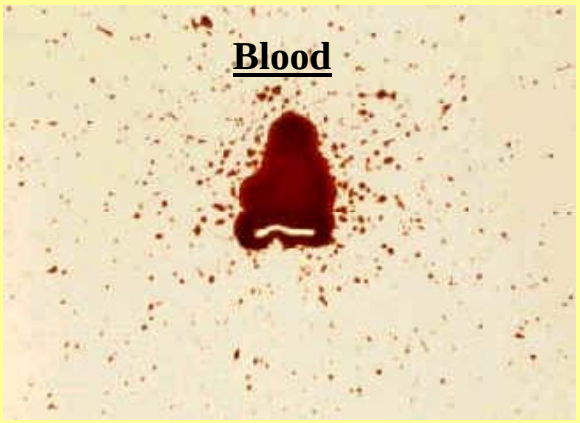
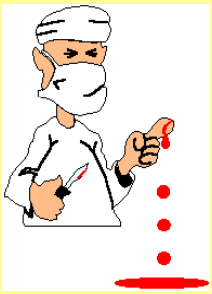
Blood



Is it Blood?

- Obvious
  - Not always an easy determination
- Not Obvious
  - Stains on clothes, carpet, etc.
    - Presumptive Tests – Blood indicated on…
    - Confirmatory Tests – Blood identified on…
  - Stains not visible (attempted cleaning)
    - Luminol – A type of presumptive test

Is it Human Blood?



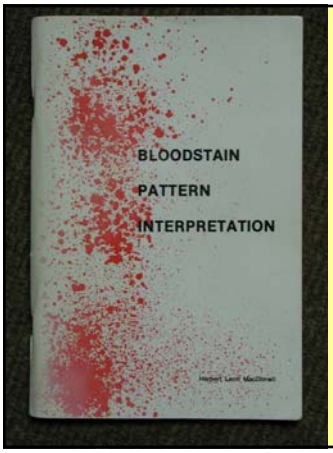
- Species determination
- Different species = different proteins
- Precipitin Test
  - Antibody, antigen test
  - If human, then the blood will precipitate its protein

Blood Evidence

- Blood found at a crime scene can be analyzed (utilized as evidence) in a variety of ways:
  - Genetics (molecular make-up for individualization)
    - DNA
  - Toxicology (foreign substances i.e. toxins)
    - Drugs, alcohol
  - Bloodstain Patterns (how blood was distributed)
    - Spatters

Blood Spatters

- NOT Blood Sp**L**atters – no "L"
  - Crime scene reconstruction
  - Validity of statements made by witness, victim, and suspect
- International Association of Bloodstain Pattern Analysts (IABPA)
  - Organization of forensic experts specializing in the field of bloodstain pattern analysis
  - Promotes education / research and establishes training standards in the field of bloodstain pattern analysis



Author:
Herbert Leon MacDonell
current IABPA Historian

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14830

Blood Spatters May Reveal:

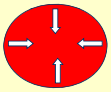
- **Origin(s) of bloodstain**
- **Distance of bloodstain from target**
- **Direction from which blood impacted**
- **Speed with which blood left its source**
- **Position of victim & assailant**
- **Movement of victim & assailant**
- **Number of blows, shots, etc.**

Liquid Blood

- **Physical properties**
  - Viscosity
  - Surface tension
  - Both are about the same as water
- **Behaves as a projectile in motion**
  - **Gravity as only force – falls vertically**
  - **Gravity with another force – falls vertically and horizontally at the same time**

Surface Tension

- **Resistant to penetration & separation**
- **Acts to reduce surface area**



- **A sphere offers the smallest surface area to volume ratio so free falling blood drops are spherical (not "teardrop") on impact**

Dripping Blood

Gravity is the only force acting

Blood drop grows until Wt (G) > S.T.

Single drop breaks free (teardrop shape)

Surface tension pulls in vertically

And horizontally

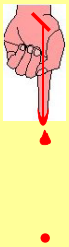
Shape settles into sphere (0.05 ml)

Does not break up until impact

Factors Affecting Drop Size

Standard drop size 50ul (0.05ml)

Rapid bleeding gives slightly larger drop

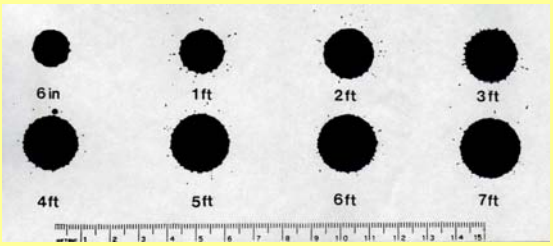


Shaking/movement casts off smaller drops
Breaks surface tension

Shape & Size of Bloodspot

- **Depends mostly on nature of target surface**
  - Texture (rough or smooth)
  - Porous or non porous
  - Angle of impact
- **Size is also related to distance fallen**
  - Given a standard 50 ul drop of blood
- **There is little change in spot diameter beyond a fall distance of 4 ft (1.2m)**

