Learning Objectives

After studying this chapter you should be able to:

- Define crime-scene reconstruction
- Discuss the information that can be gained from bloodstain pattern analysis about the events involved in a violent crime
- Explain how surface texture, directionality, and angle of impact affect the shape of individual bloodstains
- Calculate the angle of impact of a bloodstain using its dimensions
- Describe the classifications of low-, medium-, and high-velocity impact spatter and appreciate how these classifications should be used
- Discuss the methods to determine the area of convergence and area of origin for impact spatter patterns
- Understand how various blood pattern types are created and which features of each pattern can be used to aid in reconstructing events at a crime scene
- Describe the methods for documenting bloodstain patterns at a crime scene

National Science Content Standards

Scientific Inquiry

Physical Science

Life Science

The Sam Sheppard Case: A Trail of Blood

Convicted in 1954 of bludgeoning his wife to death, Dr. Sam Sheppard achieved celebrity status when the storyline of TV's *The Fugitive* was apparently modeled on his efforts to seek vindication for the crime he professed not to have committed. Dr. Sheppard, a physician, claimed he was dozing on his living room couch when his pregnant wife, Marilyn, was attacked. Sheppard's story was that he quickly ran upstairs to stop the carnage, but was knocked unconscious briefly by the intruder. The suspicion that fell on Dr. Sheppard was fueled by the revelation that he was having an adulterous affair. At trial, the local coroner testified that a pool of blood on Marilyn's pillow contained the impression of a "surgical instrument." After Sheppard had been imprisoned for ten years, the U.S. Supreme Court set aside his conviction because of the "massive, pervasive, and prejudicial publicity" that had attended his trial.

In 1966, the second Sheppard trial commenced. This time, the same coroner was forced to back off from his insistence that the bloody outline of a surgical instrument was present on Marilyn's pillow. However, a medical technician from the coroner's office now testified that blood on Dr. Sheppard's watch was from blood spatter, indicating that Dr. Sheppard was wearing the watch in the presence of the battering of his wife. The defense countered with the expert testimony of eminent criminalist, Dr. Paul Kirk. Dr. Kirk concluded that blood spatter marks in the bedroom showed the killer to be left-handed. Dr. Sheppard was right-handed.

Dr. Kirk further testified that Sheppard stained his watch while attempting to obtain a pulse reading. After less than 12 hours of deliberation, the jury failed to convict Sheppard. But the ordeal had taken its toll. Four years later Sheppard died, a victim of drug and alcohol abuse.

Crime-Scene Reconstruction: Bloodstain Pattern Analysis

10

Key Terms

angle of impact
area of convergence
area of origin
arterial spray
back spatter
cast-off
crime-scene reconstruction
drip trail pattern
expirated blood pattern
flow patterns
forward spatter
high-velocity spatter
impact spatter
low-velocity spatter
medium-velocity spatter
satellite spatter
skeletonization
transfer pattern
void

Crime-Scene Reconstruction

Previous discussions of identification and comparison have stressed laboratory work routinely performed by forensic scientists. However, there is another dimension to the role of forensic scientists in a criminal investigation: working as a team to reconstruct events before, during, and after the commission of a crime.

Reconstructing the circumstances of a crime scene entails a collaborative effort that includes experienced law enforcement personnel, medical examiners, and criminalists. All of the professionals contribute a unique perspective to develop the **crime-scene reconstruction**. Was more than one person involved? How was the victim killed? Were actions taken to cover up what actually took place? To answer these questions, everyone involved with the investigation must pay careful attention and apply logical thinking.

crime-scene reconstruction The method used to support a likely sequence of events at a crime scene by the observation and evaluation of physical evidence and statements made by individuals involved with the incident

Crime-scene reconstruction is the method used to support a likely sequence of events at a crime scene by observing and evaluating physical evidence and statements made by individuals involved with the incident. The evidence may also include information obtained from reenactments. Therefore, reconstructions have the best chance of being accurate when investigators use proper documentation and collection methods for all types of evidence.

The physical evidence left behind at a crime scene plays a crucial role in reconstructing the events that took place surrounding the crime. Although the evidence alone does not describe everything that happened, it can support or contradict accounts given by witnesses and/or suspects. Information obtained from physical evidence can also generate leads and confirm the reconstruction of a crime to a jury. The collection and documentation of physical evidence is the foundation of a reconstruction. Reconstruction supports a likely sequence of events by observing and evaluating physical evidence and statements made by witnesses and those involved with the incident.

Law enforcement personnel must take proper action to enhance all aspects of the crime-scene search so as to optimize the crime-scene reconstruction. First, and most important, is securing and protecting the crime scene. Protecting the scene is a continuous endeavor from the beginning to the end of the search. Evidence that can be invaluable to reconstructing the crime can be unknowingly altered or destroyed by people trampling through the scene, rendering the evidence useless. The issue of possible contamination of evidence will certainly be attacked during the litigation process and could make the difference between a guilty and not-guilty verdict.

Before processing the crime scene for physical evidence, the investigator should make a preliminary examination of the scene as it was left by the perpetrator. Each crime scene presents its own set of circumstances. The investigator's experience and the presence or absence of physical evidence become critical factors in reconstructing a crime.

The investigator captures the nature of the scene as a whole by performing an initial walk-through of the crime scene and contemplating the events that took place. Using the physical evidence available to the naked eye, he or she can hypothesize about what occurred, where it occurred, and when it occurred. During the walk-through, the investigator must document observations and formulate how the scene should ultimately be processed.

As the collection of physical evidence begins, any and all observations should be recorded through photographs, sketches, and notes. By carefully collecting physical evidence and thoroughly documenting the crime scene, the investigator can begin to unravel the sequence of events that took place during the commission of the crime.

Person

Often reconstruction requires the involvement of a medical examiner or a criminalist. For example, a trained medical examiner may determine whether a corpse has been moved after death by evaluating the livor distribution within the body. If livor has developed in areas other than those closest to the ground, the medical examiner can reason that the victim was probably moved after death. Likewise, the examiner can determine whether the victim was clothed after death, because livor will not develop within areas of the body that are restricted by clothing. Such determinations can often reveal pertinent information that will aid the investigation.

A criminalist or trained crime-scene investigator can also bring special skills to the reconstruction of events that occurred during the commission of a crime. For example, a criminalist using a laser beam to plot the approximate bullet path in trajectory analysis can help determine the probable position of the shooter relative to that of the victim (see Figure 10–1). Other skills that a criminalist may employ during a crime-scene reconstruction analysis include blood spatter analysis (discussed in this chapter), determining the direction of impact of projectiles penetrating glass objects (Chapter 4), locating gunshot residues deposited on the victim's clothing to estimate the distance of a shooter from a target, and searching for primer residues deposited on the hands of a suspect shooter (both covered in Chapter 16).

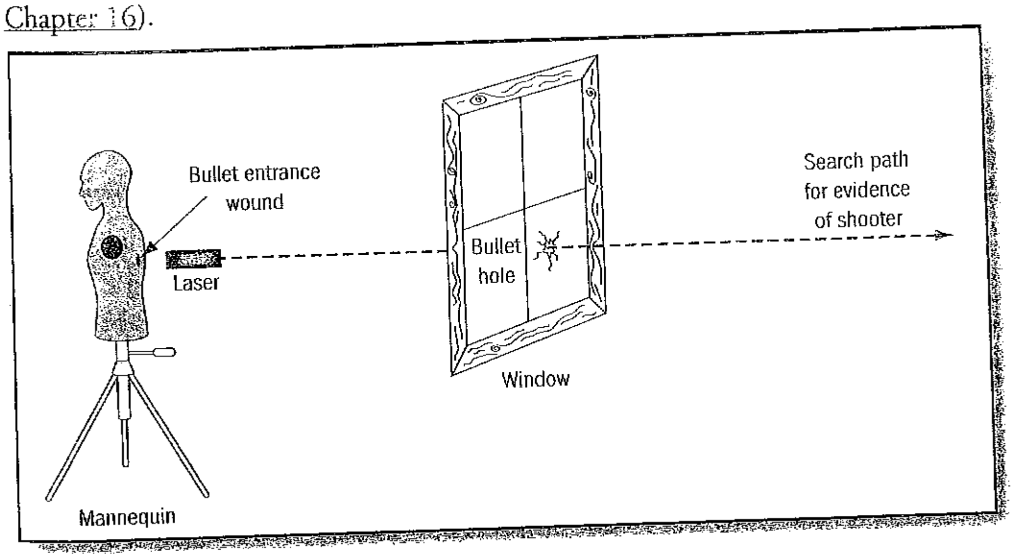


FIGURE 10-1 A laser beam is used to determine the search area for the position of a shooter who has fired a bullet through a window and wounded a victim. The bullet path is determined by lining up the victim's bullet wound with the bullet hole in the glass pane.

Reconstruction is a team effort that involves putting together many different pieces of a puzzle (see Figure 10–2). The right connections must be made among all the parts involved so as to portray the relationship among the victim, the suspect, and the crime scene. If successful, reconstruction can play a vital role in helping a jury arrive at an appropriate verdict.

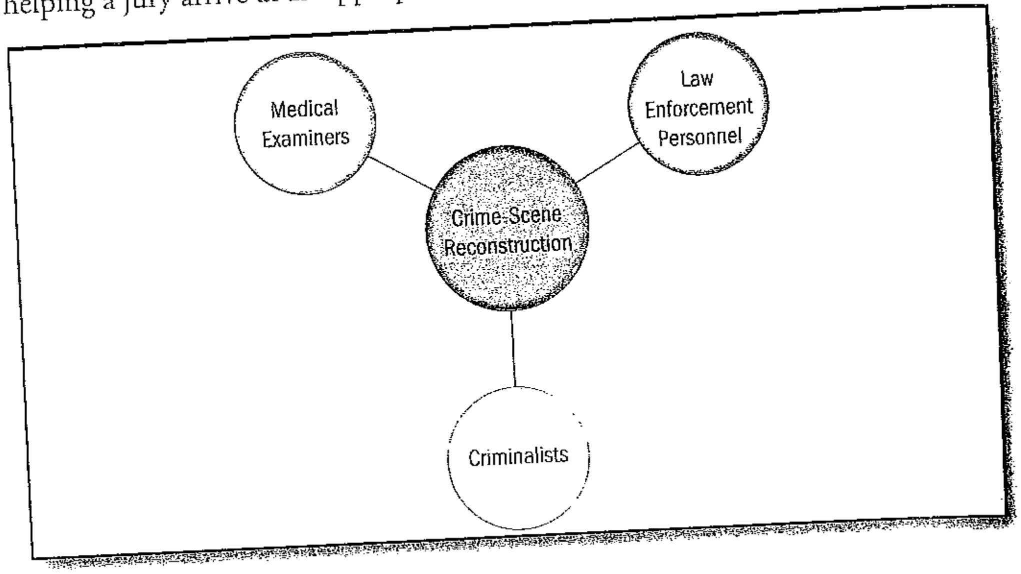


FIGURE 10-2 Crime-scene reconstruction relies on the combined efforts of medical examiners, criminalists, and law enforcement personnel to recover physical evidence and to sort out the events surrounding the occurrence of a crime.

Quick Review

- Crime-scene reconstruction relies on the combined efforts of medical examiners, criminalists, and law enforcement personnel to recover physical evidence and to sort out the events surrounding the occurrence of a crime.
- Examples of crime-scene reconstruction include determining whether a body was moved after death, determining whether a victim was clothed after death, analyzing bullet trajectory, analyzing blood spatter, determining the direction from which projectiles penetrated glass objects, estimating the distance of a shooter from a target, and locating primer residue on suspects.

General Features of Bloodstain Formation

Crimes involving violent contact between individuals are frequently accompanied by bleeding and resultant bloodstain patterns. Crime-scene analysts have come to appreciate that bloodstain patterns deposited on floors, walls, ceilings, bedding, and other relevant objects can provide valuable insights into events that occurred during the commission of a violent crime. The information one is likely to uncover as a result of bloodstain pattern interpretation includes the following:

- The direction from which blood originated
- The angle at which a blood droplet struck a surface
- The location or position of a victim at the time a bloody wound was inflicted
- The movement of a bleeding individual at the crime scene

- The minimum number of blows that struck a bleeding victim
- The approximate location of an individual delivering blows that produced a bloodstain pattern

The crime-scene investigator must not overlook the fact that the location, distribution, and appearance of bloodstains and spatters may be useful for interpreting and reconstructing the events that accompanied the bleeding. A thorough analysis of the significance of the position and shape of blood patterns with respect to their origin and trajectory is exceedingly complex and requires the services of an examiner who is experienced in such determinations. Most important, the interpretation of bloodstain patterns necessitates a carefully planned control experiment using surface materials comparable to those found at the crime scene. This chapter presents the basic principles and common deductions behind bloodstain pattern analysis to give the reader general knowledge to use at the crime scene.

