Bloodstains

The shape and location of bloodstains provide clues about where the victim and suspect were when the crime took place and where they went afterwards. Blood also reveals the presence of disease, drugs, or alcohol, and it can be used to determine the identity of the victim and the suspect through DNA analysis.

Understanding Blood’s Character

In 1901, an Austrian biologist named Karl Landsteiner recognized that all human blood wasn’t the same and he determined the ABO classification system. As he continued his investigation he discovered the rhesus (Rh) factor in 1940. Now, more than 100 factors are known.

Blood is important to crime scenes for many reasons, and one in particular is because of the way it moves and clots. These characteristics are because of its composition.

Blood is a complex substance, consisting of liquid and solid components. As a liquid, blood shared many of the same physical properties as other liquids, including water. It moves and flows as gravity dictates and tends to pool in low-lying areas. It spreads to cover a surface or to conform to the shape of a container. It possesses viscosity (measure of its thickness) and surface tension (an elastic-like property that results from the attraction of a liquid’s molecules to each other).

Unlike water, blood is living, breathing liquid. It is thicker than water, and clots. Cellular elements such as red blood cells, white blood cells, platelets and various proteins are in a blood’s liquid plasma. When blood clots, it separates into a solid dark-ref clot and a clear yellow liquid known as serum. Plasma and serum look similar to the naked eye, but they are differ in important ways:

- **Plasma**: the liquid portion of whole, unclotted blood that contains proteins involved in the clotting process. Plasma can be separated from the whole blood in a centrifuge, a device that rapidly spins a test type of blood causing cells to settle to the bottom, leaving the plasma on top.
- **Serum**: the liquid that remains after the blood’s proteins have done their job and the blood has clotted and retracted into a clump.

Blood will remains as a liquid as long as it’s moving inside the body. At death, the heart stops pumping the blood through the body, and the blood stagnates and clots. When blood leaves the bots, it clots or gels with in a few minutes.

A closer look at blood

The surface of each red blood cell contains millions of characteristic chemical structures called antigens. The antigens are proteins that are responsible for the different types of blood. Type A blood has A antigens, type B blood has B antigens, and type O blood has neither antigen. What types of antigens do you think AB blood has?

![Antigens](http://www.enh.org/uploadedimages/antigens.jpg)
Not only are there RBC’s, but there are also white blood cells. Some white blood cells produce proteins called antibodies in their serum that fight invading substances in the body such as snake venom, bacteria or someone else’s blood. A person with type A blood has type A antigens on his or her red blood cells. That person will also produce certain antibodies to attack and destroy B blood cells, and B antigens.

**ABO Blood Types**

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigens on RBC</th>
<th>Antibodies in Serum</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>AB</td>
<td>A and B</td>
<td>None</td>
</tr>
<tr>
<td>O</td>
<td>None</td>
<td>A and B</td>
</tr>
</tbody>
</table>

Antibodies are bivalent. (They can attach to two antigen sites, thus causing agglutination or clumping) If a person with B type blood receives a transfusion from type A blood, the antibodies in the B blood with attach to the donor’s A RBC’s and cause clumping. The results can be fatal.

**Donor Blood Facts**

<table>
<thead>
<tr>
<th>Blood Type</th>
<th>Antigen</th>
<th>Antibody</th>
<th>Donor for</th>
<th>Recipient for</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A, AB</td>
<td>A, O</td>
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<tr>
<td>B</td>
<td>B</td>
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<td>B, AB</td>
<td>B, O</td>
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<td>AB</td>
<td>A and B</td>
<td>None</td>
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<td>All</td>
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<td>O</td>
<td>None</td>
<td>A and B</td>
<td>All</td>
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</tr>
</tbody>
</table>

*Understanding Clotting*

Normal clotting time for blood is 3 to 15 minutes, but clotting time is extremely individual and can be affected by certain diseases, such as hemophilia and some leukemia, and various medications, including blood thinners.

