



Blood Stain Pattern Analysis

A Little Science

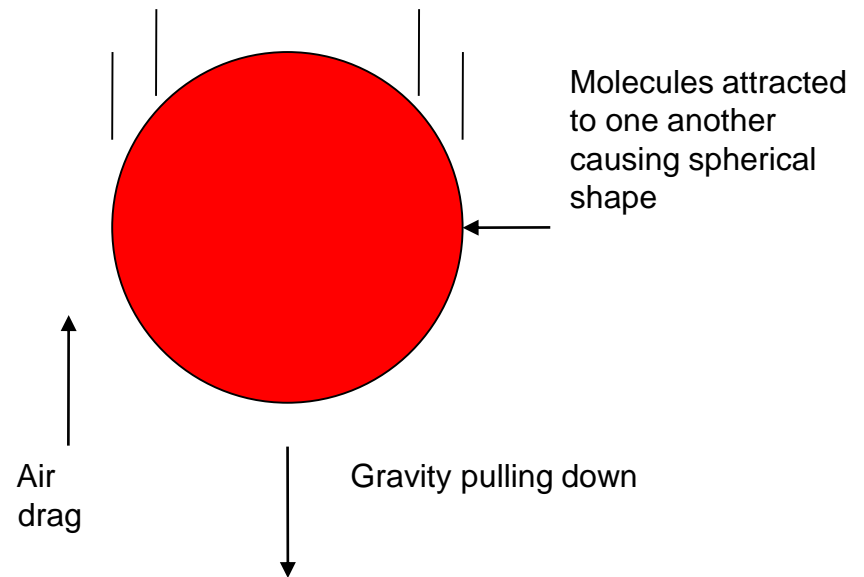
- All fluids follow the laws of physics
 - What **Forces** affect falling objects?
 - Newton's Laws of Motion???



Falling

- Gravity
- Air Resistance
- Surface Tension,
in the case of any fluid
containing a high % of
 H_2O

Falling Blood Drop



What Did **Newton** Tell US?

- Resists *changing motion* until a force is applied (1st Law)
 - blood tries to remain moving at the speed of the source
 - As gravity pulls it down, it is shaped
 - By air and surface tension

Newton's **2nd** Law

- Force applied is proportional to Acceleration achieved

$$F = \text{mass} \times \text{acceleration}$$

- Work done = $F \times \text{distance fallen}$
 - Greater fall results in greater spattering

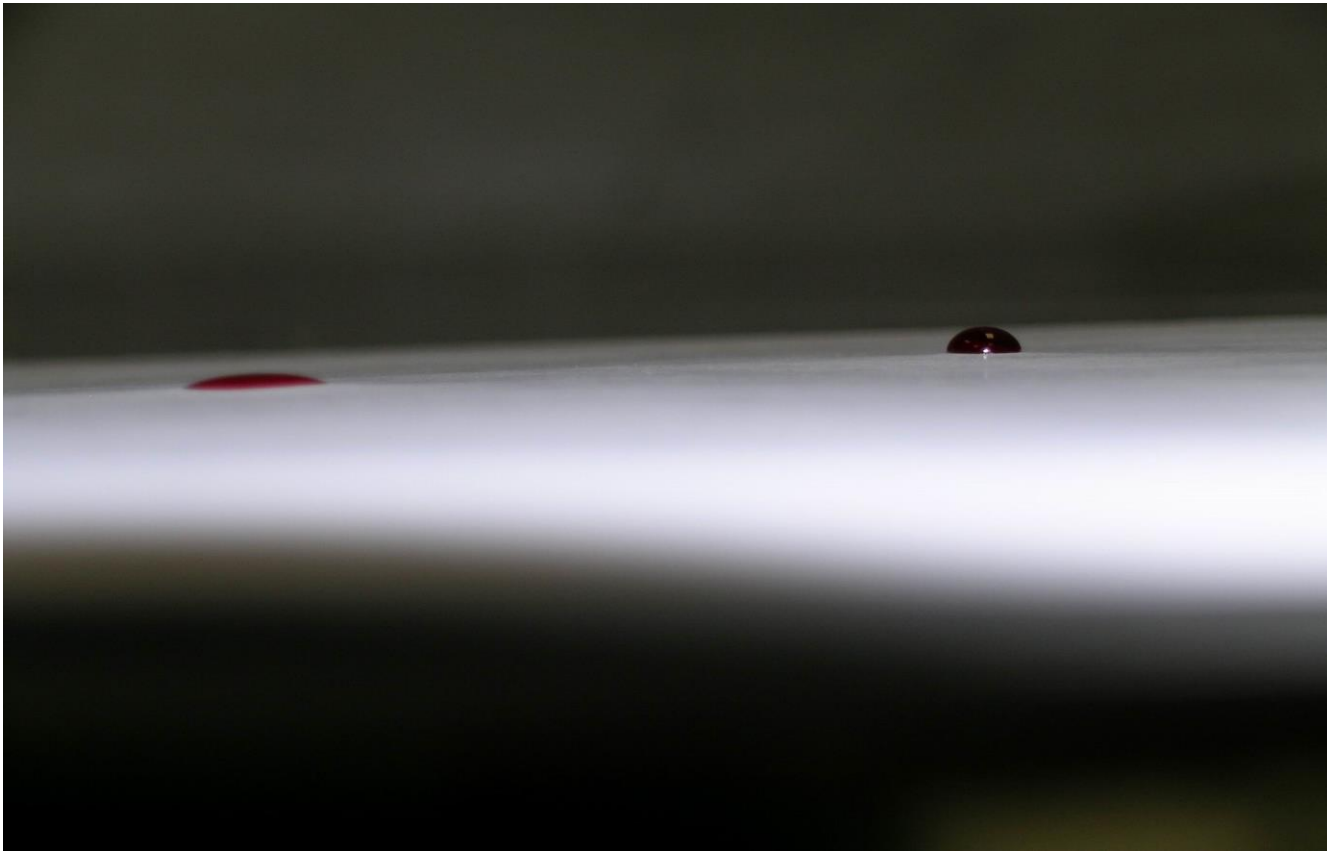
Wider spatter from **greater fall**

- Greater work - Weakens surface tension



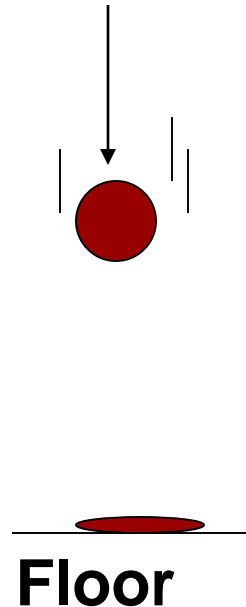
Greater **work** done

- Flatter stain from reducing surface tension



Newton's **3rd Law**

- Action and Reaction
 - Force of impact causes floor to apply reaction force on blood



Properties of Blood

- 8% of total body weight
- 5-6 liters of blood for males
- 4-5 liters of blood for females— except for pregnancy
- 40% blood volume loss, internally or externally required to produce death
- 1.5 L will cause incapacitation
- A cut vein or artery will result in a loss of .5 liters of blood per minute