MyCrimeKit: WebExtra 10.1
See How Bloodstain Spatter Patterns Are Formed
www.mycrimekit.com

Surface texture is of paramount importance in the interpretation of bloodstain patterns arising from blood dripping off an object. Comparisons between standards and unknowns are valid only when identical surfaces are used. In general, harder and nonporous surfaces (such as glass or smooth tile) result in less spatter. Rough surfaces, such as carpeting or wood, usually result in irregularly shaped stains with serrated edges, possibly with **satellite spatter** (see Figure 10-3).

satellite spatter Small drops of blood that are distributed around the perimeter of a drop or pool of blood and were produced as a result of the blood impacting the target surface

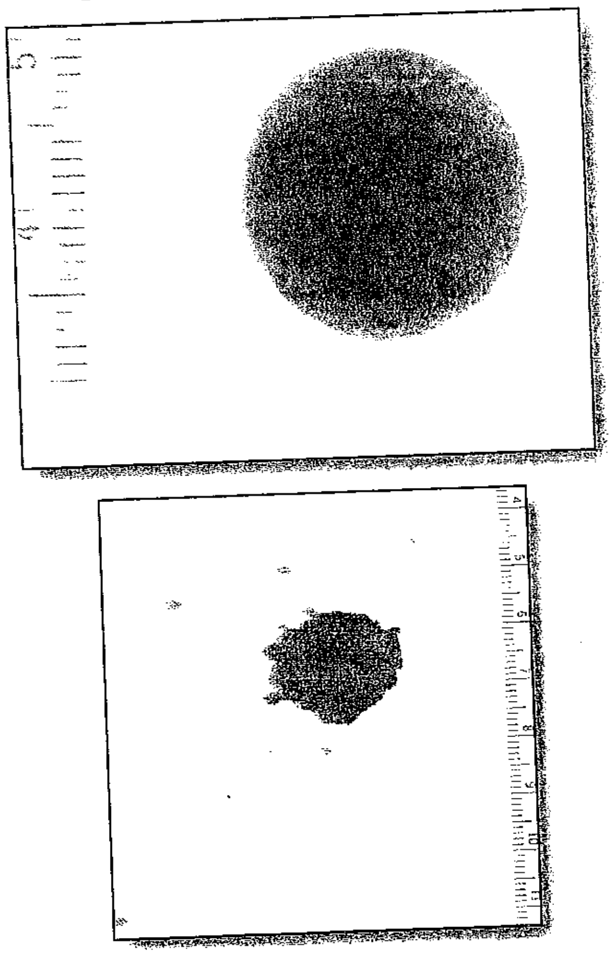


FIGURE 10-3 (a) A bloodstain from a single drop of blood that struck a glass surface after falling 24 inches. (b) A bloodstain from a single drop of blood that struck a cotton muslin sheet after falling 24 inches. *Courtesy A.Y. Wonder*

An investigator may discern the direction of travel of blood striking an object by studying the stain's shape. As the stain becomes more elliptical in shape, its direction of impact becomes more discernable because the pointed end of a bloodstain faces its direction of travel. Also, the distorted or disrupted edge of an elongated stain indicates the direction of travel of the blood. In Figure 10–4, the bloodstain pattern was produced by several drops of blood that were traveling from left to right before striking a flat, level surface.

FIGURE 10-4 A bloodstain pattern produced by droplets of blood that were traveling from left to right. *Courtesy A.Y. Wonder*

angle of impact
The angle formed between the path of a blood drop and the surface that it contacts

It is possible to determine the impact angle of blood on a flat surface by measuring the degree of circular distortion of the stain. A drop deposited at an **angle of impact** of about 90 degrees (directly vertical to the surface) will be approximately circular in shape with no tail or buildup of blood. However, as the angle of impact deviates from 90 degrees, the stain becomes elongated in shape. Buildup of blood will show up in the larger angles, whereas longer and longer tails will appear as the angle of impact becomes smaller (see Figure 10–5).

Inside the Science

Determining the Angle of Impact of Bloodstains

The distorted or disrupted edge of an elongated stain indicates the direction of travel of the blood drop. One may establish the location or origin of bloodshed by determining the directionality of the stain and the angle at which blood came into contact with the landing surface. To determine the angle of impact, calculate the stain's length-to-width ratio and apply the formula:

$$\sin A = \frac{\textit{width of blood stain}}{\textit{length of blood stain}}$$

where A = the angle of impact.

For example, suppose the width of a stain is 11 mm and the length is 22 mm. Then,

$$\sin A = \frac{11mm}{22mm} = (11mm \div 22mm) = 0.50$$

A scientific calculator with trigonometric functions will calculate that a sine of 0.50 corresponds to a 30-degree angle.

Note: There is a 5-degree error factor with this formula. This means that calculations are good to plus or minus 5 degrees of the actual value of the angle of impact. The measurements for length and width should be made with a ruler, micrometer, or photographic loupe.

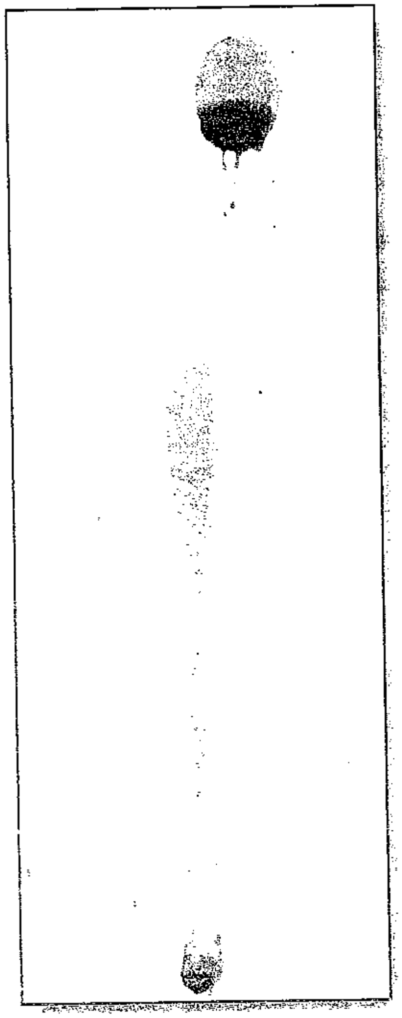


FIGURE 10-5 The higher pattern is of a single drop of human blood that fell 24 inches and struck hard, smooth cardboard at 50 degrees. On this drop the collection of blood shows the direction. The lower pattern is of a single drop of human blood that fell 24 inches and struck hard, smooth cardboard at 15 degrees. On this drop the tail shows the direction. *Courtesy A.Y. Wonder*

Quick Review

- Individual bloodstains can convey to the bloodstain analyst the directionality and angle of impact of the blood when it impacted a surface. Bloodstain patterns may convey to the analyst the location of victims or suspects, the movement of bleeding individuals, and the number of blows delivered.
- Surface texture is of paramount importance in the interpretation of bloodstain patterns; rounder drops generally are produced from smooth, nonporous surfaces, whereas rough surfaces create irregular-edged drops. However, correlations between standards and unknowns are valid only if identical surfaces are used.
- The direction of travel of blood striking an object may be discerned by the stain's shape. The pointed end of a bloodstain always faces in its direction of travel.
- The angle of impact of an individual bloodstain can be approximated by the degree of distortion or lengthening of the bloodstain, or it can be more effectively estimated using the ratio of width/length of the stain.

Impact Bloodstain Spatter Patterns

One of the most common type of bloodstain pattern found at a crime scene is **impact spatter.** This pattern occurs when an object impacts a source of blood. The spatter projected outward and away from the source, such as an exit wound, is called **forward spatter. Back spatter**, sometimes called blow-back spatter, consists of the blood projected backward from the source, such as an entance wound, potentially being deposited on the object or person creating the impact. Impact spatter patterns consist of many drops radiating in direct lines from the origin of blood to the target (see Figure 10–6).

impact spatter
A bloodstain pattern produced when an object makes forceful contact with a source of blood, projecting drops of blood outward from the source

forward spatter
Blood that travels away from the source in the same direction as the force that caused the spatter

back spatter
Blood directed back toward the source of the force that caused the spatter

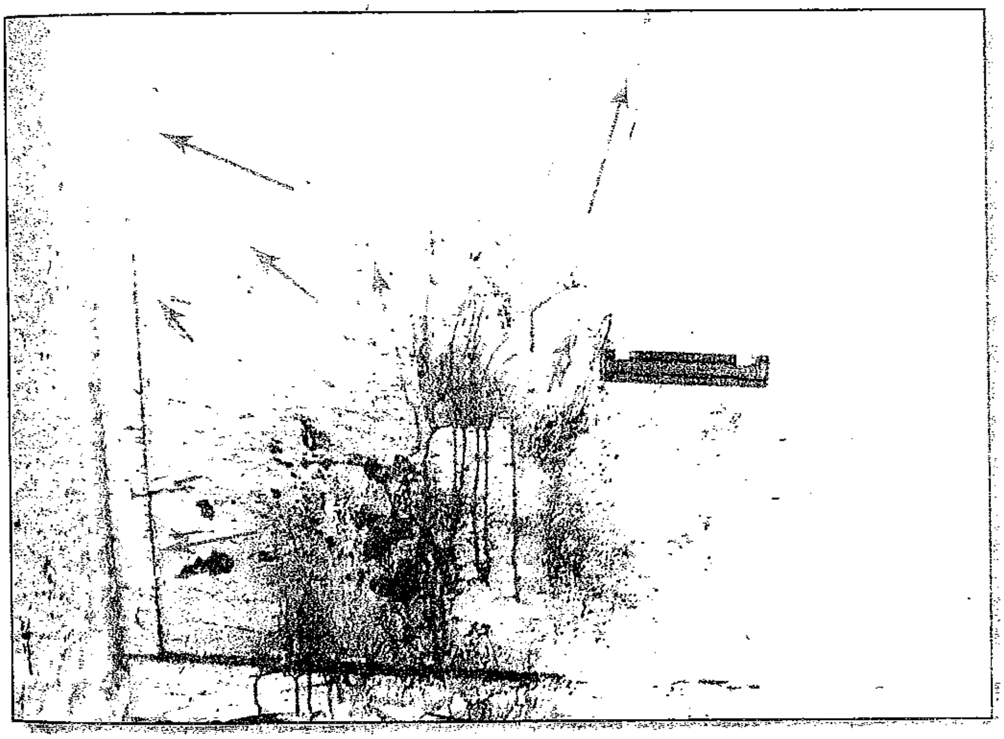


FIGURE 10-6 Impact spatter produced by an automatic weapon. The arrows show the multiple directions of travel from origin of impact as several different bullets struck the target. *Courtesy A.Y. Wonder*

Investigators have derived a common classification system of impact spatter from the velocity of a blood droplet. In general, as the force of the impact on the source of blood increases, so does the velocity of the blood drops emanating from the source. It is also generally true that as both the force and velocity of impact increase, the diameter of the resulting blood drops decreases.

low-velocity spatter
An impact spatter pattern created by a force traveling at 5 feet per second or less and producing drops with diameters greater than 3 millimeters

Low-Velocity Spatter An impact pattern consisting of large separate or compounded drops with diameters of 3 millimeters or more is known as **low-velocity spatter.** This kind of spatter is normally produced by minimal force. Typically, the drops hit the surface at a speed of less than 5 feet per second.

Medium-Velocity Spatter A pattern consisting of small drops with diameters from 1 to 3 millimeters is classified as **medium-velocity spatter**. This type of impact spatter is normally associated with blunt-force trauma to an individual. Drops of medium-velocity spatter hit the surface at 5 to 25 feet per second.

medium-velocity spatter
An impact spatter pattern created by a force traveling at 5 to 25 feet per second and producing drops with diameters between 1 and 3 millimeters

high-velocity spatter An impact spatter pattern created by a force traveling at 100 feet per second or faster and producing drops with diameters less than 1 millimeter

High-Velocity Spatter Very fine drops with diameters of less than 1 millimeter are classified as **high-velocity spatter**. Here the drops hit the surface at 100 feet per second or faster. Gunshot exit wounds or explosions commonly produce this type of spatter. However, because the drops are very small, they may not travel far; they may fall to the floor or ground where investigative personnel could overlook them.

