Measurements for the overall dimensions of the stains grouped into patterns may also be documented.

4.1.4 Characterize stain and pattern shapes.

4.1.4.1 Circular

4.1.4.2 Elliptical

4.1.4.3 Irregular

4.1.4.4 Linear or curvilinear

4.1.4.5 Edge characteristics, to include observable characteristics such as clearly defined sharp edges, spines, or feathering.

4.1.5 Characterize stain distribution.

4.1.5.1 Stain arrangement: radiating, linear, curvilinear, etc.

4.1.5.2 Size distribution within a pattern

4.1.5.3 Distribution of aspect ratio ellipses fitted to the stains (circular to elliptical)

4.1.5.4 Angular distributions of the main axes of the stains (directionality)

4.1.5.5 If stains within a pattern converge to an area

4.1.5.6 2D or 3D deposition – e.g., located on the top surface only or penetrating the target substrate.

4.1.5.7 Density of stains within a pattern

4.1.6 Characterize stain and pattern appearance

4.1.6.1 Coloration, dilution, thickness

4.1.6.2 Wet, dry, flaking

4.1.6.3 Clotted

4.1.6.4 Altered

4.1.6.5 Flow, gravity effects

4.1.6.6 Impression patterns: Friction ridge detail, footwear

4.1.6.7 Vacuoles/bubble rings and mucous strands

4.1.6.8 Repeating pattern of the same characteristics

4.1.7 Characterize the surface the stains are present on

4.1.7.1 Fixed versus moveable objects

4.1.7.2 Porous, non-porous
- Construction and composition of fabrics and textiles

4.1.7.3 Smooth, irregular, textured, treated, flexible, etc.

4.1.7.4 Curved, flat, angled

4.1.8 Document other observable material, e.g., tissue, hair, bullet holes

4.1.9 Characterize the physical location of stains

4.2 Designate areas of blood into groupings of stains/patterns

4.2.1 Organize patterns by stain size, shape, distribution, appearance, and location.

4.2.1.1 Not all bloodstains can be organized into patterns because their observable characteristics do not provide enough information to proceed.

4.2.2 Determine the utility of bloodstains or bloodstain patterns. A utility determination can be decided based on a multitude of reasons.

4.2.2.1 The observed characteristics of the bloodstains and bloodstain patterns may have ambiguous information that can be attributed to multiple pattern types and the determination is made that a classification is not possible.

4.2.2.2 The lack of quantity of stains present may not allow the analyst to definitively exclude any mechanism or make any meaningful classification.

4.2.2.3 The bloodstains or bloodstain patterns may exhibit characteristics of alteration to an extent that the original deposition cannot be reliably classified.

4.2.2.4 The bloodstains or bloodstain patterns may be deposited on a surface that would result in unreliable characteristics leading to unreliable classifications due to the interaction that the blood and target surface would have.

4.2.2.5 The bloodstains or bloodstain patterns appear to be overlapping in such a way that it cannot be reliably determined which stains are associated and which stains are not associated.

4.3 Classification of Patterns from Observable Characteristics

Classification of bloodstains and bloodstain patterns is the process that utilizes observable characteristics to include those mechanisms that cannot be excluded, resulting in an interpretation. At this step/stage the analyst shall only use observable stain(s) and pattern characteristics to make their initial interpretation(s).

4.3.1 The analyst should consider potential mechanisms or means of deposition that can be excluded. The analyst shall then note all pattern types that will be given further consideration during the refinement process. Pattern types can be assigned based on mechanism or force and can be as definitive as using the ASB BPA terminology or generally describing a mechanism or force (e.g., gravity, airborne, or contact).

4.3.2 Additional forensic analysis, such as forensic biology and DNA testing, may assist in refinement of the pattern classification and the logical exclusion of mechanisms. The analyst should determine if collected samples will be submitted for this forensic analysis.

4.3.3 Where applicable, the analyst may utilize methods to apply to areas of spatter patterns to aid in determining flight path characteristics, area of origin, area of convergence, etc.

4.3.4 The analyst should be able to justify why a stain/pattern has not been classified. The value and potential significance of these stains/patterns will be assessed based upon the observed data and/or task-relevant information.

4.4 Refinement of Interpretations Applying Task-relevant Contextual Information

Refinement is the logical exclusion of pattern types included in the interpretations above with the addition of forensic biology/DNA and medical/pathology reports. This refinement is relevant when assessing whether to exclude impact, expiration, forward and backspatter, cast-off, or projected patterns. Examples of refinement which can be made based on review of this task-relevant contextual information:

- If there is no pathological evidence of a gunshot injury, backspatter and forward spatter may be excluded as possible pattern types.

- If the source of blood has been narrowed to a single deceased individual and there is no evidence of blood in that person's airway from autopsy reports, then expiration from that person can be eliminated as a possible mechanism.

4.4.1 The analyst shall only consider information relevant to source and/or blood-letting injuries necessary for pattern interpretation refinement. The analyst shall document and apply this information to eliminate pattern types not supported by blood-letting injuries.

4.4.2 Considering the results of the forensic analysis, the analyst should refine the previously documented list of potential mechanisms or means of deposition and further exclude any pattern types that are no longer logical given the results.