Injuries, Death and Blood

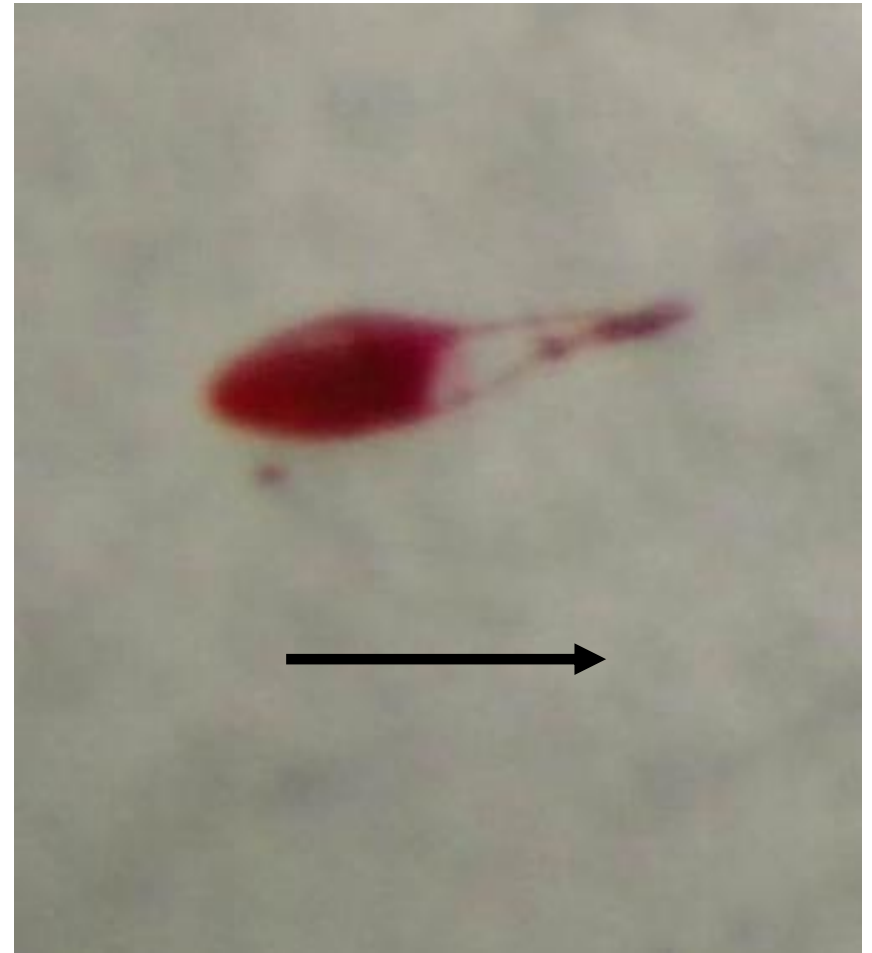
- Dead people do not bleed
- If a body part is struck with an object the first blow will not cause blood spatter
- Spatter occurs after the first blow when the wound begins to bleed

Patterns Tell Us....

- Information about
 - **Direction** of movement
 - *Speed* of movement
 - **Point** of origin
 - **Distance** fallen and
 - Angle of impact (as well as other information)

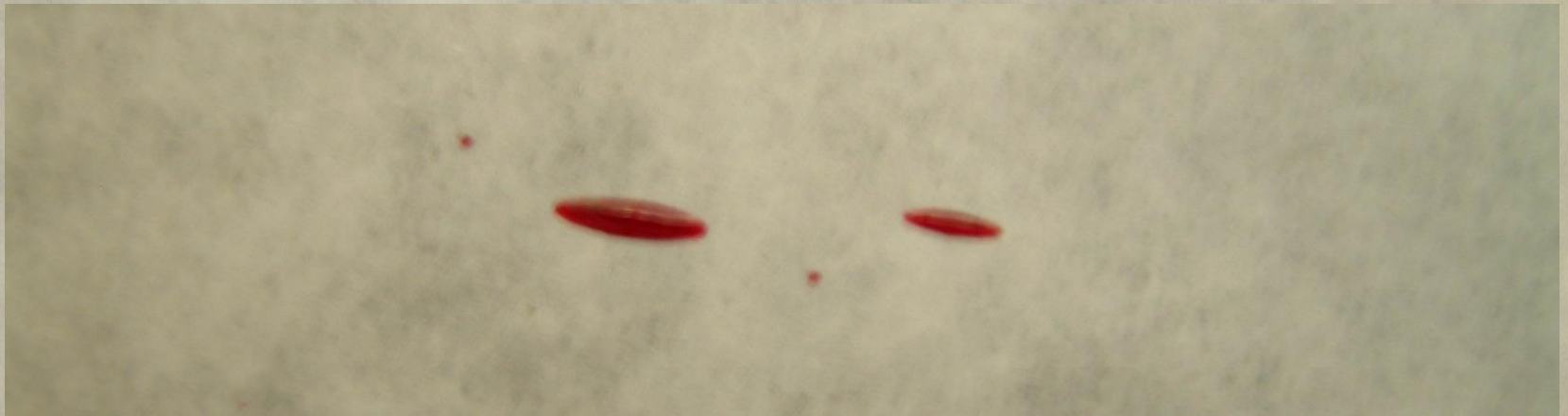
Direction of Movement

- Shaped by
 - Resists leaving the source
 - Air resistance
 - Surface tension and
 - Impact
- **Tail** shows direction



Speed of Movement

- Stain is more elongated with faster movement
- Slower movement
- Faster movement