Using droplet size to classify impact patterns by velocity is a useful tool for giving investigators insight into the general nature of a crime. However, the velocity at which blood strikes a surface by itself cannot illuminate the specific events that produced the spatter pattern. For example, beatings can produce high-velocity spatter or patterns that look more like low-velocity spatter. In general, one should use velocity categories very cautiously and for descriptive purposes only in evaluating impact spatter patterns.

As we will learn, blood spatter patterns can arise from a number of distinctly different sources. Illustrations of patterns emanating from impact (just discussed), cast-off (page 388), and arterial spray (page 390) are shown in Figure 10–7.

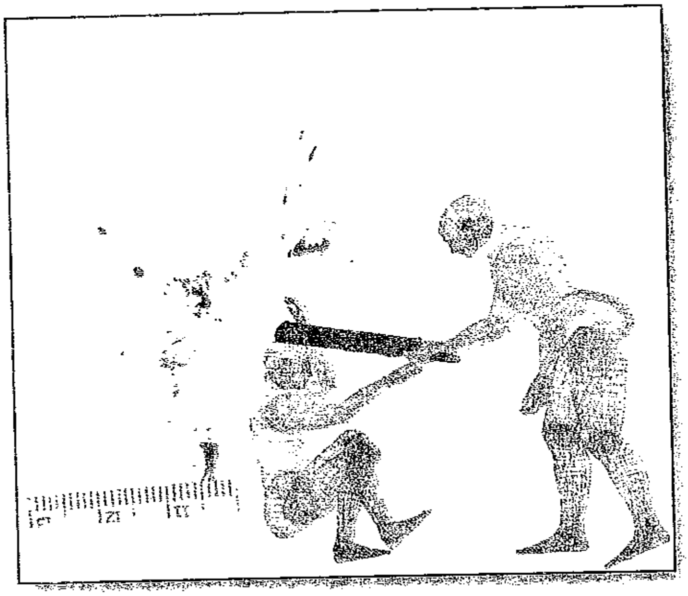


FIGURE 10-7 A

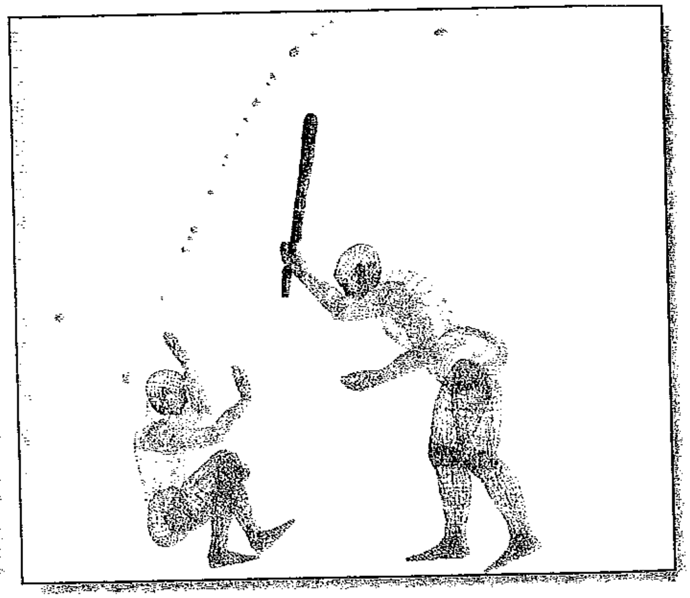


FIGURE 10-7 B

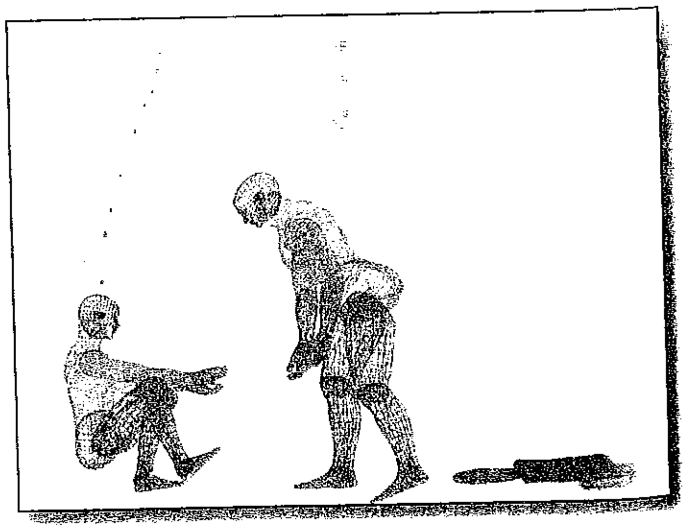


FIGURE 10-7 C

FIGURE 10-7
(a) The action associated with producing impact spatter.
(b) The action associated with producing cast-off spatter.
(c) The action associated with producing arterial spray spatter.
Courtesy of A.Y. Wonder

Impact spatter patterns can offer investigators clues that help determine the origin of the blood source and the position of the victim at the time of the impact.

Area of Convergence The **area of convergence** is the area on a two-dimensional plane from which the drops originated. This can be established by drawing straight lines through the long axis of several individual bloodstains, following the line of their tails. The intersection of these lines is the area of convergence, and the approximate area of origin will be on a line straight out from this area. Figure 10–8 illustrates how to draw lines to find an area of convergence.

An object hitting a source of blood numerous times will never produce exactly the same pattern each time. One may therefore determine the number of impacts by drawing the area of convergence for groups of stains from separate impacts.

area of convergence
The area on a two-dimensional plane where lines traced through the long axis of several individual bloodstains meet; this approximates the two-dimensional place from which the bloodstains were projected

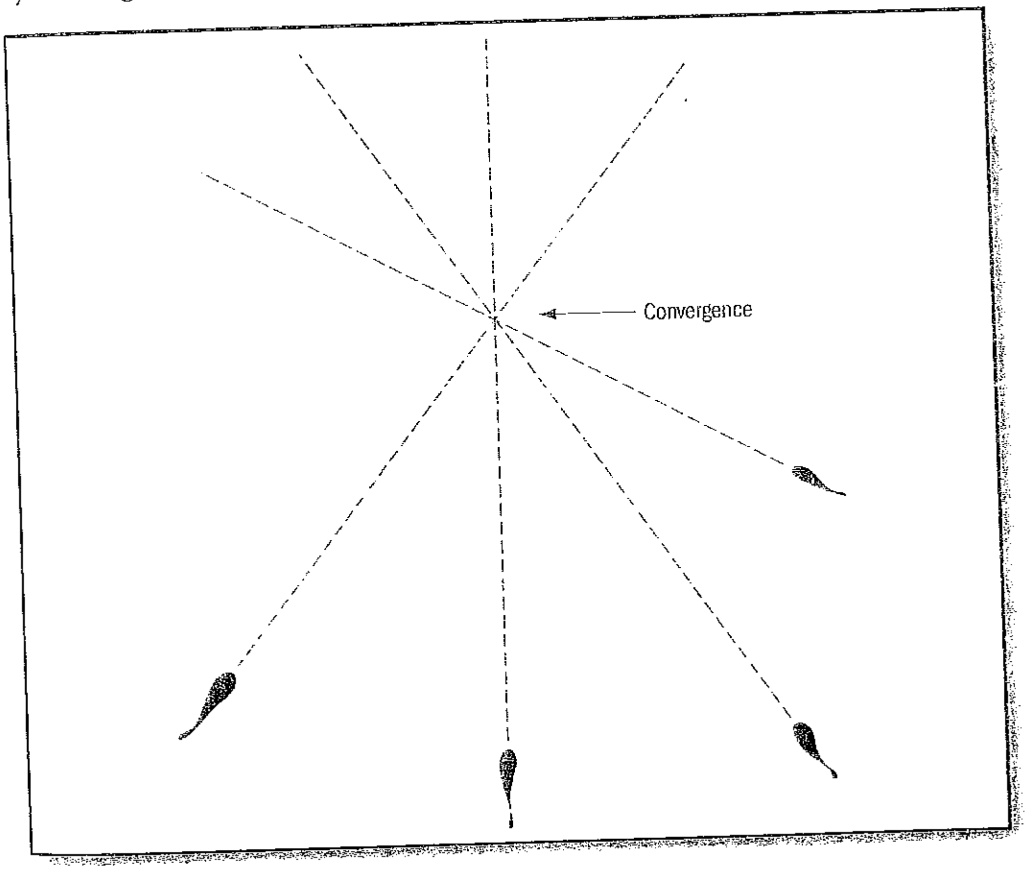


FIGURE 10-8 An illustration of stain convergence on a two-dimensional plane. Convergence represents the area from which the stains emanated. *Courtesy Judith Bunker, J.L. Bunker & Assoc., Ocoee, FL*

Area of Origin It may also be important to determine the **area of origin** of a bloodstain pattern, the area in a three-dimensional space from which the blood was projected. This will show the position of the victim or suspect in space when the stain-producing event took place. The distribution of the drops in an impact pattern gives a general idea of the distance from the blood source to the bloodstained surface. Impact patterns produced at a distance close to the surface will appear as clustered stains. As the distance from the surface increases, so do the distribution and distance between drops.

area of origin
The location in three-dimensional space from which blood that produced a bloodstain originated. The location of the area of convergence and the angle of impact for each bloodstain is used to approximate this area

A common method for determining the area of origin at the crime scene is called the string method. Figure 10–9 illustrates the steps in the string method:

1. **Find the area of convergence for the stain pattern.**
2. **Place a pole or stand as an axis coming from the area of convergence.**
3. **Attach one end of a string next to each droplet. Place a protractor next to each droplet and lift the string until it lines up with the determined angle of impact of the drop. Keeping the string in line with the angle, attach the other end of the string to the axis pole.**
4. **View the area of origin of the drops where the strings appear to meet. Secure the strings at this area.**

This method produces an approximation of the area of origin with an error of 2 feet.

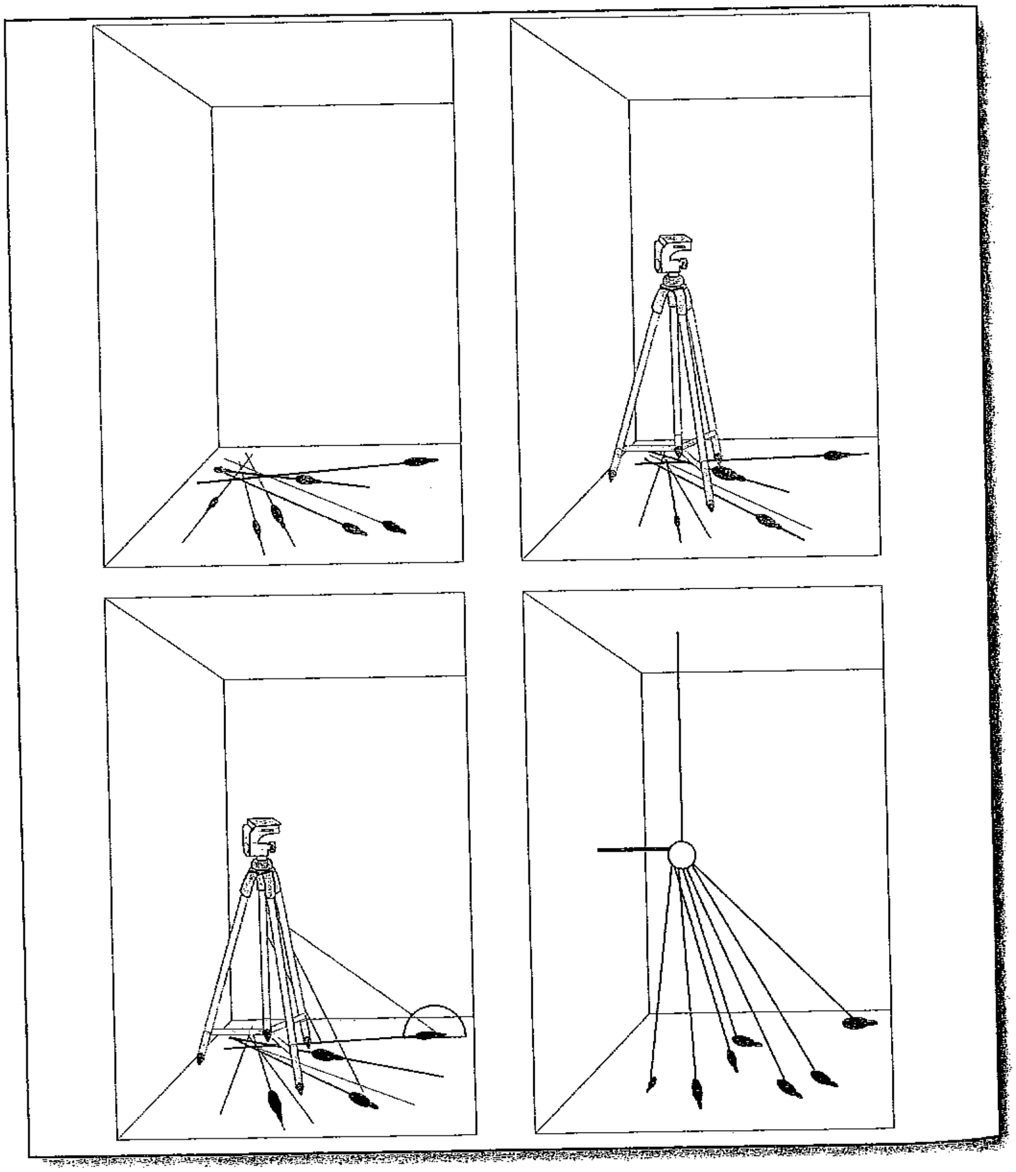


FIGURE 10-9 An illustration of the string method used at a crime scene to determine the area of origin of blood spatter. *Courtesy Bloodstain Pattern Evidence by Anita Y. Wonder, p. 47. Copyright Elsevier, 2007*