Drop Size vs. Height Fallen



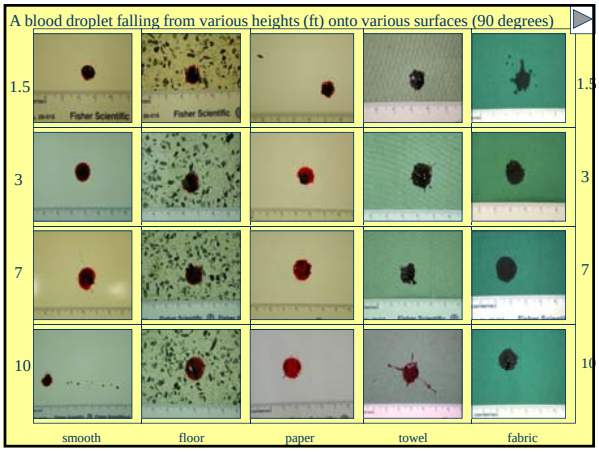
Single drops of blood falling from fingertip onto smooth cardboard from various heights.
No change in diameter beyond 7 ft.

Adapted from
Introduction to Forensic Sciences,
W. Eckert, CRC, 1997

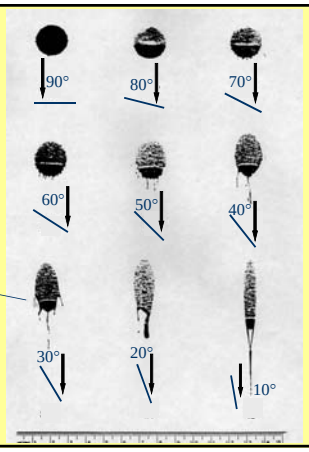
Drop Shape vs. Target Surface

Spreads out smoothly

ST of spreading edge is broken by irregular surface (Micro-droplets)



Angle of Impact



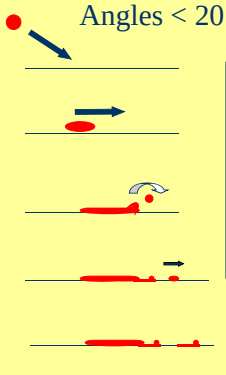
Elongated shape; more dense at lower edge

Adapted from
Introduction to Forensic Sciences,
W. Eckert, CRC, 1997

David Sadler:

Wave Cast-off

Angles < 20 degrees to surface

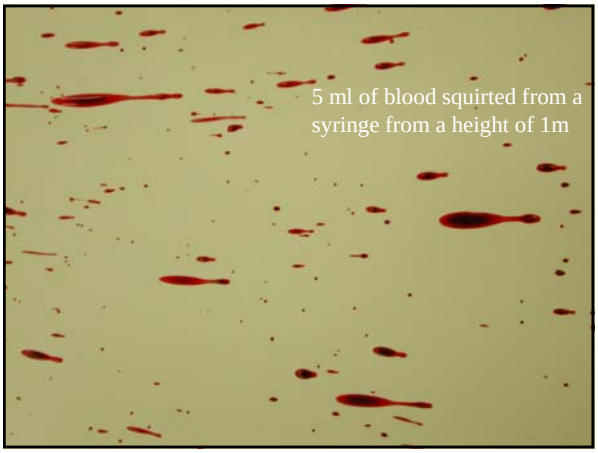


Tail of elongated stain points in direction of travel

Tail of wave cast-off points back to parent drop

Parent drop

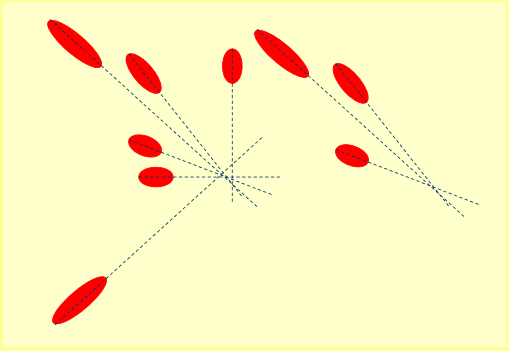
wave cast-off



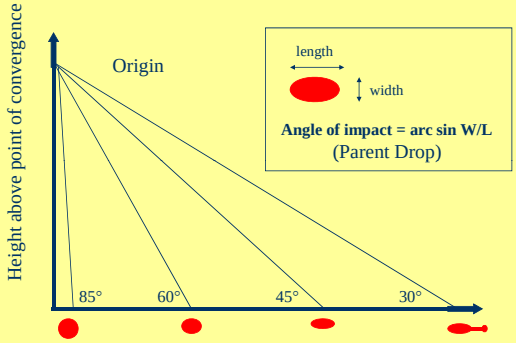
Direction and Origin

- Point of Convergence
  - Two dimensional
  - Shows direction
- Point of Origin
  - Three dimensional
  - Shows direction and height