Point of Origin

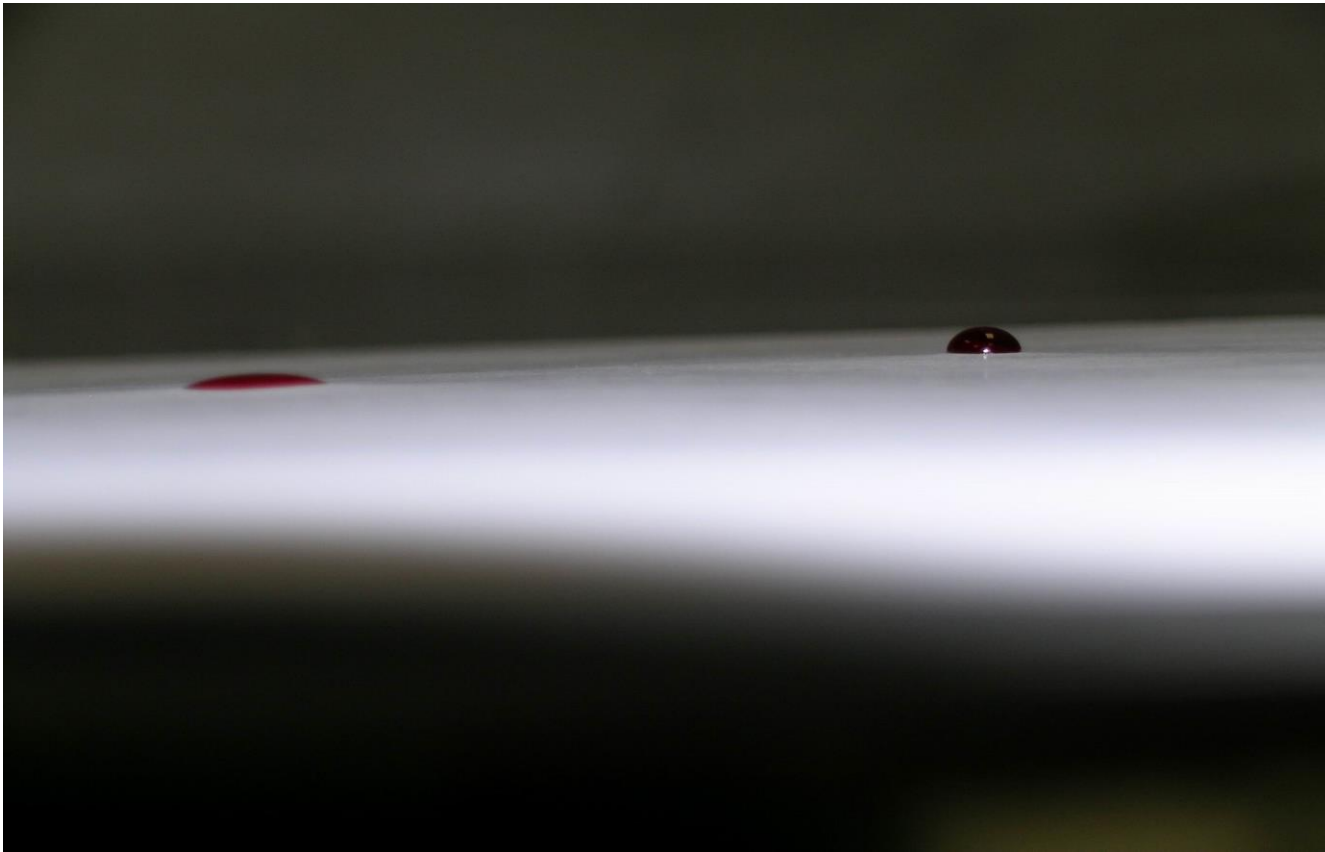
- Draw lines down center of long axis of stains



- All arrows intersect at point of convergence (place on a 2D surface)
- If also calculate angle of impact can tell Area of Origin (place in a 3D area)

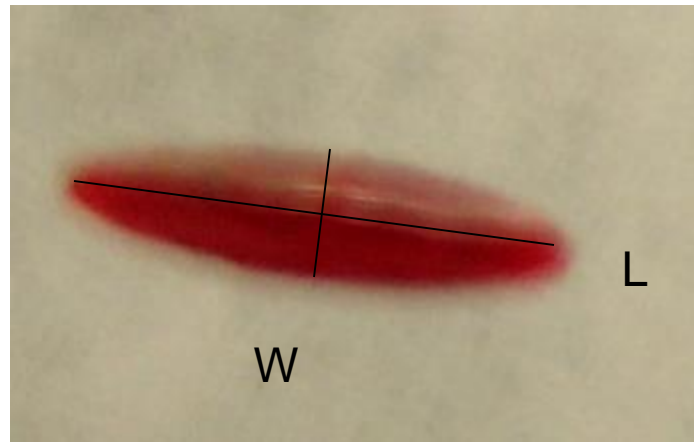
Distance Fallen

- Greater fall
 - Wider, flatter stain

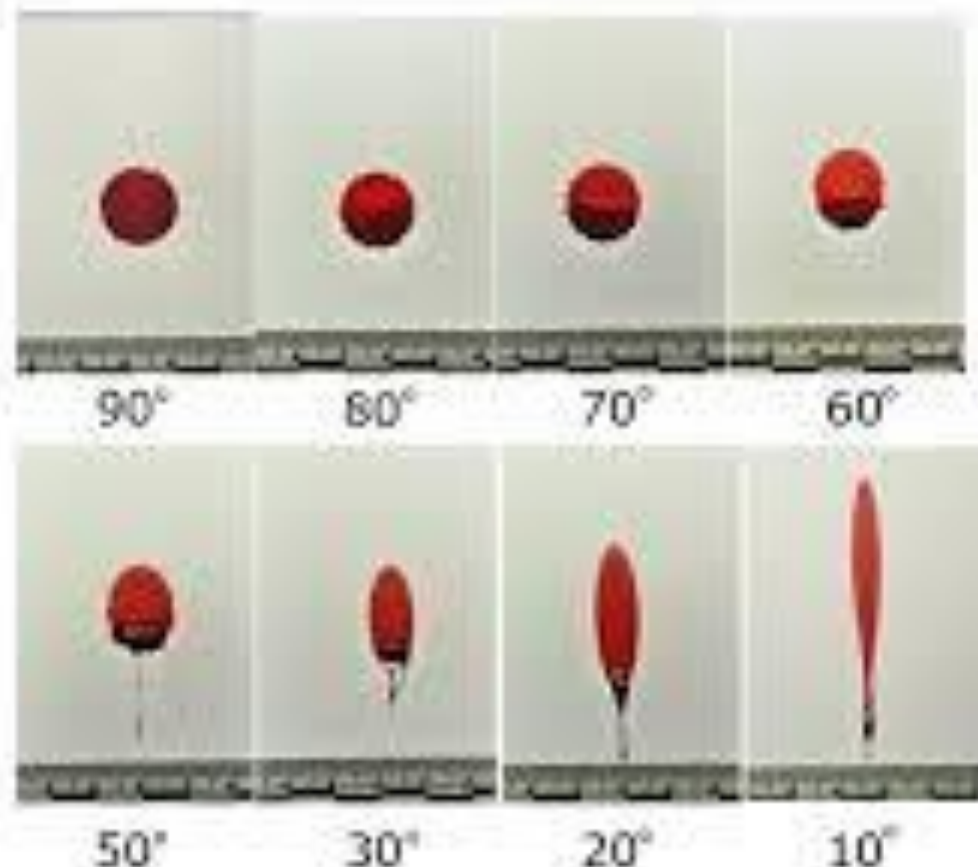


Angle of Impact

- Calculate with two measurements
- Length of stain and width of stain
- Impact Angle $\theta = \sin^{-1} (\text{width}/\text{length})$