Quick Review

- An impact spatter pattern occurs when an object impacts a source of blood. This produces forward spatter projected forward from the source and back spatter projected backward from the source.
- Impact spatter patterns can be classified as low velocity (>3 mm drops), medium velocity (1–3 mm drops), or high velocity (<1 mm drops) for descriptive purposes. These categories should not be used to assume what kind of force created the pattern.
- The area of convergence is the point on a two-dimensional plane from which the drops of an impact spatter pattern originated. This area can be estimated by drawing straight lines through the long axis of several individual bloodstains, following the line of their tails.
- The area of origin of a bloodstain pattern is the area in three-dimensional space where blood was projected from, showing the position of the victim or suspect when the stain-producing event took place. The string method is commonly used at a crime scene to approximate the position of the area of origin.

More Bloodstain Spatter Patterns

A shooting may leave a distinct gunshot spatter pattern. This may be characterized by both forward spatter from an exit wound and back spatter from an entrance wound. However, the gunshot produces only back spatter if the bullet does not exit the body. If the victim is close enough to a vertical surface when suffering a gunshot wound, the blood will be expelled both forward and backward. This will leave a pattern of very fine drops radiating out in a cone-shaped pattern characteristic of high-velocity spatter (see Figure 10–10).

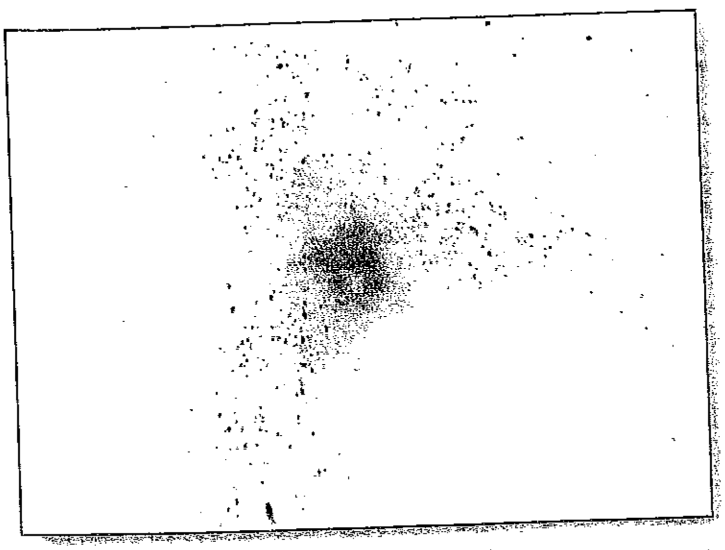


FIGURE 10-10 The high-velocity spatter from the cone-shaped deposit of gunshot spatter. *Courtesy A.Y. Wonder*

The location of the injury, the size of the wound created, and the distance between the victim and the muzzle of the weapon all affect the amount of back spatter that occurs. Finding high-velocity spatter containing the victim's blood on a suspect can help investigators place the suspect in the vicinity when the gun was discharged. Back spatter created by a firearm discharge generally contains fewer and smaller atomized stains than does forward spatter. A muzzle blast striking an entrance wound is expected to cause the formation of atomized blood.

Depending on the distance from the victim at which the gun was discharged, some back spatter may strike the shooter and enter the gun muzzle. This is called the drawback effect. Blood within the muzzle of a gun can place the weapon in the vicinity of the gunshot wound. The presence of blow-back spatter on a weapon's muzzle is consistent with the weapon being close to the victim at the time of firing (see Figure 10–11).

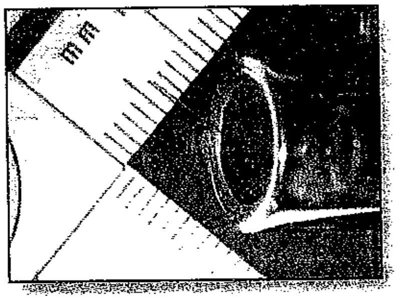


FIGURE 10-11 Back spatter bloodstains entering the muzzle of a weapon discharged in close proximity to a victim. *Courtesy of Ralph R. Ristenbatt III and Robert Shaler*

cast-off
A bloodstain pattern that is created when blood is flung from a blood-bearing object in motion onto a surface

A **cast-off** pattern is created when a blood-covered object flings blood in an arc onto a nearby surface. This kind of pattern commonly occurs when a person pulls a bloody fist or weapon back between delivering blows to a victim (see Figure 10–7(b)). The bloodstain tails will point in the direction in which the object was moving.

The width of the cast-off pattern created by a bloody object may help suggest the kind of object that produced the pattern. The sizes of the drops are directly related to the size of the point from which they were propelled. Drops propelled from a small or pointed surface will be smaller and the pattern more linear; drops propelled from a large or blunt surface will be larger and the pattern wider. The volume of blood deposited on an object from the source also affects the size and number of drops in the cast-off pattern. The less blood on the object, the smaller the stains produced. The pattern may also suggest whether the blow that caused the pattern was directed from right to left or left to right. The pattern will point in the direction of the backward thrust, which will be opposite the direction of the blow. This could suggest which hand the assailant used to deliver the blows.

Cast-off patterns may also show the minimum number of blows delivered to a victim. Each blow should be marked by an upward-and-downward or forward-and-backward arc pattern (see Figure 10–12). By counting and pairing the patterns, one can estimate the minimum number of blows. An investigator should

Case Files Blood Spatter Evidence

Stephen Scher banged on the door of a cabin in the woods outside Montrose, Pennsylvania. According to Scher, his friend, Marty Dillon, had just shot himself while chasing after a porcupine. The two had been skeet shooting at Scher's cabin, enjoying a friendly sporting weekend, when Dillon spotted a porcupine and took off out of sight. Scher heard a single shot and waited to hear his friend's voice. After a few moments, he chased after Dillon and found him lying on the ground near a tree stump, bleeding from a wound in his chest. Scher administered CPR after locating his dying friend, but he was unable to save Dillon, who later died from his injuries. Police found that Dillon's untied boot had been the cause of his shotgun wound. They determined that he had tripped while running with his loaded gun and shot himself. The grief-stricken Scher aroused no suspicion, so the shooting was ruled an accident.

Shortly thereafter, Scher moved from the area, divorced his wife, and married Dillon's widow. This was too suspicious to be ignored; police reopened the case and decided to reconstruct the crime scene. The reconstruction provided investigators with several pieces of blood evidence that pointed to Scher as Dillon's murderer.

Police noticed that Scher's boots bore the unmistakable spray of high-velocity impact blood spatter,. evidence that he was standing within an arm's length of Dillon when Dillon was shot. This pattern of bloodstains cannot be created while administering CPR, as Scher claimed had happened. The spatter pattern also clearly refuted Scher's claim that he did not witness the incident. In addition, the tree stump near Dillon's body bore the same type of blood spatter, in a pattern that indicated Dillon was seated on the stump and not running when he was shot. Finally, Dillon's ears were free of the high-velocity blood spatter that covered his face, but blood was on his hearing protectors found nearby. This is a clear indication that he was wearing his hearing protectors when he was shot, and they were removed before investigators arrived. This and other evidence resulted in Scher's conviction for the murder of his long-time friend Marty Dillon.

take into consideration that the first blow would only cause blood to pool to the area; it would not produce a cast-off pattern. Also, some blows may not come into contact with blood and so will not produce a pattern. The medical examiner is in the best position to estimate the number of blows a victim received.

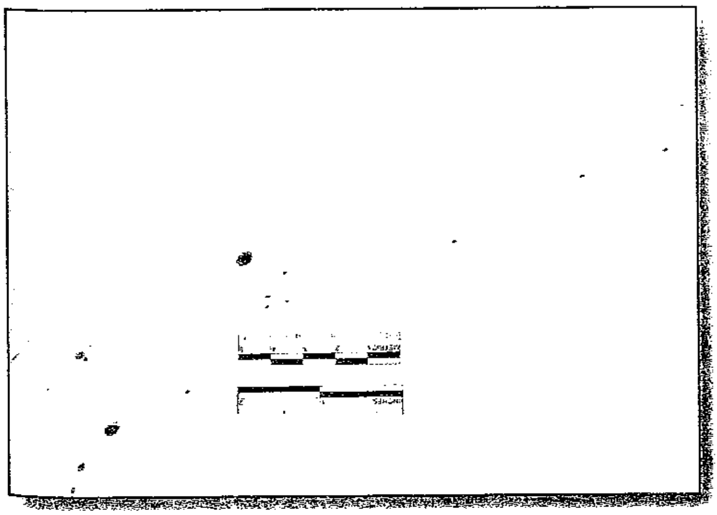


FIGURE 10-12
The cast-off pattern created from one backward and one forward motion of an overhand swing. The larger drops are away from the victim because they're made when the weapon holds the greatest amount of blood. The smaller spatters are directed toward the victim. Source: Bloodstain Pattern Evidence by Anita Y. Wonder, p. 295. *Copyright Elsevier, 2007*

arterial spray
A characteristic bloodstain pattern containing spurts that resulted from blood exiting under pressure from an arterial injury

Arterial spray spatter is created when a victim suffers an injury to a main artery or the heart. The pressure of the continuing pumping of blood causes blood to spurt out of the injured area (see Figure 10–7(c)). Commonly, the pattern shows large spurted stains for each time the heart pumps. Some radial spikes, satellite spatter, or flow patterns may be evident because of the large volume of blood being expelled with each spurt. Drops may also be seen on the surface in fairly uniform size and shape and in parallel arrangement (see Figure 10–13).

FIGURE 10-13 Arterial spray spatter found at a crime scene where a victim suffered injury to an artery. *Courtesy Norman H. Reeves,* Bloodstain Pattern Analysis, *Tucson, AZ, www.bloody1.com*

The lineup of the stains shows the victim's movement. Any vertical arcs or waves in the line show fluctuations in blood pressure. The large stains are at the end of the overall pattern. The initial breach can produce a mist effect from the initial pressure. Then as the pressure drops, larger blood deposits occur because arterial pressure is not causing them to break up. Arterial patterns can also be differentiated because the oxygenated blood spurting from the artery tends to be a brighter red color than blood expelled from impact wounds.

