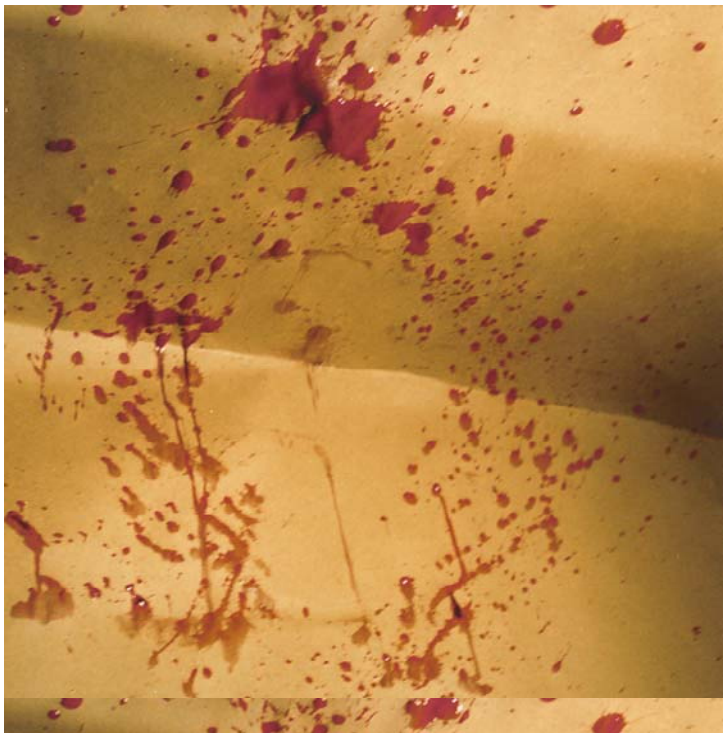

Interpretation of Blood Spatter for Licensed Professional Investigators ©

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Blood spatter interpretation may be defined briefly as an analysis and interpretation of the patterns of blood stains or spatters at the scene of a crime or accident in order to reconstruct the crime scene and the sequence of events involved. It is accomplished by looking at the overall patterns and by measuring the individual blood stains and making the calculations explained below in order to trace backwards from the blood stain to the point in space where the drop originated from the person who let the blood or the object from which it was cast off or to which it was transferred.

Without having to become a blood spatter expert, a basic understanding of the principles and procedures of blood spatter analysis will allow the professional investigator to understand the importance of blood spatter at a scene and even to draw cautious

conclusions from the spatter as to the cause and manner of death. Fortunately, the basic principles and procedures of blood spatter analysis are not complicated and can be learned from a source as brief as this article. The understanding is important, because the interpretation of blood spatter patterns and other evidence at crime scenes may reveal critically important information to the professional investigator such as:

1. The positions of the victim, assailant, and objects at the scene.
2. The type of weapon that was used to cause the spatter.
3. The number of blows, shots, stabs, etc. that occurred.
4. The movement and direction of victim and assailant, after bloodshed began, and
5. It may support or contradict statements given by witnesses[i].

The professional investigator may use blood spatter interpretation to answer the important questions of:

1. What events occurred
2. When and in what sequence they occurred
3. Who was, or was not, there
4. What did *not* occur

The lists of precisely what information can be learned by the interpretation of blood stain patterns are similar for Bevel and Gardner[ii], James and Eckert[iii], Hueske[iv], Slemko[v], and Sutton[vi].

This paper is intended to familiarize the professional investigator with blood spatter analysis. To do so, the theory and formulas must be understood first.

The Theory: Teardrop vs. Blood Drop

Experiments have shown that blood tends to form into a sphere rather than a teardrop shape when free falling or projected in drop size volume (approximately 0.05ml or 20 drops per milliliter; though some are larger and some are smaller.)[vii] The formation of the sphere is a result of surface tension[viii]. Fresh blood is slightly more viscous and

stickier than water because of its components: corpuscles, leukocytes, platelets, trace elements, and so it tends to hold the sphere shape in flight. The sphere shape of blood in flight is critical to the calculation of the angle of impact of blood spatter which will be used to determine the point or area from which the blood originated or the Point of Hemorrhage (POHm)[1-2].