Angle of impact

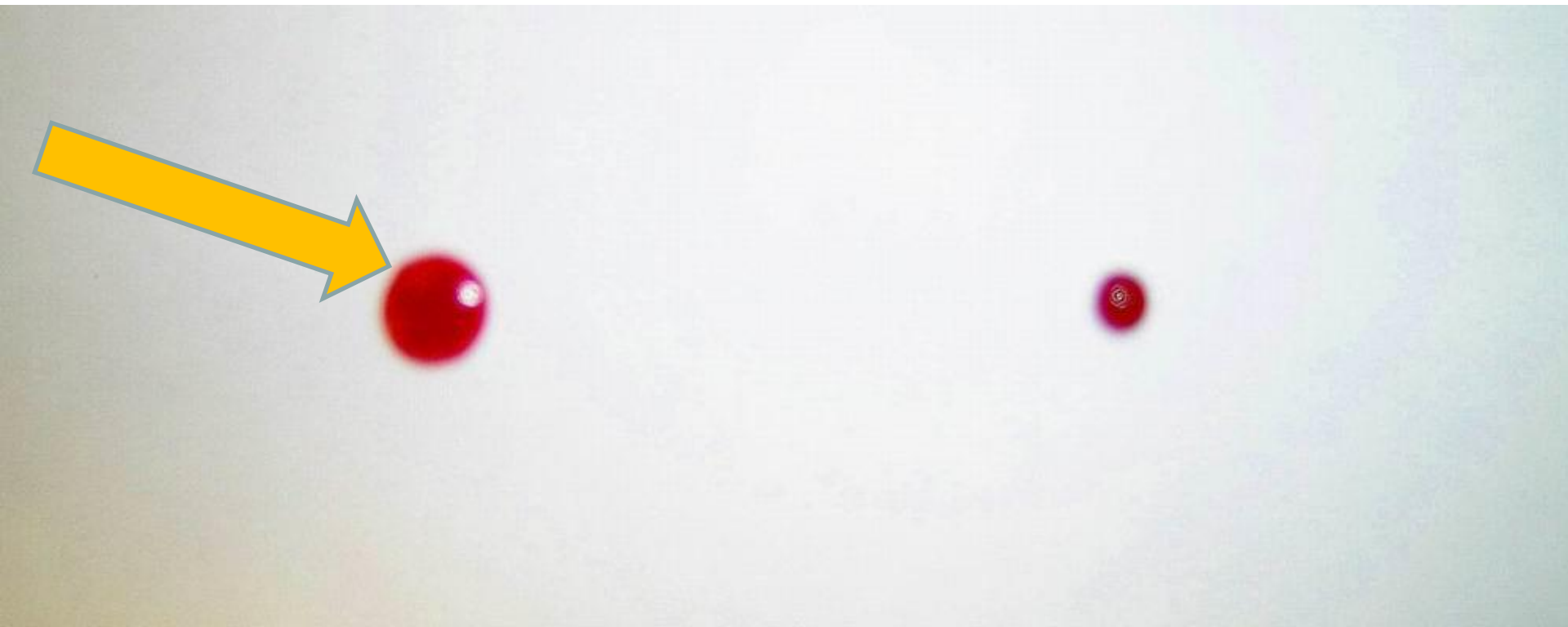


Decreasing angles of impact of single falling blood droplets.

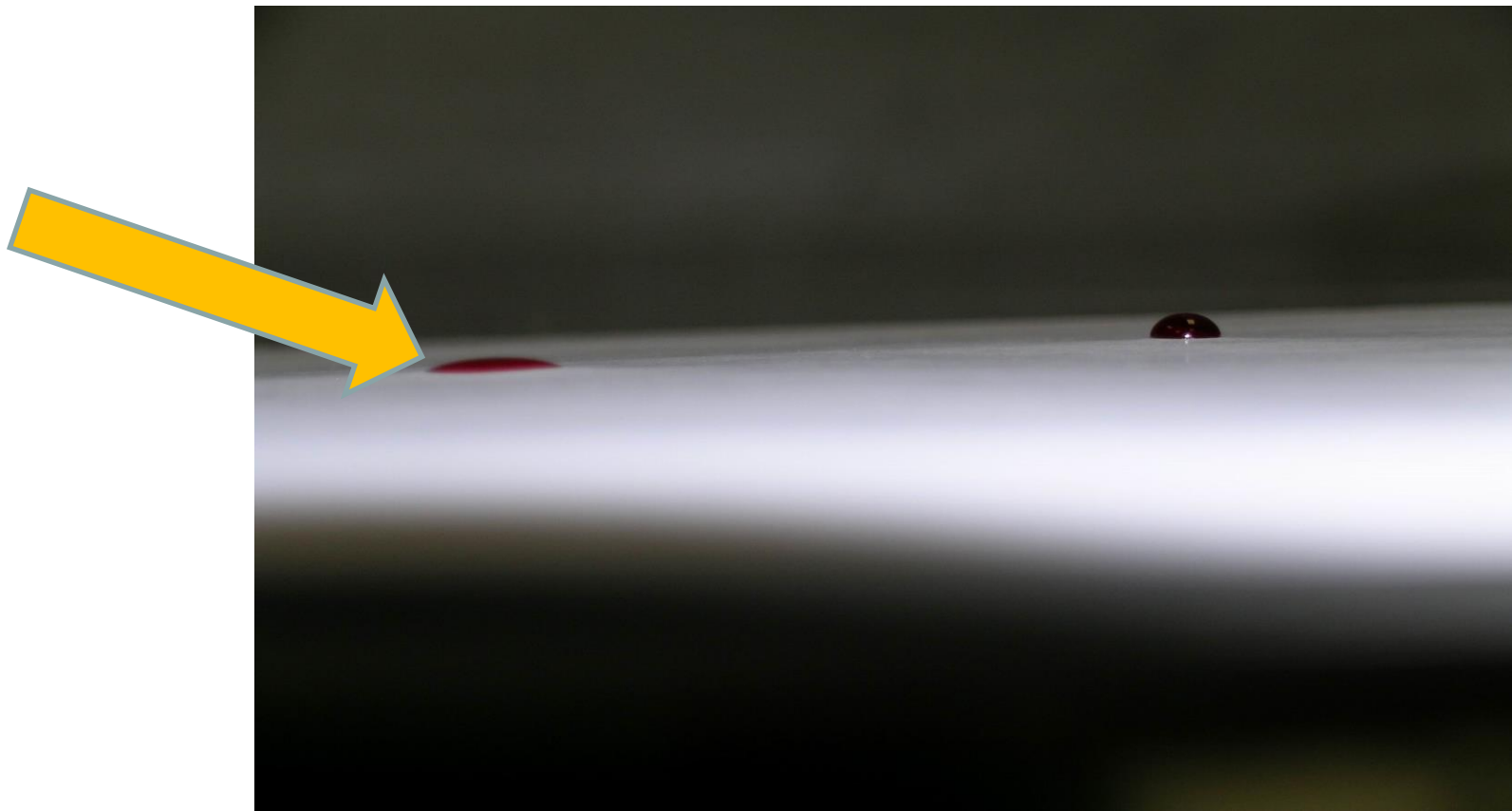
Images used with permission from Edward James, February 2007