When blood begins to clot, it forms a dark, shiny, jelly-like mass. With time, the clot begins to contract and separate from the yellowish serum. Investigators use the state of blood clotting as a rough guide to estimate how much time has passed since the blood was shed. Of the blood is still liquid, the bleeding occurred only a few minutes before. If it’s a shiny, gelatinous pool, bleeding occurred less than an hour before. And if the blood is separated into clot and serum, several hours have probably passed.

Bloodstains that resulted from blood spurting or gushing must have happened before death, when blood was still moving through the body. Impact spatter and splashes can occur after death, but only the assailant can cause these kinds of stains, for example by continuing to strike the victim after that victim is dead, or stepping into a pool of blood.
Oozing, gushing, and dripping
Blood may drip, ooze, flow, gush, or spurt out of the body. Each kind of blood movement leaves a recognizable bloodstain pattern or spatter. The way in which the blood left the body can be divided into two categories:
1. Passive: when bleeding depends only on gravity alone; this kind of bleeding oozes and drips
2. Projected: when a person or object applies some force other than gravity. Arterial spurts, cast-off blood, and impact spatter are examples of projected blood.

Analyzing Bloodstain Patterns
Once blood is found at a crime scene, a great deal of information can be learned. Who shed the blood? How did it get where it was? What was the sequence of events that caused this type of pattern? The information bloodstain patterns provide includes:
- The origin of the bloodstain
- The type of instrument that caused the bloodstains
- The direction from which an object struck the victim
- The relative positions of the victim, assailant, or assailants, and bystanders
- The locations and movements of the victim and assailant during the attack
- The number of blows or gunshots the victim received
- The truthfulness of any suspect and witnesses

Analyzing passive blood stain patterns
Stairs, ramps, and even slight inclines can carry blood considerable distances before it clots. Gushing or fast-flowing blood obviously gathers in larger amounts and can travel farther from the body than oozing blood. Slow ooze clots before blood moves too far from the body.
Blood can drip from an injured person’s wounds, a blood covered weapon, the assailant’s hands, a tabletop, or any elevated object. Getting shot or stabbed in the shoulder can cause blood to run down your arm and drip from your fingers. Similarly, an escaping assailant can drip blood from a knife or other weapon.
Because of surface tension, drops remain spherical until they strike a surface or until they’re struck by another object. Drops don’t break into smaller drops by simply falling through the air. If a drop hits the edge of a table, or if a swinging arm or weapon strikes it, the drop breaks apart. Otherwise, it falls as a sphere until it reaches the floor or some surface.
When a falling drop of blood strikes a surface, it splashes in all directions, spattering in a circular pattern around the point of impact. The shape and size of the blood spatter pattern depend upon the size of the drop, how fast it falls, at what angle it hits the surface and the kind of surface it strikes.
A blood drop picks up speed as it falls until it reaches terminal velocity, its maximum free-fall speed. The terminal velocity of blood is approximately 25 feet per second, and a drop can reach that speed only after a fall of 20-25 feet. But the circular spatter pattern produced by a drop increases in size when it falls from an inch up to about 7 feet. The diameter of spatter patterns from drops falling high than 7 feet don’t significantly increase. The size of the diameters of spatter patterns for single drops varies from 13 millimeters to 22 millimeters, depending on the distance the drops travel and the size of the drops.
When a drop strikes a surface at a right angle (90°), the spatter pattern forms an even circle around the point of impact. If the blood strikes from a smaller angle, the spatter creates an elongated oval pattern with the narrow or pointed end aiming in the drop’s direction of travel.

The surface that the blood hits can change the size and shape of the spatter. Hard, smooth surfaces like glass, tile or polished marble create much smaller spatters than rough, irregular surfaces like unfinished wood, or concrete.