4.4.3 If the analyst becomes aware that any piece of this contextual information is potentially unreliable, the analyst shall return to the interpretations from 4.3 and not consider this information.

4.4.4 An analyst shall not include a pattern type based solely on contextual information.

4.5 Event Reconstruction/Case Interpretations

Event reconstruction in bloodstain pattern analysis is the process of incorporating and assimilating all observed data and interpretations to begin to determine the possible scene events that created the pattern(s)/stain(s). All outcomes at this step are termed to be interpretations. The interpretations may be generic (e.g., an impact occurred in this location, or a transfer pattern is located on the floor) or specific to the case (e.g., The evidence of a drip trail spanning the area between the kitchen and the front door, which has been DNA sourced to

[name], would indicate movement of a source of their blood between these two points). Reconstruction of events are first addressed in finite periods of time or event segments[3] where specific patterns may be associated with specific events. It is also possible for these event segments to be sequenced relative to one another as part of the event reconstruction. It is understood that not every event segment can be determined and therefore, it is not expected that every stain or pattern can be or needs to be interpreted.

Each interpretation involves the generation of a hypothesis and testing the hypothesis by comparing predictions against observed data. A hypothesis is generated as a possible explanation for some initial set of information, and then tested by examining independent data or information that tests critical aspects of the hypothesis and/or differentiate it from alternative explanations. Analysts must consider alternative hypotheses and either eliminate them or refine the original hypothesis to include them.

The analyst may apply additional case-specific, task-relevant information to inform their bloodstain pattern interpretations and hypotheses. The analyst shall document when the contextual information was accessed. Some of the contextual information may also contain task-irrelevant and biasing information. Analysts shall document the specific task-relevant information utilized and not utilize task-irrelevant information. When task-irrelevant information is accessed, the biasing power and objectivity of the information should be evaluated to mitigate its effects. In some cases, this additional case-specific information will not be needed at all.

Examples of additional contextual information include:

- First responder actions
- Investigative reports
- Other relevant forensic reports (e.g., footwear comparison, patent latent print comparison)

4.5.1 The analyst shall determine and document all assumptions made and limitation that may have influenced interpretation.

Examples:

- Only one source of blood was present at the crime scene.
- Only Person X has injuries consistent with a projected blood source.
- The deposition of all bloodstains occurred contemporaneous to the bloodletting event(s) in question.
- Possible scene altercation is present from medical intervention.
- Clean-up activities occurred.
- Analysis was performed from photographs only and was limited to the documentation provided.

[3] Gardner, R. and Bevel T., 2009. *Practical crime scene analysis and reconstruction*. CRC Press.

4.5.2 Concurrent with 4.4.1, where applicable and reasonable, the analyst shall make interpretations in regard to the following with the understanding that not every stain or pattern needs to be interpreted as stated above:

4.5.2.1 Interrelationship(s) of stains(s) and pattern(s) based on their locations (e.g., satellite patterns adjacent to projected patterns or impact patterns on adjacent walls in a corner of a room). This interrelationship can be based on the physical proximity of two or more patterns, recognized repeating patterns throughout the scene, or potential correlating mechanisms of patterns.

4.5.2.2 Directionality of stains and patterns based upon their shapes and characteristics (e.g., within swipe and wipe patterns).

4.5.2.3 Potential sources of blood that contributed to stains or patterns such as wounds, pools, and objects containing blood which may be responsible for stains and patterns. Where possible, correlate potential blood sources to stains and patterns with potential location of sources during the mechanistic event (e.g., incorporating area of origin calculations to wound locations). Where applicable, source associations shall incorporate results from available DNA reports to further aid in determining sources.

4.5.2.4 Sequencing the order of deposition of stains and patterns

4.5.2.5 Voids and how they may have been created (e.g., limiting angles)

4.5.2.6 Repositioned objects/movement using voids or flow patterns

4.5.2.7 Identifying patterns that could potentially be pre- or post-incident artifacts (e.g., insect stains, stains that appear to be very old, or medical personnel attempts to aid injured persons).

4.5.2.8 Potential influence of environmental factors on blood deposition and patterns (e.g., temperature, humidity, or altered stains)

4.5.2.9 Indications of time since deposition (e.g., perimeter stains, coloration, or serum separation)

4.6 Final Opinion

4.6.1 Upon completing all interpretations, the analyst, where applicable, should render a final opinion regarding the request or investigative questions. This opinion shall not use any unsupported data. Examples of unsupported opinions include:

- "The blood spatter on Mr. X's clothing indicated he was less than two meters away from the victim at the time of impact."

- "Based upon the size of the bloodstain pattern on the bed, a minimum of two liters of blood was present."
- "The presence of clotting within spatter stains showed that bleeding had commenced more than X minutes prior to impact."

4.6.2 In cases where the request for bloodstain pattern analysis includes a specific question or statement analysis (e.g., a statement about what happened and bloodstain pattern analysis is used to support or refute such statements) the analyst shall evaluate all proposed possibilities, and document support for and support against them. The analyst should be actively looking for and trying to find support for alternative hypotheses. In some cases, a proposed possibility may not have sufficient data to make a determination. The analyst may determine that another hypothesis has more support based on the evidence and interpretations. In such cases, the analyst shall document the basis of this opinion.