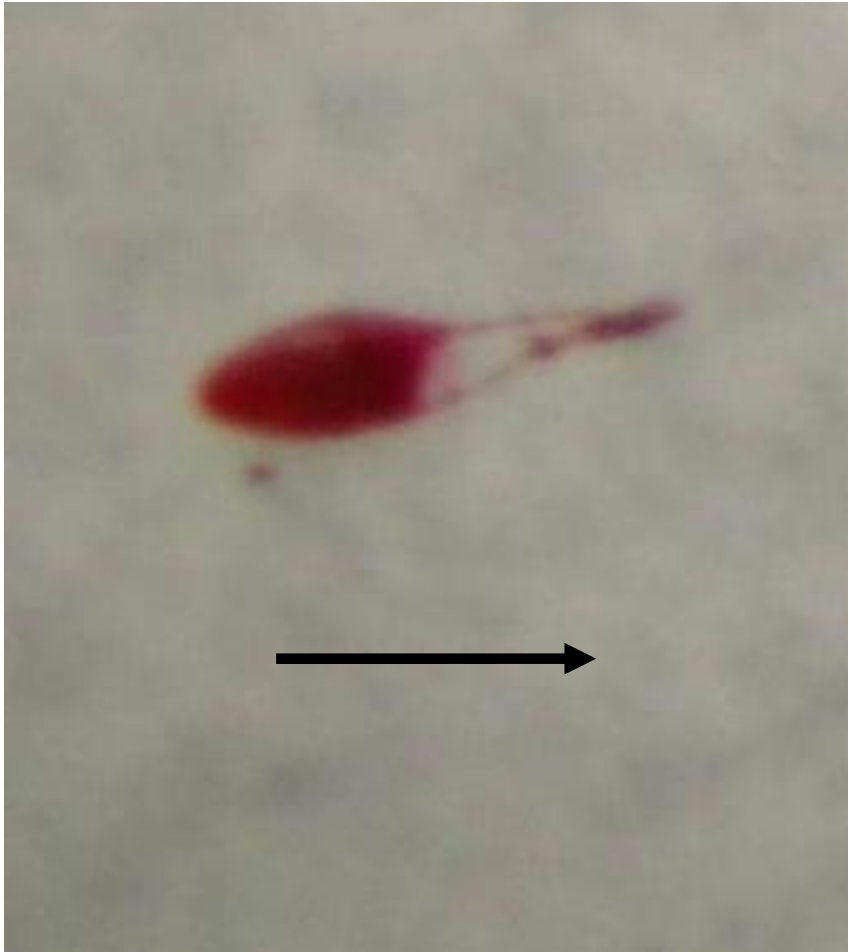
Quick review from Lab

- Single drops
- Bigger fall, bigger splat
- Completely vertical



- Still vertical
- Bigger fall, flatter splat





- Tail shows direction it's going
- FS is more about where it came from. .
- Fast speeds to get tail

- Movement usually looks more like this



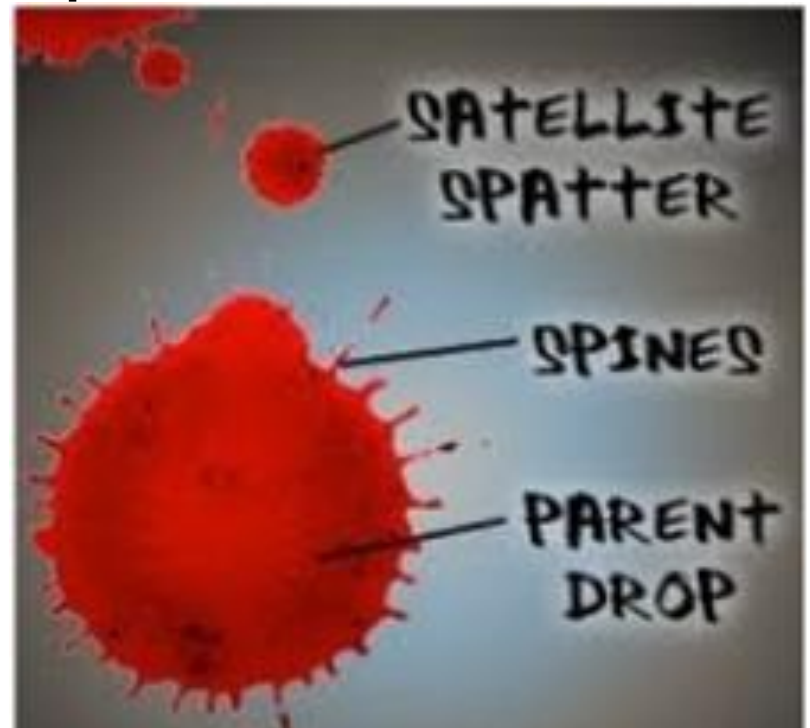
- Not tails so much as elongation

Some of you saw this

- Requires large sized drop

Or

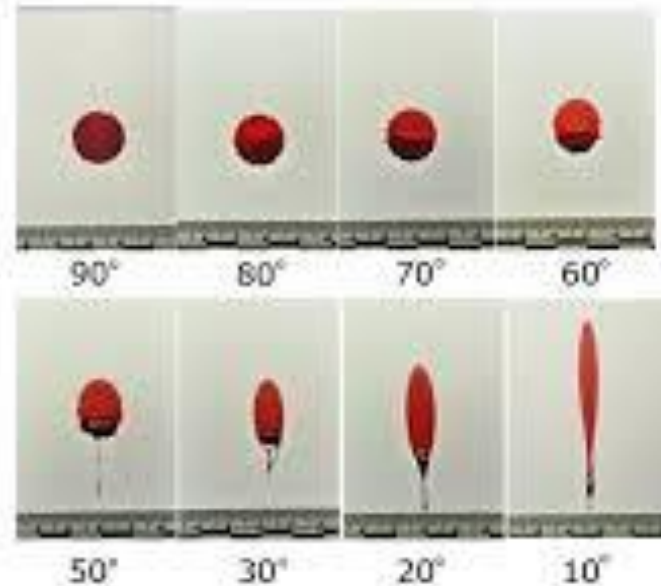
- High height



Hey look! Tails!

- Tails point where it's going (down)
- For reconstruction it's more useful to know from whence it came

Angle of impact



Decreasing angles of impact of single falling blood droplets.

Other patterns

- Other patterns that can reveal information
- The most common and the least controversial
- More Research needed

DROP OF BLOOD

- **Parent Drop** – The droplet from which a satellite spatter originates.
- **Satellite Spatters** – Small drops of blood that break off from the parent spatter when the blood droplet hits a surface.
- **Spines** – The pointed edges of a stain that radiate out from the spatter; can help determine the direction from which the blood traveled.

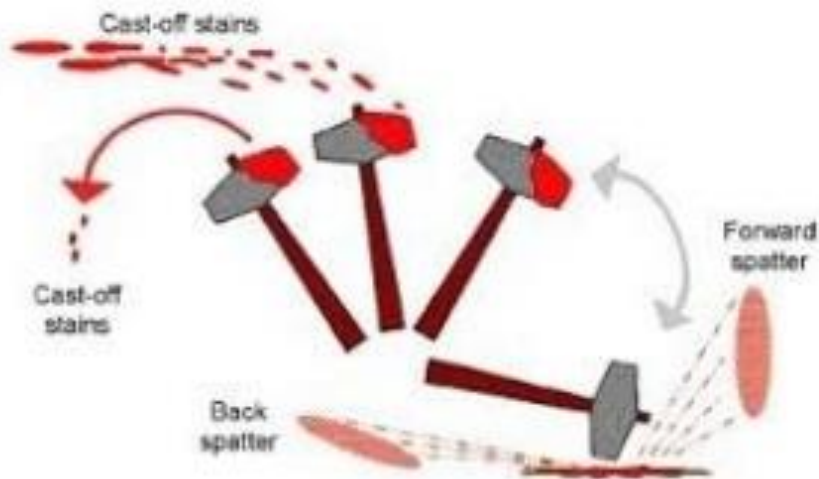


Void Pattern

- A **void** is created when an object blocks the deposition of blood spatter onto a target surface or object and 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
- Voids may be applicable for establishing the body position of the victim or assailant at the time of the incident

Categories of Bloodstains

- Passive
- Transfer
- Projected



- Spatters are created when blood is acted upon by force, and travels through the air before landing on a target surface.
- Transfers occur when a blood source comes in direct contact with a target surface area.