Secondary or satellite spatters often create confusion when criminalists analyze bloodstains. If a large drop of blood falls onto a hard surface, small secondary droplets may surround the original circular stain. Because these droplets hit the surface at angles that are less than 90°, the secondary stains are elongated, but the elongated tails of these satellite droplets tend to point toward the direction from which they came, not the direction in which they were traveling.

Analyzing projected blood spatters
These spatters happen when something other than gravity applies force to a blood source. This force may be a naturally occurring internal activity like the heartbeat or the victim’s breathing, or it may be an external force like a gunshot or a blunt-force trauma.

A single bloodstain is not spatter, but a group of stains is. Spatters can be produced by several different mechanisms – stabbings, beatings, gunshots, arterial bleeding, cast-off blood, splashing, and expirated blood. Expired blood describes blood that sprays from a person’s mouth and nose.

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Determining where the deed went down

Spatter patterns aid the ME in determining the source of blood, the source’s location at the crime scene, and the mechanism that produces the bloodstains. This critical information can show investigators the position of the assailant and the victim when the attack occurred. The report completed by the investigator usually provides possible points of origin of the blood source. Investigators use the directionality of each stain to make the following determinations:

✓ **Point of convergence:** A two-dimensional representation of the point where lines tracking the pathways of two or more spatters meet indicating the general location of the blood source in relation to the spatters. At the crime scene, investigators stretch strings from each stain according to the angle of impact; where those strings meet is the point of convergence.


✓ **Point of origin:** A three-dimensional representation of the point where lines tracking not only the pathways but also the angles of impact of two or more spatters meet, indicating the general spatial location of the blood source. By stretching strings along the angle of impact of each stain, investigators can find the point of origin.

![Point of Origin Diagram](http://www.nacdl.org/public.nsf/UNID/C046FB0E5E266A6885256FF600528506?OpenDocument)
Interpreting void patterns

A **void pattern** is an absence of blood spatters in an area where you’d otherwise expect to see them. Often this void indicates where the attacker stood because his/her body prevented the blood from spattering on the surfaces behind him. Example: If someone was severely beaten, and investigators find blood spatters on the walls or furniture in every direction except to one side of the victim, the attacker probably stood in that position during the attack and intercepted the spattered blood. Finding blood spatters on a suspect’s body or clothing confirms for investigators that the suspect was at the scene at the time of attack. Spatterings of blood only occur during the impacts that produce them. As a result, finding spatters on a suspect’s clothes, arms, or face means he/she must have been in close proximity to the victim at the time of attack. Stains found on someone who came along after the attack and accidentally got blood on his/her clothes wouldn’t show a spatter pattern. This information helps investigators confirm or refute statements about whether a suspect was at the scene during the attack.

Classifying projected spatters

Two methods of classifications:

1. **Velocity**: This method examines the velocity at which the impacting object strikes the blood source and also the velocity at which the blood leaves the blood source when it’s struck. This system divides into low, medium, and high velocity spatters. These subcategories give an indication of the object and the mechanism that created the spatter.
a. **Low velocity spatter** occur when an object moving less than 5 feet per second strikes a surface. This impact results in fairly large spatters, typically four millimeters or greater in diameter. Ex: drops dripping under the influence of only gravity from a wound or a blood-soaked weapon. If the dripping source is standing still, the drops will fall vertically and create circular stains. But if the source is moving – an injured victim taking flight or an escaping assailant carrying a blood-covered weapon – the drops strike the floor at an angle, producing elongated stains with spines or projections of blood extending in the direction of the movement.

i. Arterial bleeding is also considered low velocity. The blood loss may take the form of gushes or spurts, depending upon the size of the artery, the extent of damage, and whether clothing or some other object covers the injury. A freely spurting artery results in a linear and cascading spatter pattern. The pattern’s distance from the wound, length, and volume may decline steadily as the victim continues to lose blood, casing his blood volume and blood pressure to decline.

