

BLOODSTAIN PATTERNS PRODUCED BY ARTERIAL AND EXPIRATORY MECHANISMS

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The first part of this presentation will review the types of bloodstain patterns observed at scenes where victims have sustained arterial damage frequently related to cutting and stabbing injuries. The types of patterns produced depend on the location of the artery, the severity of the injury, the position of the victim at the time of arterial injury as well as movement and post-injury activities of the victim.

The second part of this presentation will discuss expiratory mechanisms that can create spatter patterns within the size range of impact spatter that result from beating, stabbing and gunshot events. The criteria necessary for expired bloodstains to be present or considered in a case will be outlined and results of experiments demonstrated.

ARTERIAL MECHANISMS

General Description of the Circulatory System

The arterial system of the body functions as the mechanism for the transportation of oxygenated blood from the ventricles of the heart to the tissues and organs of the body. The exception is the pulmonary artery that transports deoxygenated or venous blood from the heart to the lungs. The aorta and the larger arteries branch out and form smaller arteries and arterioles and finally capillaries. Arterial walls are thick and contain smooth muscle, connective tissue and elastic fibers in order to tolerate the pressure of blood coursing through them.

By contrast the venous system consists of veins and venules and functions as the mechanism for the transportation of deoxygenated blood from the tissues and organs of the body to the vena cava and the heart. The exception is the pulmonary vein that transports oxygenated blood from the lungs to the heart. Venous walls possess a thinner and less muscular wall with less elasticity as compared to the arterial walls since the blood flow is under minimal pressure. They contain valves to prevent backflow.

Physical trauma or damage to arteries produces significant and frequently fatal consequences as blood is released rapidly under pressure. The mechanism of trauma is frequently associated with cutting and stabbing injuries but may also occur in blunt force and gunshot injuries. The location of the breached artery will dictate whether excessive internal bleeding or external bloodshed will occur. Severe internal bleeding within the abdominal cavity occurs with damage to the aorta and external bleeding may not be significant. Arteries that are closer to the surface of the body release blood under pressure to the external environment resulting in gushing and spurting. In either case the blood will continue to surge from the damaged artery as long as the heart continues to pump and there is available blood. Medical intervention is critical for survival.

Some Common Arteries Close to the Surface

Temporal	Temples
Carotid	Neck
Subclavian	Under clavicles
Axillary	Axilla
Brachial	Arms
Radial	Wrists
Femoral	Upper thighs
Popliteal	Knees
Tibial	Ankles

Arterial Bloodstain Patterns

Arterial bloodstain patterns are the result of a projection mechanism (arterial pressure) that propels a volume of blood upward, forward or downward from a damaged artery with physical characteristics that can be observed and documented.

A literature search for bloodstain terminology or definitions that addressed arterial patterns indicated that the common phrases for terminology are arterial spurt or spurting and arterial gushing or both used interchangeably. The common denominator from the sources was the exiting or escape of blood under pressure from a breached artery. Reference was also made in many instances to evidence of, spines, pressure fluctuations or pulsation features of the patterns.

A distinction between the terms arterial gushing and arterial spurting was noted in some sources referring to gushing as large patterns and spurting as a series of individual bloodstains representing less volume and more distinct in showing the pressure variation. One or more of these series of spurts represented arterial gushing.

Size range of stains

The size of individual stains ranges from less than a millimeter to more than a centimeter in diameter.

Shape of stains

- The stains may exhibit elongated spines and satellite spatters around the central area of the stain
- The central area of the stain may be circular, elongated or irregular
- The central area of the stain may be associated with downward flow patterns
- May be dependent upon the nature of the target surface

Shape of pattern

- Individual stains within the pattern often align with each other in a parallel fashion relative to their direction of travel
- The pattern may exhibit pulsation or undulation
- Small droplets may be deposited in a spray type distribution

These physical characteristics are influenced by:

- Location of artery (deep v. closer to surface)
- Severity of injury (nick or severing)
- Volume of blood dispersed
- Orientation of the surface
- Nature of the surface
- Blocking effect of skin, tissue or clothing
- Position of victim
- Movement and activities of the victim subsequent to injury including manual compression of the wound site
- Sequence of multiple injuries
- Overlapping of patterns created by other mechanisms
- Alteration of stains
- Medical intervention

The presence of arterial bloodstain patterns indicates arterial damage but their absence does not preclude arterial damage from having occurred.