PASSIVE BLOODSTAINS

- Passive bloodstains are drops created or formed by *the force of gravity acting alone.*

Passive Patterns:

- Drops
- Drip patterns
- Pools
- Clots



Drops



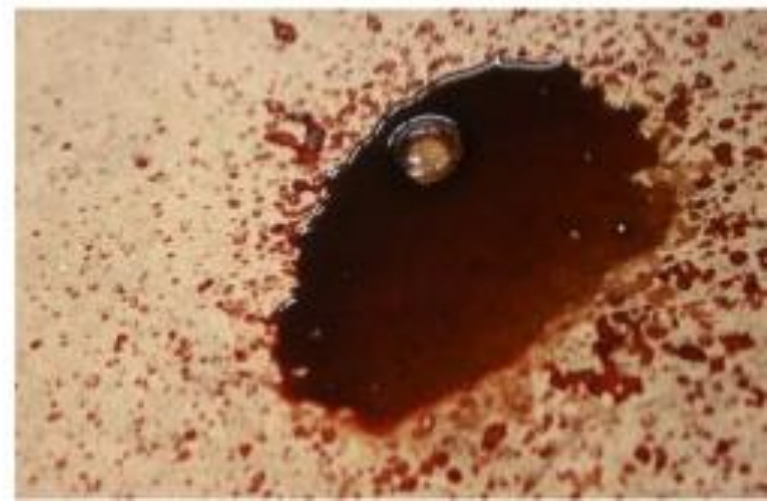
Drip

Types of Passive Blood Stains

Clots



Pool



TRANSFER BLOODSTAINS

- A transfer bloodstain is created when a wet, bloody surface comes in contact with a secondary surface.

TYPES OF TRANSFER BLOOD STAINS

- Contact bleeding
- Swipe or smear
- Wipe / Smudge
- Back Spatter



Contact Bleeding



Swipe / Smear

Types of Transfer Blood Stains

Wipe / Smudge

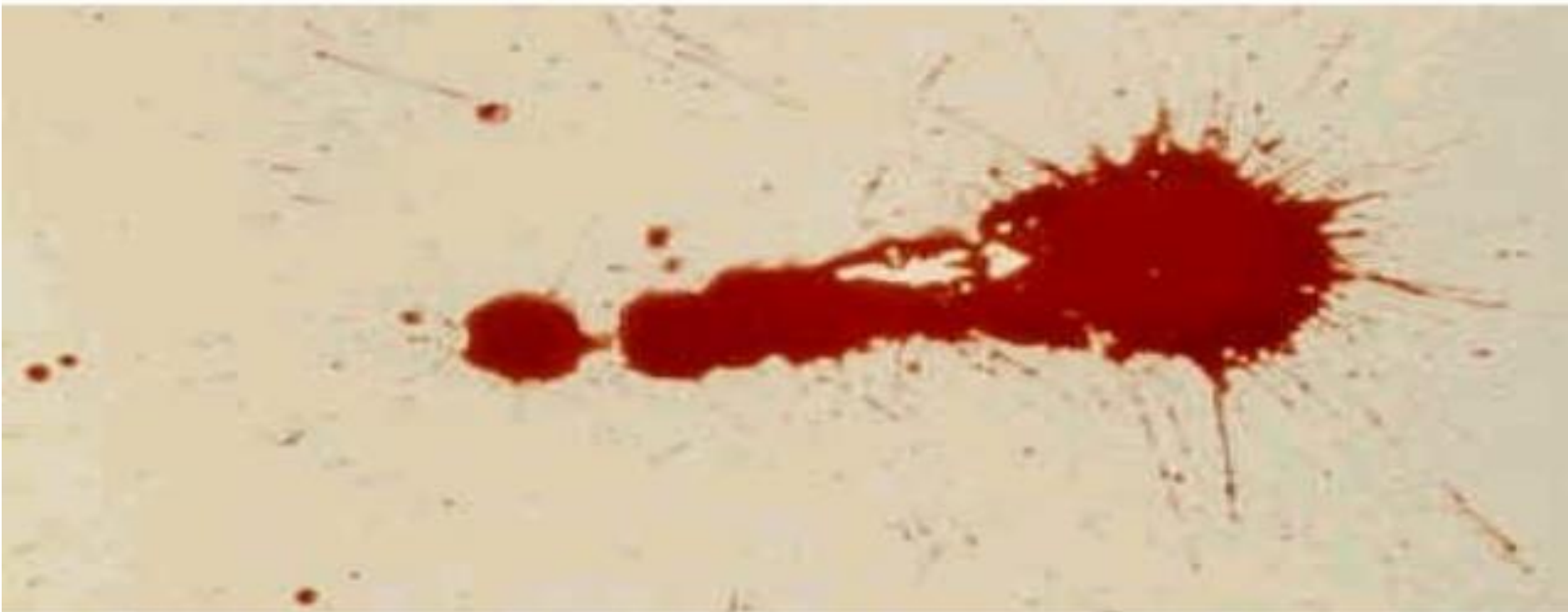


Pool



PROJECTED BLOOD

- Projected bloodstains are created when an exposed blood source is subjected to an action or force, greater than the force of gravity. (Internally or externally produced.)
- The size, shape, and number of resulting stains will depend, primarily, on the amount of force utilized to strike the blood source.



ARTERIAL SPURT/GUSH

- Bloodstain patterns resulting from blood exiting the body under pressure from a breached artery.



Impact Spatter

- Impact spatter occurs when an object impacts a source of blood
- **Forward spatter** is projected outward and away from the source
- **back spatter**, sometimes called blow-back spatter, is projected backward from the source

LOW VELOCITY IMPACT SPATTER

Low velocity spatter is about 5 ft / second and usually 3 mm or greater in diameter and indicates blood is dripping. Low impact is really blood under the influence of gravity - it just falls.



MEDIUM VELOCITY IMPACT SPATTER

Medium velocity spatter is 5 – 25 ft / second with a <3 mm diameter and usually indicates blunt trauma or sharp trauma or it could be cast-off. Medium impact occurs when a force such as a bat is applied.