The determination of the Angle of Impact and placement of the POHm should be based on the consideration of a number of spatters. The process for determining the Angle of Impact is not complicated. When a sphere of blood strikes a flat surface the diameter of the sphere in flight will equal the width of the stain on the surface (which is equal to the Opposite Side of a right triangle) as seen in Figure 1. The length of the spatter will be equal to the hypotenuse of an inverted triangle. This is portrayed graphically in Figure 1.

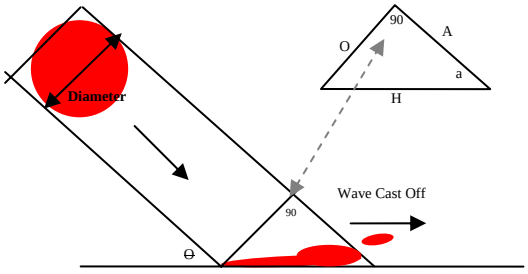


Figure 1 Side View of blood sphere in air, and then striking a flat surface

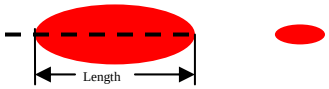


Figure 2 Resulting stain left by drop of blood that impacted at about 30 degrees of a flat surface.

[1] This author prefers to use the term Point of Hemorrhage to distinguish the area from which the blood was disgorged from other *points of origin*, the latter phrase being a widely used term in blood spatter, ballistics, crime, and accident scene investigation and reconstruction.
[2] Although most experts use the word *Point*, the word *Area* would be a more prudent and conservative one to use.

To find the Point of Hemorrhage (POHm), the investigator must first determine the two dimensional Point of Convergence (POC). The POC is the intersection where lines drawn through the center of the individual stains meet (i.e. at the intersection of the X-Y Axis) determined by running strings through long axis of individual spatters as seen in Figure 3 below.

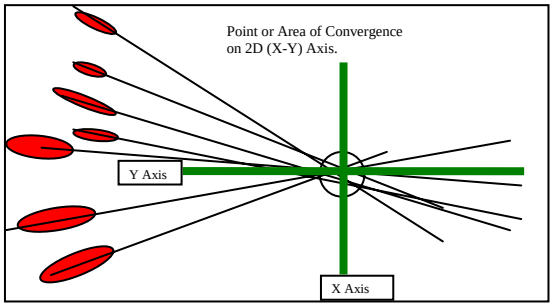


Figure 3 Lines through the central axes of the spatter cross at the Point of Convergence

The next step in the process is to determine the Angle of Impact (AOI) for representative bloodstains. The AOI will necessarily be the same as angle *a* inside the triangle. The Angle of Impact is the inverse arc sin of the W/L ratio, so first calculate the ratio (W/L) then SIN -1 (2^{nd} function) to get the degrees of *a* and A.

VELOCITIES OF BLOOD SPATTER

There are three classifications of velocities of blood patterns with a large undefined gap between the medium and high speed velocities. This gap is a result of the velocity classifications having grown out of the blood stains found at crime scenes which have limited causes i.e. gravitational pull, blunt instrument acceleration, and super high speed misting as a result of gun shot wounds. The velocity is that of the force causing the blood to move rather than of the speed of the blood itself and it is measured in feet per second (fps).

Low Velocity Blood Spatter

Low Velocity: Low velocity stains are produced by an external force less than 5 fps (normal gravity) and the stains are 3mm and larger. It is usually the result of blood dripping from a person who is still, walking, or running, and sometimes from cast off. Dripping blood often falls at a 90° angle and forms a 360° stain when it hits a flat perpendicular surface, depending on the texture of the surface. Low velocity blood may be found in the trail of a person who is bleeding and larger pools of blood may indicate where the person paused