A pattern created by blood that is expelled from the mouth or nose from an internal injury is called an **expirated blood pattern**. If the blood that creates such a pattern is under great pressure, it produces very fine high-velocity spatter. Expirated blood at very low velocities produces a stain cluster with irregular edges (see Figure 10–14). The presence of bubbles of air in the drying drops can differentiate a pattern created by expirated blood from other types of bloodstains. Expirated blood also may be lighter in color when compared to impact spatter as a result of dilution by saliva. The presence of expirated blood gives an important clue as to the injuries suffered and the events that took place at a crime scene.

expirated blood pattern
A pattern created by blood that is expelled out of the nose, mouth, or respiratory system as a result of air pressure and/or airflow

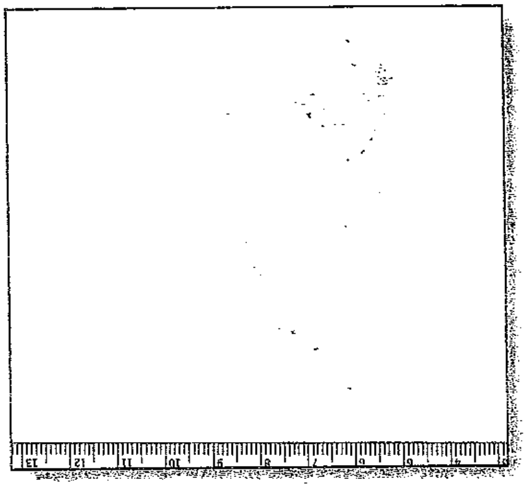


FIGURE 10-14 An example of expirated blood expelled with two wheezes from the mouth. *Courtesy A.Y. Wonder*

A void is created when an object blocks the deposition of blood spatter onto a target surface or object (see Figure 10–15). The spatter is deposited onto the object or person instead. The blank space on the surface or object may give a clue as to the size and shape of the missing object or person. Once the object or person is found, the missing piece of the pattern should fit in, much like a puzzle piece, with the rest of the pattern. Voids may be applicable for establishing the body position of the victim or assailant at the time of the incident.

void
An area within a deposited spatter pattern that is clear of spatter, caused by an object or person blocking the area at the time of the spatter's deposition

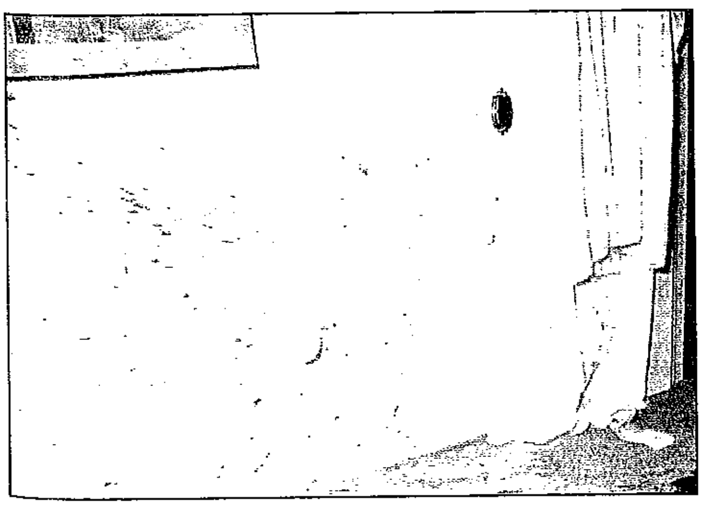


FIGURE 10-15 A void pattern is found behind the door where the surface of the door blocked the deposition of spatter on that area. This void, and the presence of spatter on the door, shows that the door was open when the spatter was deposited.
Courtesy Norman H. Reeves, Bloodstain Pattern Analysis, *Tucson, AZ, www.bloody1.com*

Quick Review

- Gunshot spatter can consist of both forward spatter from an exit wound and back spatter from an entrance wound; however, only back spatter will be produced if the bullet does not exit the body.
- A cast-off pattern is created when a blood-covered object flings blood in an arc onto a nearby surface. This kind of pattern commonly occurs when a person pulls a bloody fist or weapon back between delivering blows to a victim.
- The characteristic arterial spray spatter is created when a victim suffers an injury to a main artery or the heart and the pressure of the continuing pumping of blood projects blood out of the injured area in spurts, which are apparent in the pattern.
- Expirated blood is expelled from the mouth or nose and may appear as very fine high-velocity spatter or large low-velocity bloodstain clusters. This kind of pattern may contain bubbles of oxygen or be mixed with saliva.
- A void pattern features an area free of spatter where an object (or person) blocks the deposition of blood spatter onto a target surface or object. Because the spatter is deposited onto the object or person instead, the shape of the void may give a clue as to the size and shape of the missing object or person.

Other Bloodstain Patterns

Not all bloodstains at a crime scene appear as spatter patterns. The circumstances of the crime often create other types of stains that can be useful to investigators.

transfer pattern
A bloodstain pattern created when a surface that carries wet blood comes in contact with a second surface; recognizable imprints of all or a portion of the original surface or the direction of movement may be observed

When an object with blood on it touches one that does not have blood on it, this produces a contact or **transfer pattern**. Examples of transfers with features include fingerprints (see Figure 10–16), handprints, footprints, footwear prints, tool prints, and fabric prints in blood. These may provide further leads by offering individual characteristics.

The size and general shape of a tool may be seen in a simple transfer. This can lead to narrowing the possible tools by class characteristics. A transfer that shows a very individualistic feature may help point to the tool that made the pattern.

Simple transfer patterns are produced when the object makes contact with the surface and the object is removed without any movement. Other transfers known as *swipe patterns* may be caused by movement of the bloody object across a surface. Generally, the swipe pattern will lighten and "feather" as the pattern moves away from the initial contact point (see Figure 10–17). The direction of separate bloody transfers, such as footwear prints in blood, may show the movement of the suspect, victim, or others through the crime scene after the blood was present. The first transfer pattern will be dark and heavy with blood, whereas subsequent transfers will be increasingly lighter in color. As the transfers get lighter, less and

FIGURE 10-16 A transfer pattern consisting of bloody fingerprints with apparent ridge detail. *Courtesy Lawrence A. Presley, Arcadia University*

less of the transferring object's surface will deposit visible traces of blood. Bloody shoe imprints may also suggest whether the wearer was running or walking. Running typically produces imprints with more space between them and more satellite or drop patterns between each imprint.

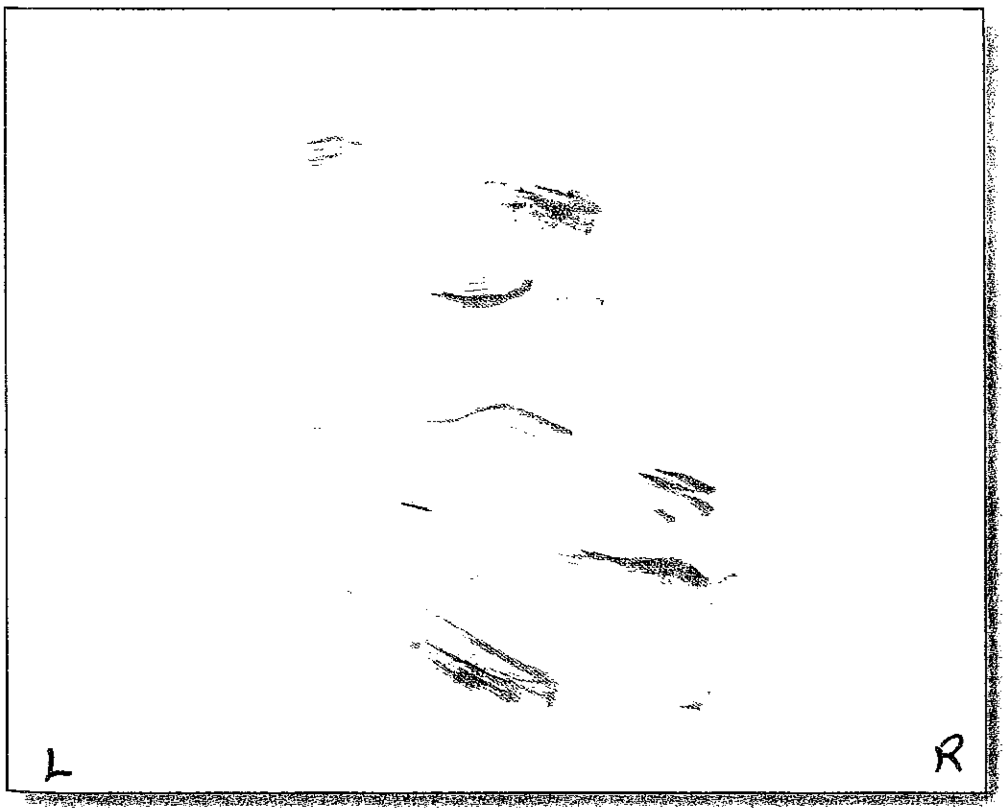


FIGURE 10-17 A series of swipe patterns moving from right to left. *Courtesy A.Y. Wonder*

flow pattern
A bloodstain pattern formed by the movement of small or large amounts of blood as a result of gravity's pull

Patterns made by drops or large amounts of blood flowing by the pull of gravity are called **flow patterns**, or flows. Flows may be formed by single drops or large volumes of blood coming from an actively bleeding wound or blood deposited on a surface from an arterial spurt. Clotting of the blood's solid parts may occur when a flow extends onto an absorbent surface.

The flow direction may show movements of objects or bodies while the flow was still in progress or after the blood had dried. Figure 10–18 illustrates a situation in which movement of the surface while the flow was still in progress led to a specific pattern.

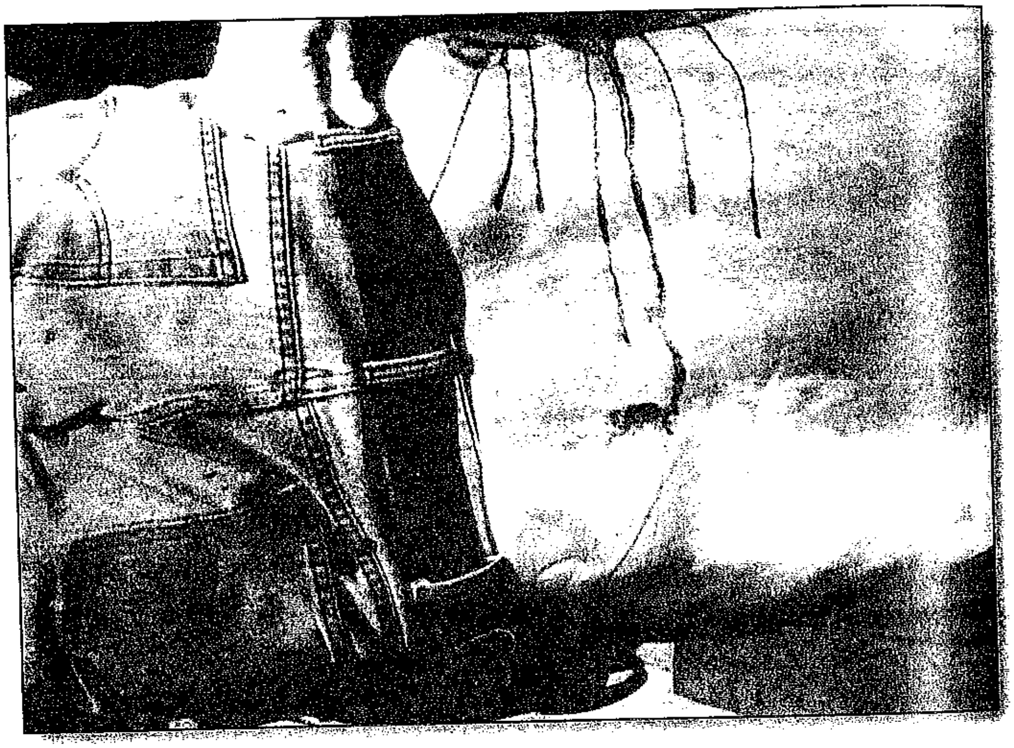


FIGURE 10-18
The flow pattern suggests that the victim was upright and then fell while blood flowed. The assailant claimed the victim was stabbed while sleeping. *Source: Bloodstain Pattern Evidence by Anita Y. Wonder, p. 98. Copyright Elsevier, 2007*

Interruption of a flow pattern may be helpful in assessing the sequence and passage of time between the flow and its interruption. If a flow found on an object or body does not appear consistent with the direction of gravity, one may surmise that the object or body was moved after the blood had dried.

A pool of blood occurs when blood collects in a level (not sloped) and undisturbed place. Blood that pools on an absorbent surface may be absorbed throughout the surface and diffuse, creating a pattern larger than the original pool. This often occurs with pools on beds or sofas.

The approximate drying time of a pool of blood is related to the environmental condition of the scene. By experimentation, an analyst may be able to estimate the drying times of stains of different sizes. Small and large pools of blood can aid in reconstruction by providing an estimate of the time that elapsed since the blood was deposited. Considering the drying time of a blood pool can yield information about the timing of events that accompanied the incident.