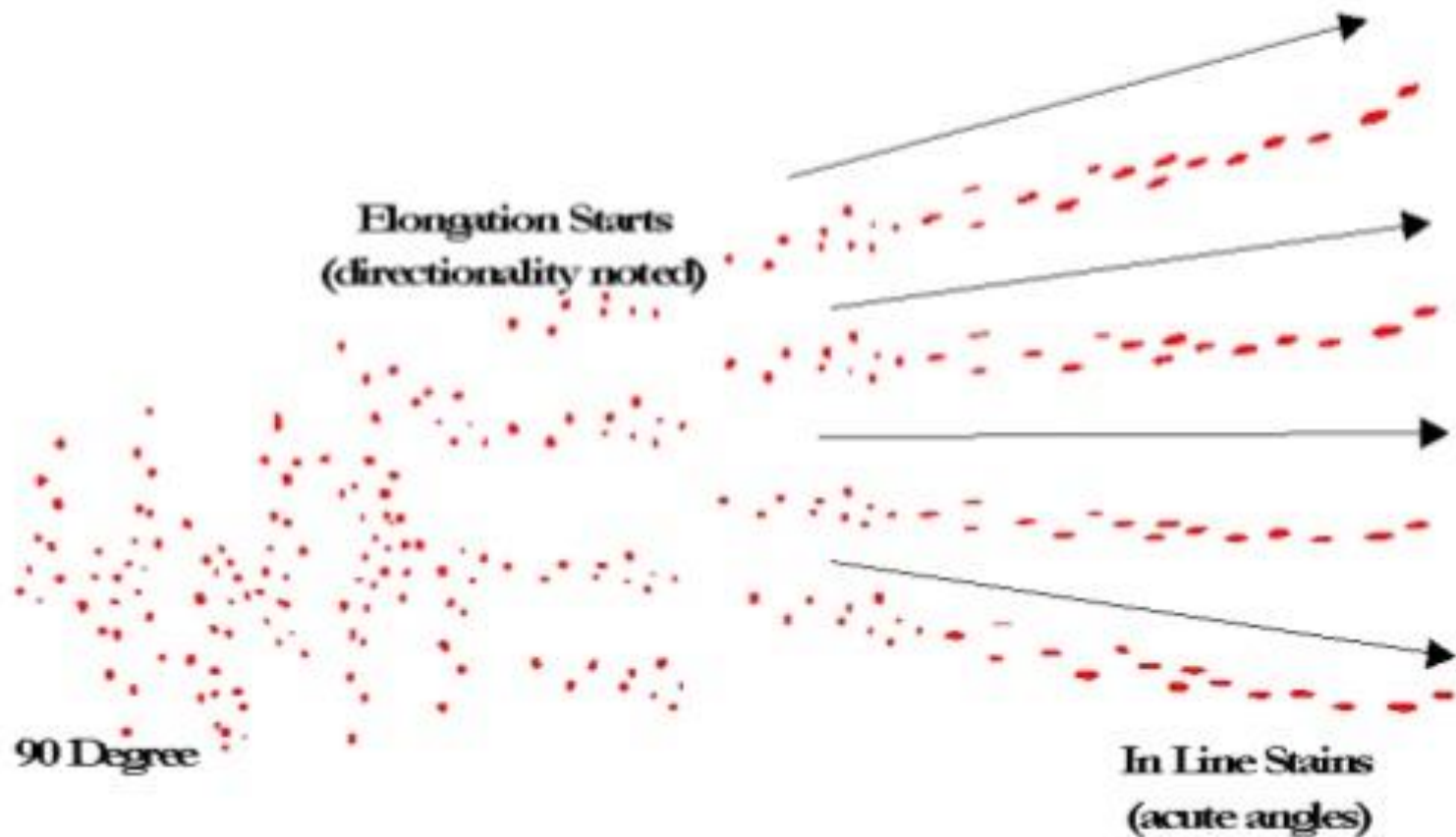
HIGH VELOCITY IMPACT SPATTER

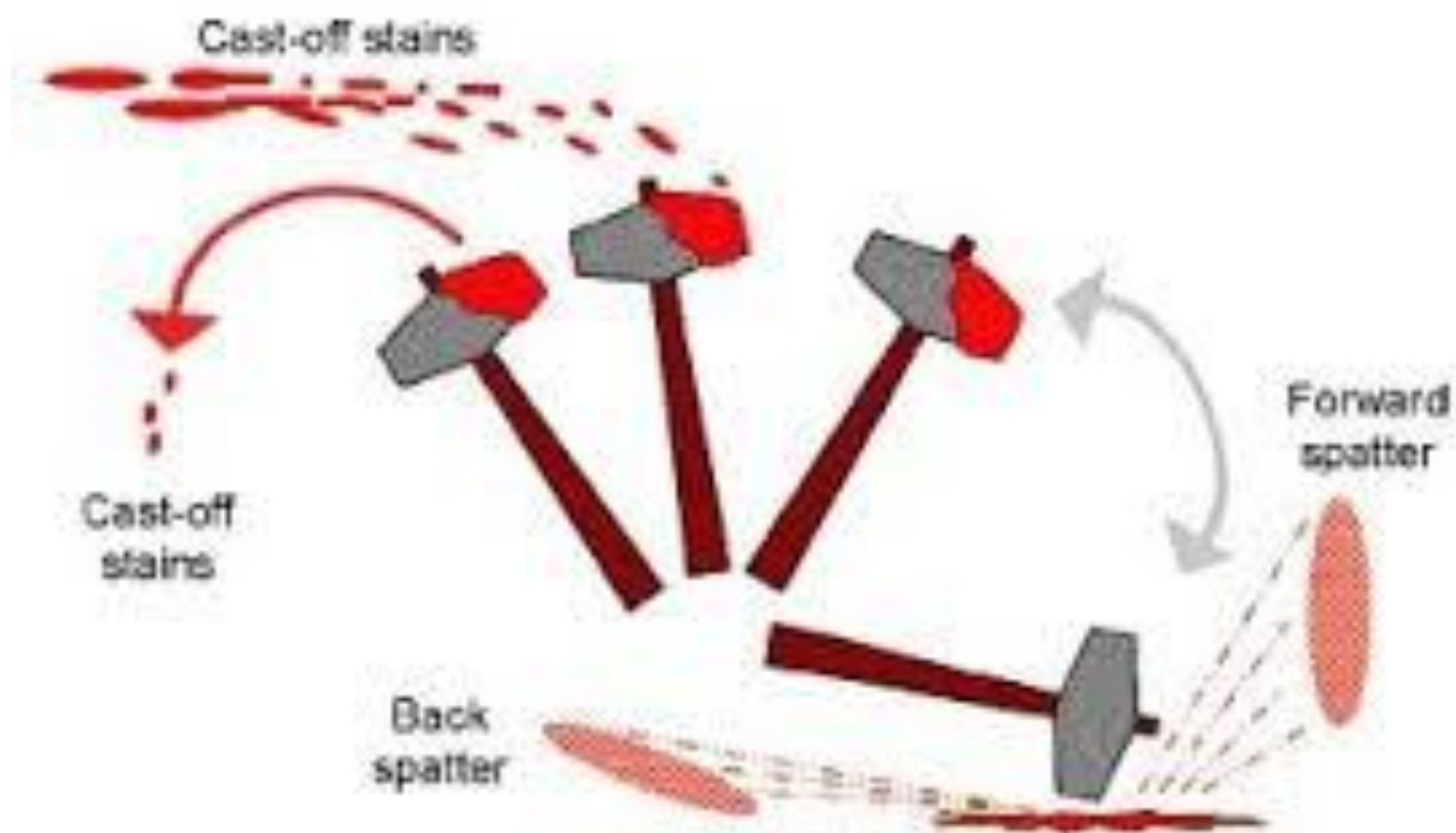
Force of 100 feet/sec and greater. Preponderant stain size 1 mm in size and smaller. Mist like appearance.