ii. Cast-off, or blood that is flung from an object because of centrifugal force is also a low-velocity spatter. These types of patterns usually occur when an attacker uses a weapon to deliver a series of arcing blows. Investigators typically find these patterns on walls and ceilings. The pattern is typically a uniform trail of droplets, which reflects the arc that the object traveled in. Determining the point of convergence and the angle of impact of these cast-off stains reveals the assailant’s position at the time he/she swung the weapon. In some cases, estimating the perpetrator’s height and even whether he/she’s right or left handed – or at least which hand struck the victim with – is possible. The number of these cast-off patterns investigators find indicates the minimum number of blows to the victim. Not necessarily every swing produces cast-off stains, the assailant may have delivered more blows, he be can’t have delivered fewer.

b. **Medium velocity spatter**: These types of spatter come from objects moving between 5 and 100 feet per second. These are typically smaller than spatters from low-velocity droplets and vary from 1 to 4 millimeters in diameter. Medium-velocity spatter come from impacts with blunt or sharp objects and from expired blood. Spatters from impacts with a blunt object distribute blood in all directions from the area of impact. If the wounds are to the face, throat, or lungs, blood mixes with the exhaled air creating a fine spray and producing a mist spatter pattern. This mist pattern maybe found on and around the victim and on the attacker.

c. **High –velocity spatter**: This results when an object strikes the victim at a speed faster than 100 feet per second. This resulting spatters tend to be very small, usually less than one millimeter in diameter, and appear as mist-like stains.

i. A bullet travels at a high velocity and thus produces a high-velocity spatter pattern. These patterns how up near entrance and exits wounds, but blood behaves differently according to whether the bullet
is coming into the body or exiting. A bloodstain associated with an entrance wound it called a *blowback* or *back spatter*, meaning the droplets travel in a direction opposite to the path of the bullet. Blowback often is found on the shooter or the weapon, even inside the barrel of the gun in very close-range shots. A bloodstain found near the exit would is called *forward spatter*. The blood droplets in this case follow the direction of the bullet. Ex: If you tossed a glass of water through a screen, the water would keep right on going through the screen, a.k.a. forward spatter. If you were to toss the same glass of water against a wall, and the water splashed back toward you, that is a simulation of back spatter.

2. Type of spatter: (divided into three categories)
   a. **Impact spatters** typically occur with beatings, stabbings, gunshots, or any other circumstance where a foreign object impacts the victim.
   b. **Projection spatters** result from arterial bleeding, cast-off blood, and expirated, or exhaled blood.
   c. **Combination spatters**, which include impact and projection spatters, often are found at crime scenes. A victim who gets stabbed in the chest or kidney may leave a combination of impact spatters from the force of the attack and projection spatters from arterial bleeding, expirated blood and cast-off blood.

*Understanding transfer patterns*

Transfer patterns result when an object soaked with blood comes into contact with an unstained object. Bloody fingerprints and shoeprints fall into this category. The perpetrator may brush against or kneel in a bloodstain, or wipe the weapon or his/her hands on his/her shirt, transferring the victim’s blood to his clothing. Matching the blood from such a transfer stain to the victim’s blood may help solve the crime. (This can be accomplished by looking at weave patterns on fabrics)

*Reconstructing the crime scene from bloodstains*

As you may recall from earlier chapters, investigators need to take control of the scene immediately to prevent contamination. After all, contaminated evidence is no evidence at all! Bloodstains are carefully photographed, capturing an overview of the scene and then zoom in on the bloodstains themselves to reveal all the needed detail including a ruler for measurement.

Some bloodstains are latent (invisible to the naked eye). Investigators often use Luminol to expose these hidden stains. **Luminol** is a chemical that reacts with the hemoglobin in blood to produce a complex substance that luminesces (glows). Luminol is extremely sensitive, detecting blood in concentrations as low as one part per 5 million. Investigators darken the room and spray Luminol over areas where they suspect blood to be. When blood is present, stains glow a bluish-white, and the photographer takes a picture of the glowing pattern.