The edges of a stain will dry to the surface, producing a phenomenon called **skeletonization** (see Figure 10–19). This usually occurs within 50 seconds of deposition of drops, and longer for larger volumes of blood. If the central area of the pooled bloodstain is altered by wiping, the skeletonized perimeter will be left intact. This can be used to interpret whether movement or activity occurred shortly after the pool was deposited, or whether the perimeter had time to skeletonize before the movement occurred. This may be important for classifying the source of the original stain.

skeletonization
The process by which the edges of a stain dry to the surface in a specific period of time (dependent on environmental and surface conditions). Skeletonization will remain apparent even after the rest of the bloodstain has been disturbed from its original position

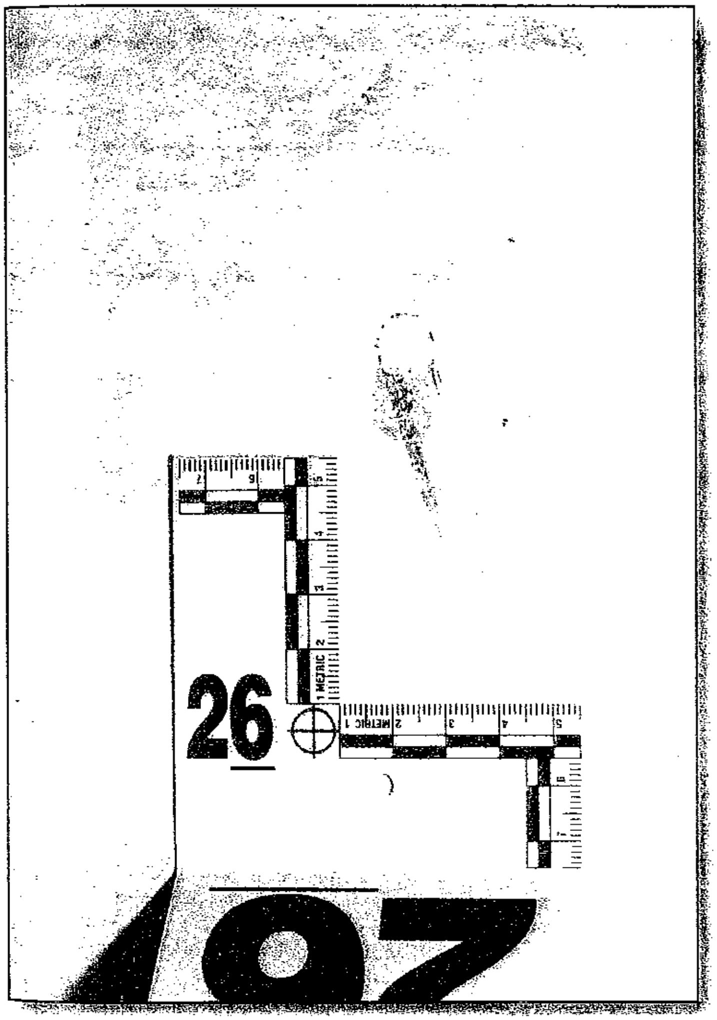


FIGURE 10-19
Skeletonization is shown in a bloodstain that was disturbed after the edges had time to skeletonize. *Courtesy Norman H. Reeves,* Bloodstain Pattern Analysis, *Tucson, AZ, www.bloody1.com*

A **drip trail pattern** is a series of drops that are separate from other patterns, formed by blood dripping off an object or injury. The stains form a kind of line or path usually made by the suspect after injuring or killing the victim, or they can show the movement of a wounded victim. It may simply show movement, lead to a discarded weapon, or provide identification of the suspect by his or her own blood. Investigators often see this type of pattern in stabbings during which

drip trail pattern
A pattern of bloodstains formed by the dripping of blood off a moving surface or person in a recognizable pathway separate from other patterns

the suspect cuts himself or herself as a result of the force necessary to stab the victim. Figure 10–20 shows a drip trail pattern away from the center of action at a crime scene.

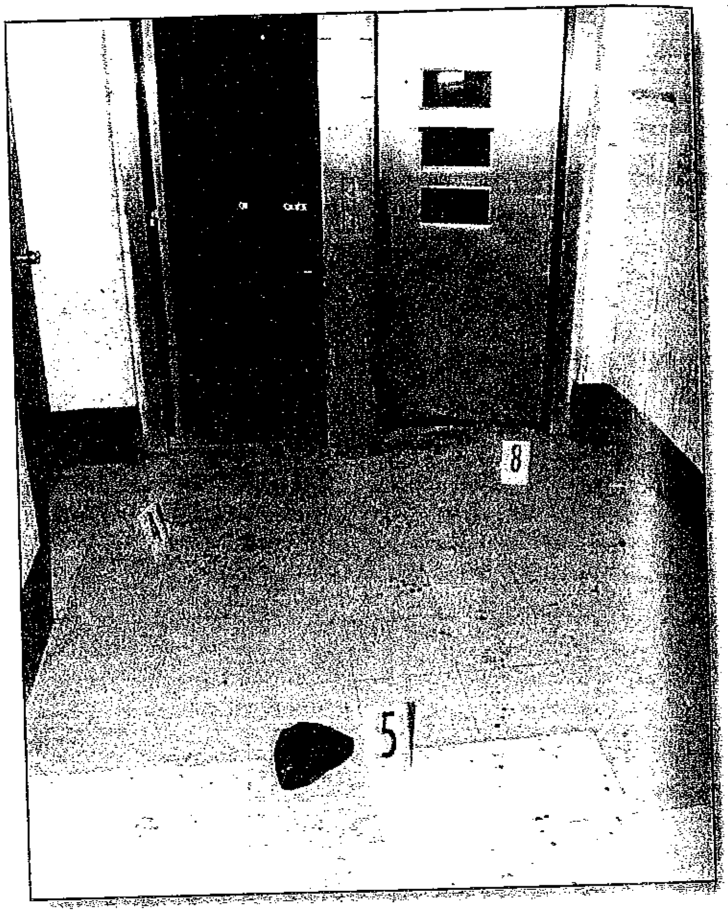


FIGURE 10-20
A drip trail pattern leads away from the center of the mixed bloodstain pattern. *Courtesy Norman H. Reeves,* Bloodstain Pattern Analysis, *Tucson, AZ, www.bloody1.com*

The shape of the stains in a drip trail pattern can help investigators determine the direction and speed at which a person was moving. The tails of the drops in a drip trail pattern point in the direction the person was moving. More circular stains are found where the person was moving slowly enough to not form tails. This information may be helpful in reconstruction.

Documenting [illegible]

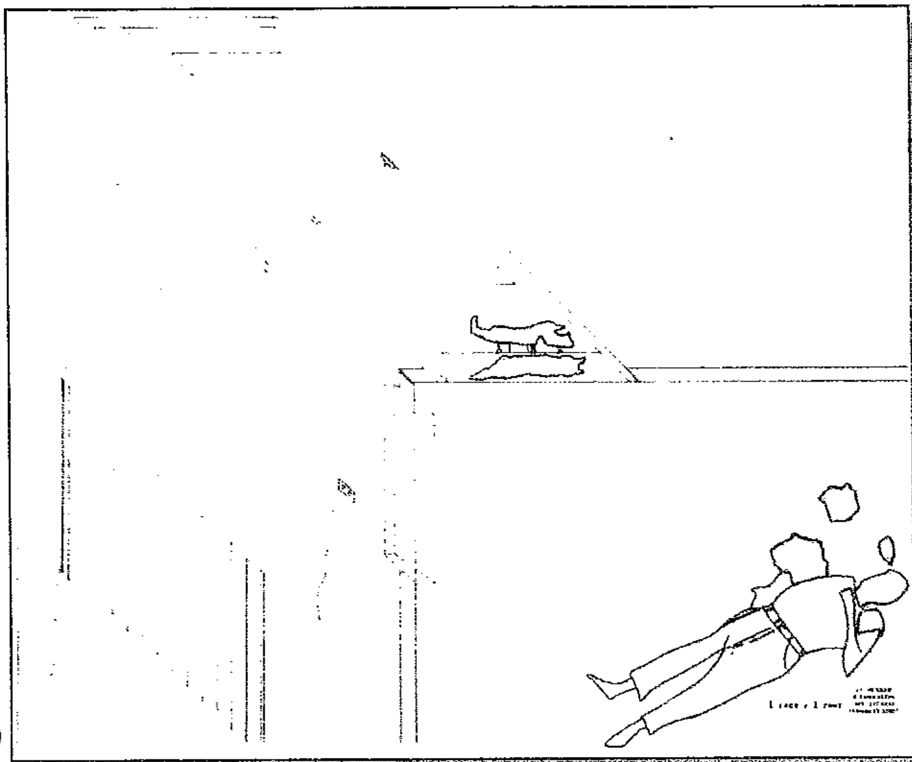
Blood spatter patterns of any kind can provide a great deal of information about the events that took place at a crime scene. For this reason, investigators should note, study, and photograph each pattern and drop. This must be done to accurately record the location of specific patterns and to distinguish the stains from which laboratory samples were taken. The photographs and sketches can also point out specific stains used in determining the direction of force, angle of impact, and area of origin.

Just as in general crime-scene photography, the investigator should create photographs and sketches of the overall pattern to show the orientation of the pattern to the scene. The medium-range documentation should include pictures and sketches of the whole pattern and the relationships between individual stains

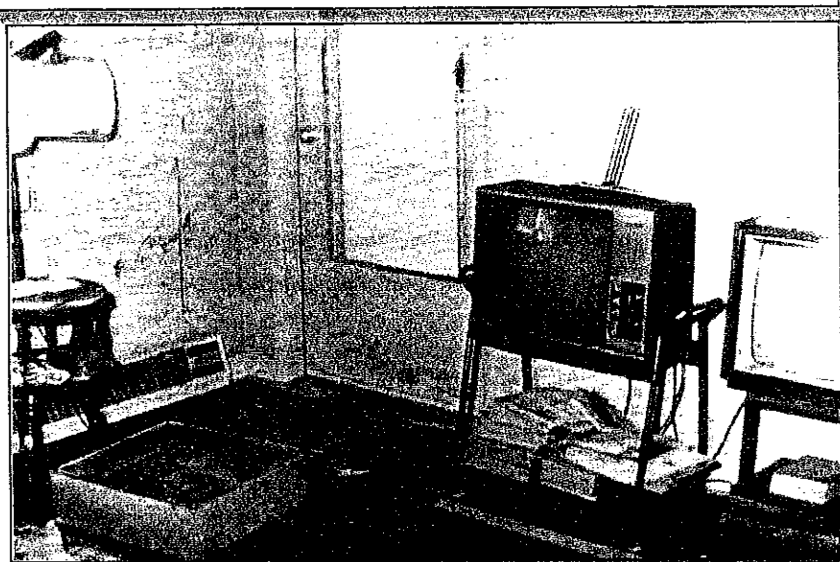
Case Files Bloodstain Reconstruction

An elderly male was found lying dead on his living room floor. He had been beaten about the face and head, then stabbed in the chest and robbed. The reconstruction of bloodstains found on the interior front door and the adjacent wall documented that the victim was beaten about the face with a fist and struck on the back of the head with his cane. A three-dimensional diagram and photograph illustrating the evidential bloodstain patterns is shown in Figures 1(a) and (b).

FIGURE 1 (a) A three-dimensional diagram illustrating bloodstain patterns that were located, documented, and reconstructed. (b) A crime-scene photograph of bloodstained areas. (a) *Courtesy Judith Bunker, J.L. Bunker & Assoc., Ocoee, Fla.* (b) *Courtesy Sarasota County (Fla.) Sheriff's Department*



(A)



(B)

(continued)

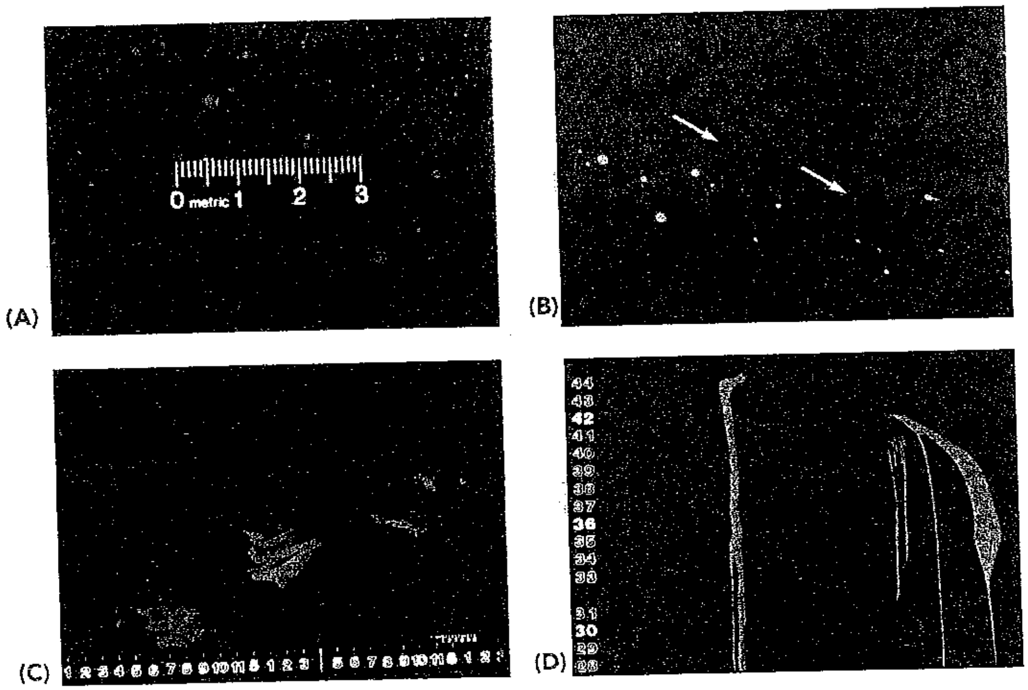
Case Files

(continued)

A detail photograph of bloodstains next to the interior door is shown in Figure 2. Arrow 1 in Figure 2 points to the cast-off pattern directed left to right as blood was flung from the perpetrator's fist while inflicting blows. Arrow 2 in Figure 2 points to three transfer impression patterns directed left to right as the perpetrator's bloodstained hand contacted the wall as the fist blows were being inflicted on the victim. Arrow 3 in Figure 2 points to blood flow from the victim's wounds as he slumped against the wall.