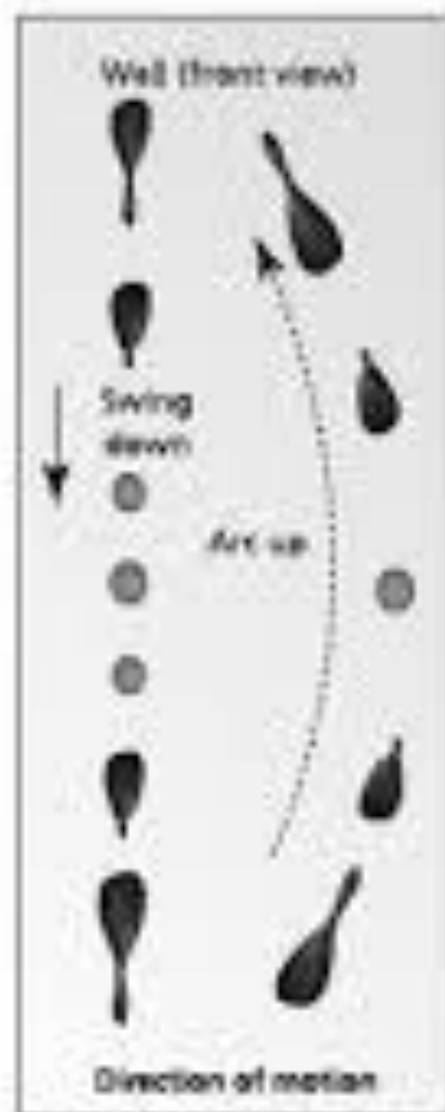
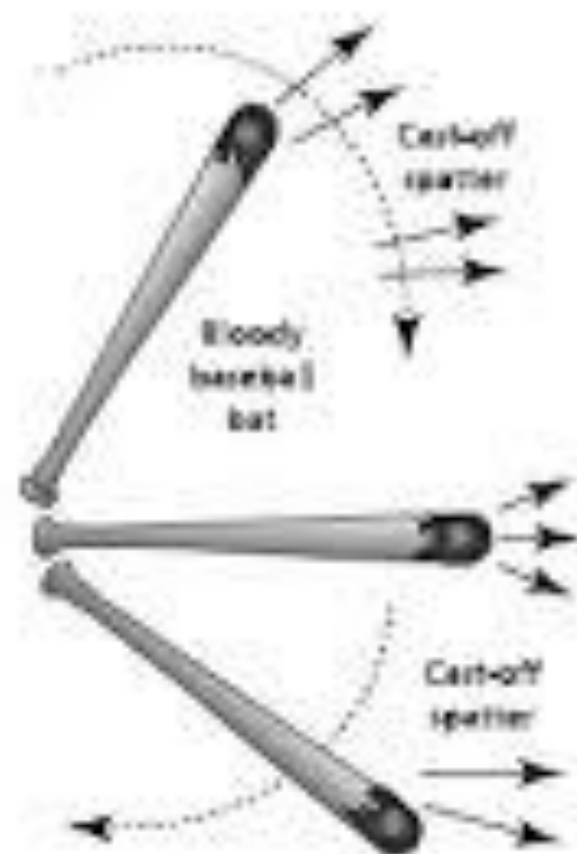


CAST-OFF STAINS

- Blood released or thrown from a blood-bearing object in motion.



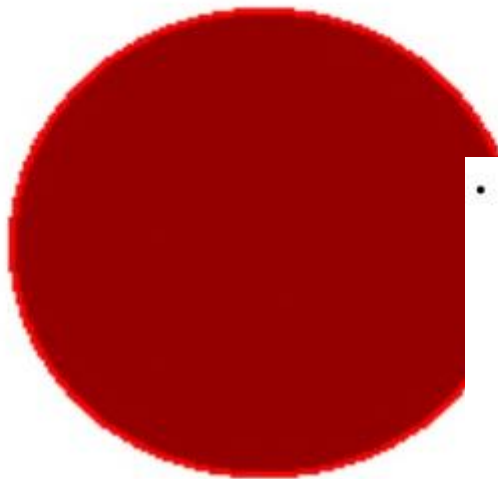




TARGET SURFACE TEXTURE

- Bloodstains can occur on a variety of surfaces, such as carpet, wood, tile, wallpaper, clothing, etc.
- The type of surface the blood strikes affects the amount of resulting spatter including the size and appearance of the blood drops.

- Blood droplets that strike a hard smooth surface, like a piece of glass, will have little or no distortion around the edge.



- Blood droplets that strike linoleum flooring take on a slightly different appearance. Notice the distortion (scalloping) around the edge of the blood droplets.



Last one

- Surfaces such as wood or concrete are distorted to a larger extent. Notice the spines and secondary spatter present.



Types of spatter

- Impact spatter
- Cast off spatter
- Aspirated spatter
- Arterial spray
- High velocity spatter
- Medium velocity spatter
- Low velocity spatter

Other Patterns

Back Spatter

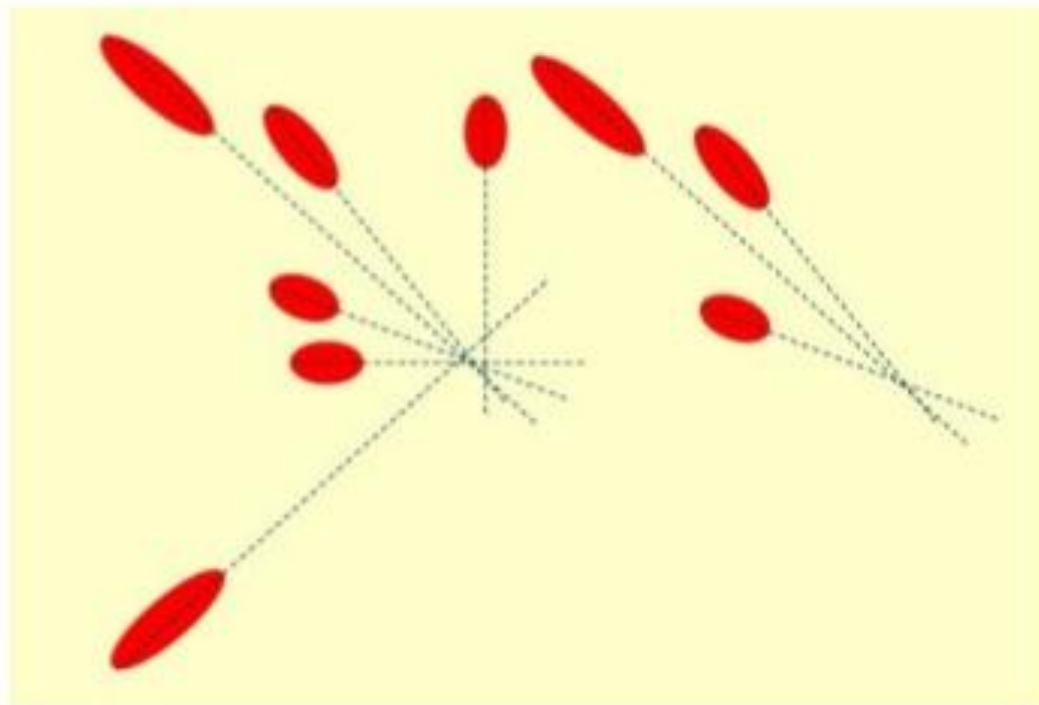


Transfer



POINT OF CONVERGENCE AND ORIGIN DETERMINATION

- The common point, on a 2 dimensional surface, over which the directionality of several bloodstains can be retraced.
- Once the directionality of a group of stains has been determined, it's possible to determine a two dimensional point or area for the group of stains.



How Bloodstain Pattern Analysis Works