EXPIRATORY MECHANISMS

General Description of the Respiratory System

The respiratory system of the body provides oxygen to the circulatory system for distribution to the tissues and organs of the body and the elimination of carbon monoxide through rapid gas exchange. Air enters the respiratory system through the nose and mouth during the inspiration or inhalation, travels through the pharynx and larynx and into the trachea. The trachea divides bilaterally into the bronchi and further subdivides into bronchioles allowing the passage of air into the alveoli of the lungs where the exchange of oxygen and carbon dioxide occurs. The lung capacity of a normal adult is 4-6 liters of air. The maximum air expelled or exhaled after maximum inspiration or inhalation is 3-5 liters.

Physical trauma or damage to the respiratory system including the nose, mouth, airway and lungs may produce an accumulation of blood in the airway passages. Trauma to the head or face may cause blood to accumulate in the nose, mouth or sinus areas. The presence of blood in one or more of these areas provides an opportunity for blood to be forcibly projected or expelled from the nose, mouth or open wound of the airway or lungs by exhalation or compression.

Expiratory Bloodstain Patterns

Expiratory bloodstain patterns are the result of a projection mechanism that propels a volume of blood and air upward, forward or downward from the nose, mouth or open wound of the airway or lungs with physical characteristics that can be observed and documented.

A literature search for bloodstain terminology or definitions that addressed expiratory patterns indicated that common phrases for terminology are expired, expiratory or exhaled blood. The common denominator from the sources was the exiting or escape of blood blown out of the nose mouth or wound connected to the airway as the result of air pressure.

- Exhalation of Blood
- Coughing of Blood
- Sneezing of Blood
- Wheezing of Blood
- **Paramedic Intervention**

Size range of stains

The size of individual stains ranges from less than a millimeter to several millimeters and in many instances overlaps the size range of impact spatters resulting from beating, stabbing and gunshot events.

- May be dependent upon the nature of the target surface

Shape of stains

The shape of the stains may be circular or elongated depending upon the angle at which they struck a surface.

Shape of pattern

- Small droplets may be deposited in a spray type distribution
- A complete pattern may be more or less circular or oval shaped or exhibit a conical distribution
- Blood expelled from both nares may produce a bilateral pattern
- Expiratory pattern may be intermixed or overlaid with spatter from other mechanisms

Indicators for Expirated Bloodstain Patterns

- Presence of Blood in Nose and/or Mouth or Airway
- Air Bubbles or Bubble Rings (Circular outline of air bubble in dried stain)
- Presence of Mucus Strands
- Evidence of Dilution of Stains
- High Amylase Concentration in Stains

If there is no blood in the nose mouth, airway passages or lungs than the bloodstains could not have been produced by expiratory or exhaled blood. It is possible however to produce expiratory-like bloodstains from compression of the abdomen when there has been a wound to the intestinal tract that could expel a mixture of intestinal gas and blood.

Expiratory Bloodstain Experiments

James, Kish and others have conducted experiments utilizing their own blood to demonstrate the bloodstain patterns produced by exhalation, coughing and sneezing blood from the nose and mouth. The results of these experiments clearly showed the similarity of size range of the individual drops within a pattern with impact spatter observed in beating, stabbing and gunshot events. Our results have demonstrated how the quantity of blood expelled can affect the overall concentration and distribution of individual spatters within an expired bloodstain pattern. In reality, we do not know the amount of blood one would have available to expel during an expiratory event. Extremely fine bloodstains were easily produced.

Air bubbles or bubble rings, mucus strands in the stains or discernable diluted stains were not a frequent occurrence.

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