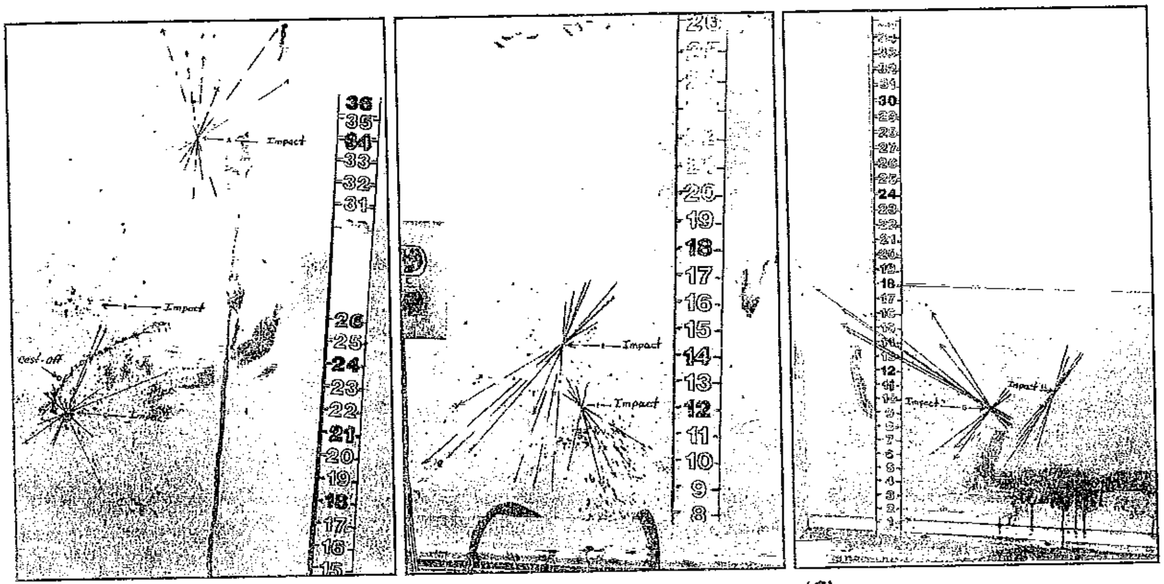
FIGURE 2 Positions of impact spatter from blows that were inflicted on the victim's face. *Courtesy Judith Bunker, J.L. Bunker & Assoc., Ocoee, Fla.*

FIGURE 3
(a) A laboratory test pattern showing an impact spatter. The size and shape of the stains demonstrate a forceful impact 90 degrees to the target. (b)A laboratory test pattern illustrating a cast-off pattern directed left to right from an overhead swing. (c) A laboratory test pattern showing a repetitive transfer impression pattern produced by a bloodstained hand moving left to right across the target. (d) A laboratory test pattern illustrating vertical flow patterns. The left pattern represents a stationary source; the right pattern was produced by left-to-right motion. *Courtesy Judith Bunker, J.L. Bunker & Assoc., Ocoee, Fla.*



Case Files

(continued)



(A) (B) (C)

FIGURE 4
(a) A convergence of impact spatter patterns associated with beating with a fist. (b) The convergence of impact spatter associated with the victim falling to the floor while bleeding from the nose. (c) The convergence of impact spatter associated with the victim while face down at the door, being struck with a cane.
Courtesy Judith Bunker, J.L. Bunker & Assoc., Ocoee, Fla.

Figure 3 contains a series of laboratory test patterns created to evaluate the patterns contained within Figure 2. Figure 4 shows how the origin of individual impact spatter patterns located on the wall and door and emanating from the bleeding victim can be documented by the determination of separate areas of convergence.

A suspect was apprehended three days later, and he was found to have an acute fracture of the right hand. When he was confronted with the bloodstain evidence, the suspect admitted striking the victim, first with his fist, then with a cane, and finally stabbing him with a kitchen knife.

The suspect pleaded guilty to three first-degree felonies.

within the pattern. The close-up photographs and sketches should show the dimensions of each individual stain. Close-up photographs should be taken with a scale of some kind apparent in the photograph.

Two common methods of documenting bloodstain patterns place attention on the scale of the patterns. The *grid method* involves setting up a grid of squares of known dimensions over the entire pattern using string and stakes (see Figure 10–21). All overall, medium-range, and close-up photographs are taken with and without the grid. The second method, called the *perimeter ruler method*, involves setting up a rectangular border of rulers around the pattern and then placing a small ruler next to each stain. In this method, the large rulers show scale in the overall and medium-range photos, whereas the small rulers show scale in the close-up photographs (see Figure 10–22). Some investigation teams use tags in close-up photographs to show evidence numbers or other details.

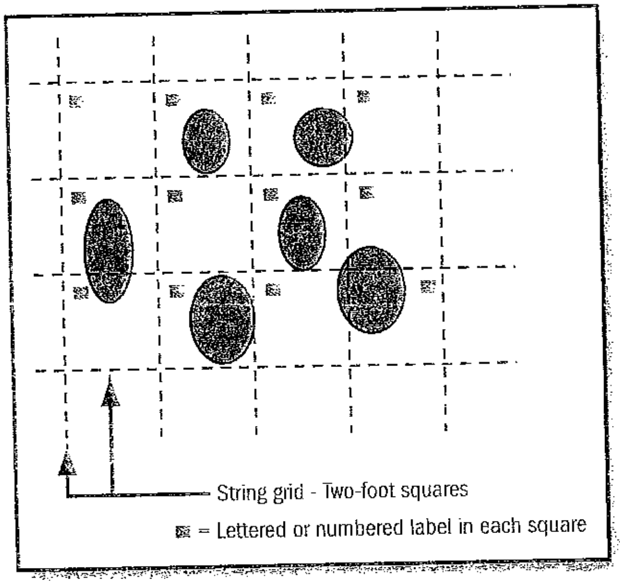


FIGURE 10-21
The grid method may be used for photographing bloodstain pattern evidence. *Source: R.R. Ogle, Jr., Crime Scene Investigation & Reconstruction, 2nd ed., Prentice Hall, Upper Saddle River, NJ, 2007*

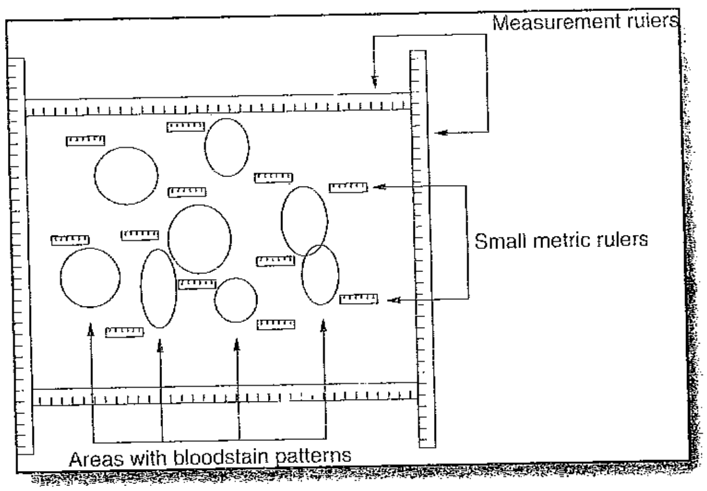


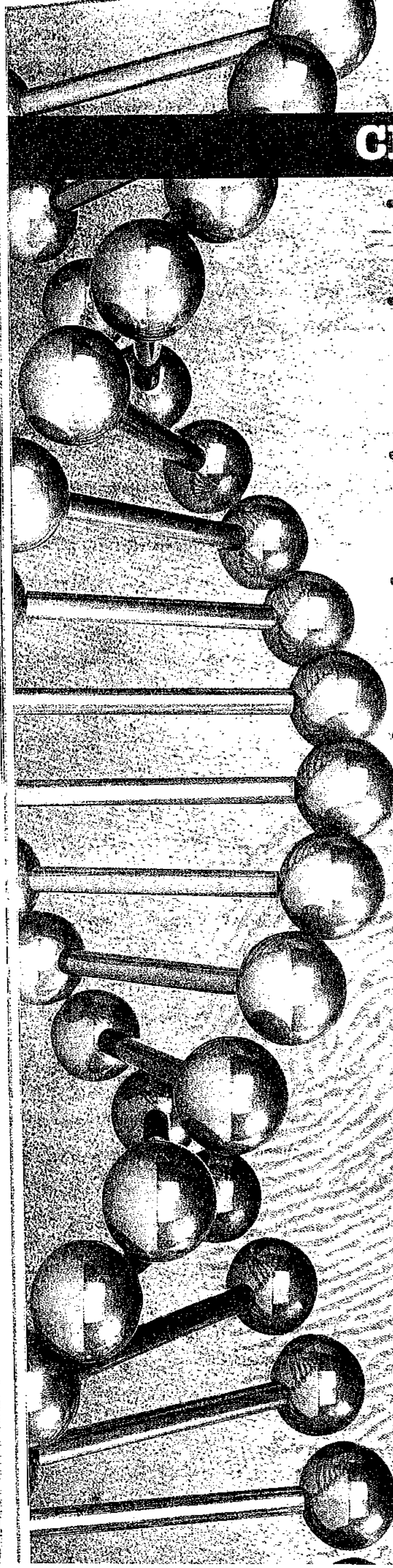
FIGURE 10-22
The perimeter ruler method may be used for photographing bloodstain pattern evidence. Source: *R.R. Ogle, Jr., Crime Scene Investigation & Resconstruction, 2nd ed., Prentice Hall, Upper Saddle River, NJ, 2007*

An area-of-origin determination should be calculated whenever possible. All measurements of stains and calculations of angle of impact and point of origin should be recorded in crime-scene notes. Especially important stains can be roughly sketched within the notes.

Only some jurisdictions have a specialist on staff to decipher patterns either at the scene or from photographs at the lab. Therefore, it is important that all personnel be familiar with patterns to properly record and document them for use in reconstruction.

Quick Review

- Transfer patterns are created when an object with blood on it makes simple contact with a surface or moves along a surface. The direction of movement may be shown by feathering of the pattern.
- Flows may originate from a single drop or a large amount of blood. The direction of the flow is caused by gravity, so the direction of a pattern may suggest the original position of the surface when the flow was formed.
- A pool is formed where large amounts of blood collect. The pool may be absorbed into the surface of deposition over time.
- The presence of skeletonization of the perimeter of a bloodstain suggests that the stain was disturbed after the edges had sufficient time to skeletonize.
- A drip trail pattern is separate from other patterns, and it is formed by single blood drops dripping off an object or injury.
- Photographs and sketches should first be created of the overall pattern to show orientation of the pattern to the scene.
- Medium-range and close-up photographs may use the grid method or perimeter ruler method to show the orientation and relative size of the pattern and individual stains.