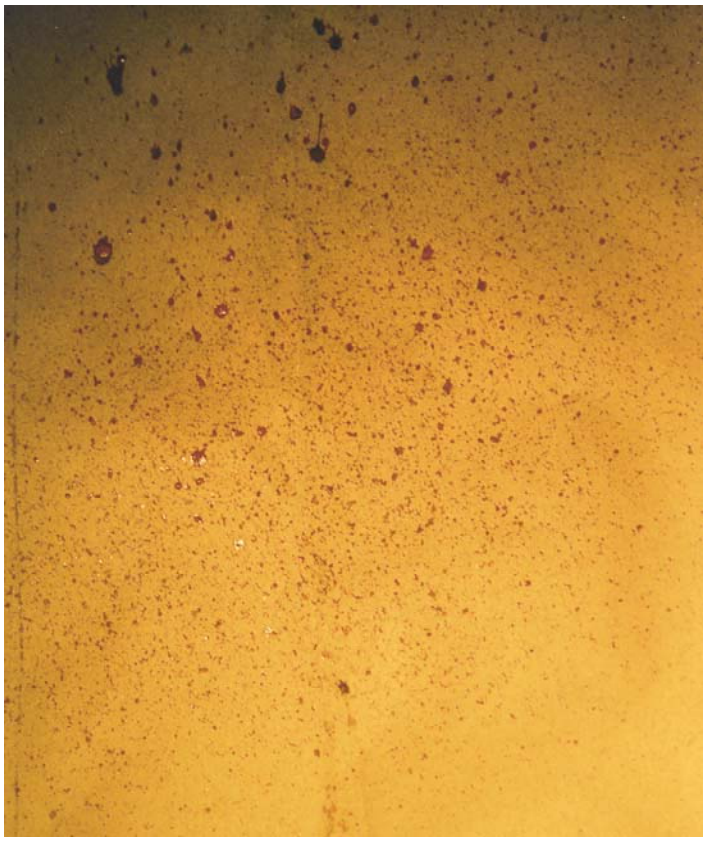
Medium Velocity Blood Spatter

***Medium Velocity*:** Medium blood spatter is produced by an external force of greater than 5 fps and less than 25 fps. The stains generally measure 1-3mm in size. They are often caused by blunt or sharp force trauma, arterial spurts, and sometimes cast off.

Cast-Off

Cast-off blood is often found at crime scenes where blunt or sharp instruments were used as the weapons of attack. Blood is flung off the weapon as a result of centrifugal force as the weapon is swung back over the attacker's head. Arterial Spurts. Arterial blood

graphically displays the pumping of the heart in squirted arcs. The arcs are commonly accompanied by bloody hand prints and other forms of transfer blood such as swipe and wipe.



High Velocity Blood Spatter

High Velocity:

High velocity blood spatter is produced by an external force greater than 100 fps and the stains tend to be less than 1mm. High velocity stains are usually created by gunshots or explosives, but may also be caused by industrial machinery or even expired air, coughing, or sneezing. High velocity droplets travel the least far because of the wind resistance against their small mass.

Is Blood Spatter Analysis a Science or an Art?

The term most commonly used to describe the process of examining bloodstains at crime scenes for the purpose of determining what happened to who by whom is Blood Stain

Analysis. However, the procedure is far more akin to a tracker reading trail sign than a hematologist working in a lab. The analyst *interprets* the evidence at the scene just as if it were tracks in the sand. In fact, the analyst uses every item of evidence at the scene, as well as the autopsy reports, the police reports, witness statements, and knowledge that he brings to the scene himself such as knowledge about the dynamics of the behavior of blood, knowledge of guns and ballistics, and knowledge of wounds to the human body. The analyst looks at the evidence, and based on what he sees in the blood spatter patterns and other evidence, makes a pronouncement about what he, or she, believes happened. Seen in this light, blood stain analysis is more of an art than a science and is always open to *interpretation*.

The professional investigator can use blood spatter pattern evidence to help determine the cause of death and to see if the patterns coincide with what witnesses describe as to the way the death occurred.

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[i] James, Stuart H, Eckert, William G. Interpretation of Bloodstain Evidence at Crime Scenes, 2nd Edition, CRC Press 1999 p10-11
[ii] Bevel, Tom; Gardner, Ross M. Bloodstain Pattern Analysis, 2nd Ed. CRC Press 2002
[iii] James, Stuart H, Eckert, William G. Interpretation of Bloodstain Evidence at Crime Scenes, 2nd Edition, CRC Press 1999.
[iv] Hueske, Edward E., Shooting Incident Investigation/Reconstruction Training Manual, 2002
[v] Slemko, J. Bloodstain Pattern Analysis Tutorial Forensic Consulting http://www.bloodspatter.com/BPATutorial.htm
[vi] Sutton, Paulette T., Bloodstain Pattern Interpretation, Short Course Manual, University of Tennessee, Memphis TN 1998
[vii] James, Stuart H, Eckert, William G., Interpretation of Bloodstain Evidence at Crime Scenes, 2nd Edition, CRC Press 1999 p20
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