Chapter Review

- Crime-scene reconstruction relies on the combined efforts of medical examiners, criminalists, and law enforcement personnel to recover physical evidence and to sort out the events surrounding the occurrence of a crime.
- Examples of crime-scene reconstruction include determining whether a body was moved after death, determining whether a victim was clothed after death, analyzing bullet trajectory, analyzing blood spatter, determining the direction from which projectiles penetrated glass objects, estimating the distance of a shooter from a target, and locating primer residue on suspects.
- Individual bloodstains can convey to the bloodstain analyst the directionality and angle of impact of the blood when it impacted a surface. Bloodstain patterns may convey to the analyst the location of victims or suspects, the movement of bleeding individuals, and the number of blows delivered.
- Surface texture is of paramount importance in the interpretation of bloodstain patterns; rounder drops generally are produced from smooth, nonporous surfaces, whereas rough surfaces create irregular-edged drops. However, correlations between standards and unknowns are valid only if identical surfaces are used.
- The direction of travel of blood striking an object may be discerned by the stain's shape. The pointed end of a bloodstain always faces in its direction of travel.
- The angle of impact of an individual bloodstain can be approximated by the degree of distortion or lengthening of the bloodstain, or it can be more effectively estimated using the ratio of width/length of the stain.
- An impact spatter pattern occurs when an object impacts a source of blood. This produces forward spatter projected forward from the source and back spatter projected backward from the source.
- Impact spatter patterns can be classified as low velocity (>3 mm drops), medium velocity (1–3 mm drops), or high velocity (<1 mm drops) for descriptive purposes. These categories should not be used to assume what kind of force created the pattern.
- The area of convergence is the point on a two-dimensional plane from which the drops of an impact spatter pattern originated. This area can be estimated by drawing straight lines through the long axis of several individual bloodstains, following the line of their tails.
- The area of origin of a bloodstain pattern is the area in three-dimensional space where blood was projected from, showing the position of the victim or suspect when the stain-producing event took place. The string method is commonly used at a crime scene to approximate the position of the area of origin.

- Gunshot spatter can consist of both forward spatter from an exit wound and back spatter from an entrance wound; however, only back spatter will be produced if the bullet does not exit the body.
- A cast-off pattern is created when a blood-covered object flings blood in an arc onto a nearby surface. This kind of pattern commonly occurs when a person pulls a bloody fist or weapon back between delivering blows to a victim.
- The characteristic arterial spray spatter is created when a victim suffers an injury to a main artery or the heart and the pressure of the continuing pumping of blood projects blood out of the injured area in spurts, which are apparent in the pattern.
- Expirated blood is expelled from the mouth or nose and may appear as very fine high-velocity spatter or large low-velocity bloodstain clusters. This kind of pattern may contain bubbles of oxygen or be mixed with saliva.
- A void pattern features an area free of spatter where an object (or person) blocks the deposition of blood spatter onto a target surface or object. Because the spatter is deposited onto the object or person instead, the shape of the void may give a clue as to the size and shape of the missing object or person.
- Transfer patterns are created when an object with blood on it makes simple contact with a surface or moves along a surface. The direction of movement may be shown by feathering of the pattern.
- Flows may originate from a single drop or a large amount of blood. The direction of the flow is caused by gravity, so the direction of a pattern may suggest the original position of the surface when the flow was formed.
- A pool is formed where large amounts of blood collect. The pool may be absorbed into the surface of deposition over time.
- The presence of skeletonization of the perimeter of a bloodstain suggests that the stain was disturbed after the edges had sufficient time to skeletonize.
- A drip trail pattern is separate from other patterns, and it is formed by single blood drops dripping off an object or injury.
- Photographs and sketches should first be created of the overall pattern to show orientation of the pattern to the scene.
- Medium-range and close-up photographs may use the grid method or perimeter ruler method to show the orientation and relative size of the pattern and individual stains.

Quick Lab: Blood Drop Analysis

Materials:

Simulated blood*
Dropper
Construction paper
Ruler
Scientific calculator

Procedure:

By examining a single blood drop at a crime scene, we can determine some important information that may help to reconstruct what occurred. One piece of data we can gather is the angle of impact for a blood drop. For this activity, start by creating some blood drops on the construction paper. Use the dropper to place drops of blood on the paper and be sure to squirt the blood at different angles onto the paper. Remember, you want drops, not a puddle. Once you have created about ten drops at different angles, let the blood dry. Once dry, use the ruler to measure the width and length of each drop in millimeters. Record your data. To determine the angle at which each blood drop impacted, use the calculator to solve the equation width/length = sin of the angle of impact. The sin of the angle of impact can be converted to the angle of impact by hitting the arcsin button ($\sin^{-1}$) on the calculator. This is the angle at which the blood drop fell onto the surface.

Follow-Up Questions:

1. How would knowing the angle of impact of a blood drop be helpful in an investigation?

2. Did any of your drops fall at a 90-degree angle? If so, what shape were they?

3. Create a graph of showing angle of impact vs. blood drop length using the data from your ten blood drops. Explain whether there is a correlation between these two pieces of data.

*Available from Forensics Source, www.forensicssource.com

Quick Lab: Blood Spatter Analysis

Materials:

Sheet of blank paper
Water-soluble red paint
Paintbrush and pointed stirring stick

Procedure:

Cast-off blood spatter is often of great help to investigators in reconstructing events at the scene of a violent crime. In particular, the shape and appearance of cast-off bloodstains can indicate the relative positions of the victim and assailant during the crime and the type of weapon used. For this exercise, students should be matched up in teams of two. Each member of the pair, working separately, will make a series of spatters on the blank paper with the red paint. Using the paintbrush, make three stains by flicking a small amount of red paint onto the paper. Hold the brush at differing angles to the paper when making each stain. One should be made at a shallow angle, the second at a steeper angle, and the third at an even steeper angle. Now make similar marks using the stirring stick instead of the paintbrush. Let the paint dry, then mark the stains A, B,C, D, E, and F. Be sure to record which instrument made each mark and the angle (shallow, steep, very steep) at which it was made. (It is best to alternate making marks with one instrument, then the other, rather than making all 3 marks with the paintbrush, then all with the stirring stick.) Now pair up with your partner and exchange sheets. Answer the following questions:

Follow Up Questions:

1. Which marks were made by the paintbrush and which were made by the stick? How do you know this?
2. For each instrument, list the stains from shallowest to steepest. How did you determine the relative angles of each stain?
3. What would the presence of shallow-angle bloodstains suggest about the relative position of victim and assailant? What would a steeper angle suggest?

Review Questions

1. Violent contact between individuals at a crime scene frequently produces bleeding and results in the formation of
   a. footwear impressions
   b. bloodstain patterns
   c. blood typing
   d. rigor mortis

2. A drop of blood that strikes a surface at an angle of impact of approximately 90° will be close to ________________ in shape.
   a. elongated
   b. elliptical
   c. teardropped
   d. circular

3. The classification system of impact spatter is based on the size of drops resulting from the velocity of the blood drops produced, and patterns can be classified as ________________, ________________, or ________________ impact spatter.
   a. low-blow; medium-blow; high-blow
   b. low-velocity; medium-velocity; high-velocity
   c. small; medium; large
   d. circular; elliptical; elongated

4. The ________________ method is used at the crime scene to determine the area of origin.
   a. perimeter ruler
   b. grid
   c. string
   d. cast-off

5. The edges of a bloodstain will generally skeletonize within ________________ of deposition and be left intact even if the central area of a bloodstain is altered by a wiping motion.
   a. 50 seconds
   b. 10 seconds
   c. 50 minutes
   d. 3 hours

6. True or False: Harder and less porous surfaces result in less spatter, whereas rough surfaces produce stains with more spatter and serrated edges.

7. True or False: Movement of a bloody object across a surface causes the pattern to darken as the object moves away from point of contact.

8. True or False: Footwear transfer patterns created by an individual who was running typically show imprints with more space between them as compared to those of an individual who was walking.

9. True or False: The direction of a flow pattern may show movements of objects or bodies while the flow was still in progress or after the blood has dried.

10. True or False: Each bloodstain pattern found at a crime scene does not have to be noted, studied, and photographed.

11. What is crime-scene reconstruction?

12. In which of the following ways can physical evidence aid in crime-scene reconstruction? (You may choose more than one response.)
   a. by supporting or contradicting statements given by witnesses and/or suspects
   b. by describing exactly what happened at the crime scene
   c. by confirming the accuracy of a crime-scene reconstruction to a jury
   d. by distinguishing between individual and class characteristics
   e. by generating leads that may help investigators solve the case

13. Give at least three examples of a specialized task a criminalist might perform in crime-scene reconstruction.

14. Which of the following is of paramount importance in the interpretation of bloodstain patterns?
   a. the direction of impact
   b. the surface texture
   c. the angle of impact
   d. the amount of blood

15. How can an investigator tell the direction of travel of blood from the shape of a bloodstain?

16. What is the difference between the shape of a bloodstain that impacts a surface at a low angle and one that impacts at a higher angle?

17. What is the difference between forward spatter and back spatter? Which is more likely to be deposited on the object or person creating the impact?

18. In general, as both the force and velocity of impact increase, what happens to the diameter of the resulting blood drops?

19. Why might investigators overlook some high-velocity spatter?

20. Define the terms *area of convergence* and *area of origin* and explain what each reveals to an investigator.

21. Name three factors that affect the amount of backward spatter produced by a gunshot wound.

22. What is the drawback effect? How is it helpful to an investigator?

23. What determines the size of blood drops in a cast-off pattern? Explain.

24. What is expirated blood? Name two ways to distinguish expirated blood from other types of bloodstains.

Virtual Lab: Blood Spatter Evidence

To perform a virtual lab analysis of blood spatter, go to www.pearsoncustom.com/us/vlm

25. What is a void pattern? How might a void pattern be useful to investigators?

26. What is a transfer pattern? How is a simple transfer pattern created?

27. How does the first transfer pattern in a series differ from subsequent ones?

28. What is a flow pattern? What should one surmise if a flow found on an object or body does not appear consistent with the direction of gravity?

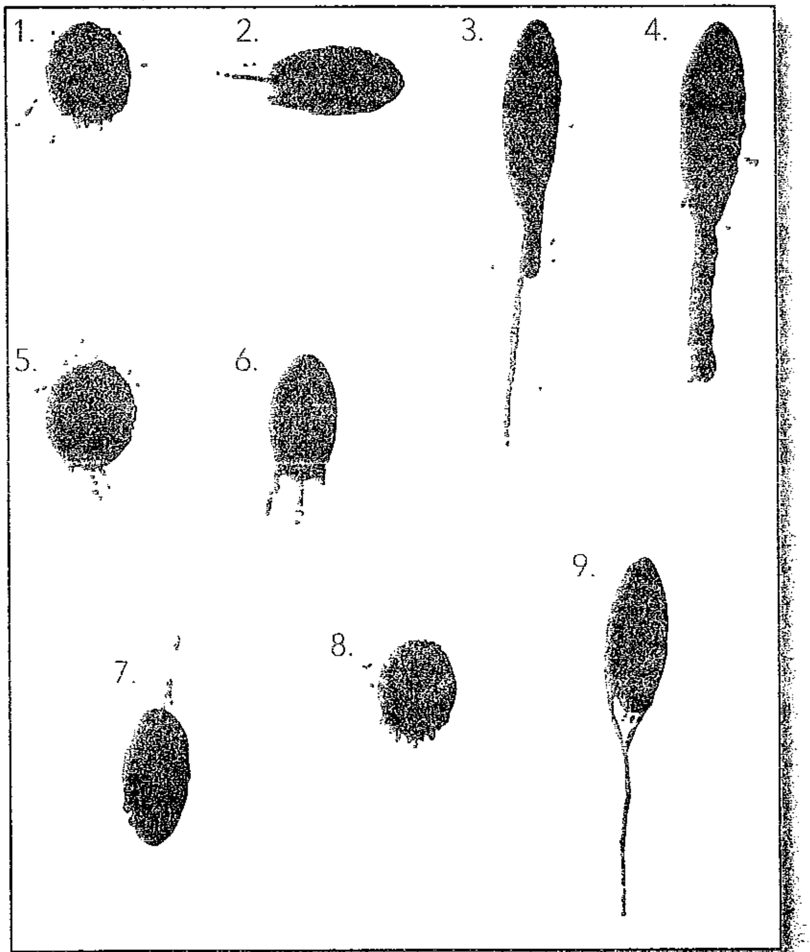
29. How can pools of blood aid in reconstructing a crime scene?

30. Explain how the shape of stains in a drip trail pattern can help investigators determine the direction and speed at which a person was moving.

31. Name and describe two methods for documenting bloodstain patterns.

Application and Critical Thinking

1. After looking at the bloodstains in the figure, answer the following questions:
   a. Which three drops struck the surface closest to a 90-degree angle? Explain your answer.
   b. Which three drops struck the surface farthest from a 90-degree angle? Explain your answer.
   c. In what direction were drops 2 and 7 traveling when they struck the surface? Explain your answer



2. Investigator Priscilla Wright arrives at a murder scene and finds the body of a victim who suffered a gunshot wound but sees no blood spatter on the wall or floor behind it. What should she conclude from this observation?

3. Investigator Terry Martin arrives at an assault scene and finds a cast-off pattern consisting of tiny drops of blood in a very linear arc pattern on a wall near the victim. What does this tell him about the weapon used in the crime?