Point of Convergence



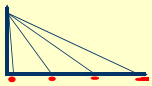
Point of Origin



Tracing Origin of Bloodspots

- **Point of convergence method**
  - 2 dimensional; shows direction

- **Point of origin method**
  - 3 dimensional; to include height



- **In practice:**
  - use of string & protractor at scene
  - use of computer at laboratory

Blood Spatter Velocity

- **Low velocity (5 f/s, 1.5 m/s)**
  - Free-falling drops, cast off from weapon
- **Medium velocity (25 - 100 f/s, 7.5 - 30 m/s)**
  - Baseball bat blows
- **High velocity (>100 f/s, >30 m/s)**
  - Gunshot, machinery

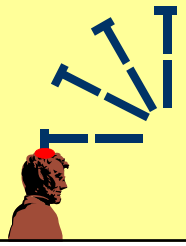
Low Velocity Blood Spatter

- **Blood source subjected to LV impact**
  - **< 5 f/s (1.5 m/s)**
- **Spot diameter: mostly 4 - 8 mm**
  - some smaller, some larger
- **Free-falling drops (gravity only)**
- **Cast off from fist, weapon, etc.**
- **Dripping (blood droplets into themselves)**
- **Splashing (stepping, throwing, etc.)**
- **Arterial spurting**

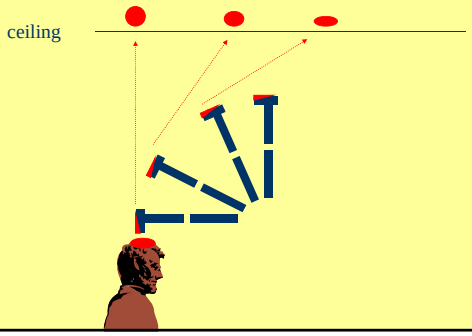
Cast-off from Weapon

- **First blow causes bleeding**
- **Subsequent blows contaminate weapon with blood**
- **Blood is cast-off at a tangent to arc of upswing or backswing (90 degrees)**
- **Pattern & intensity depends on:**
  - type of weapon
  - amount of blood adhering to weapon
  - length of arc, swing

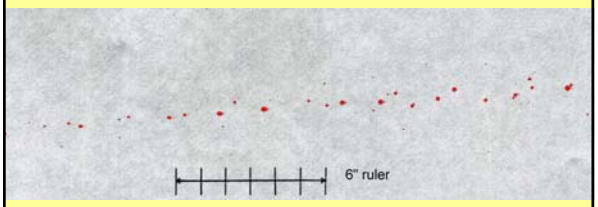
Downswing of Hammer



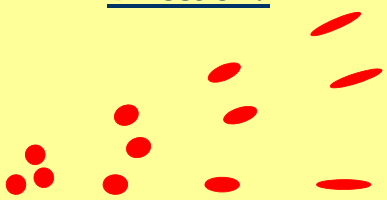
Cast-off from Weapon



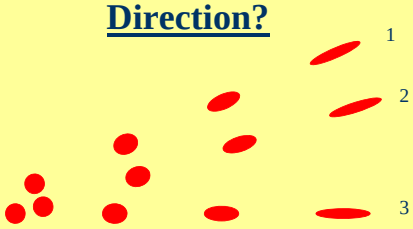
Overhead swing with bloodied metal bar



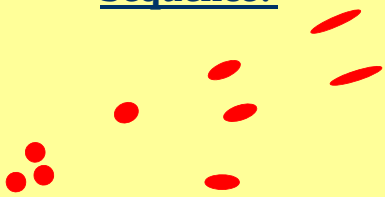
Cast-off Pattern (1/2) Direction?



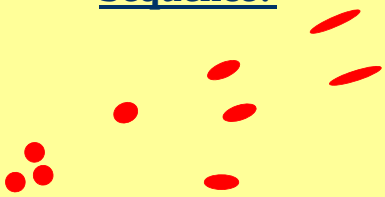
Cast off Pattern (2/2) Direction?



Cast off Pattern (1/2) Sequence?



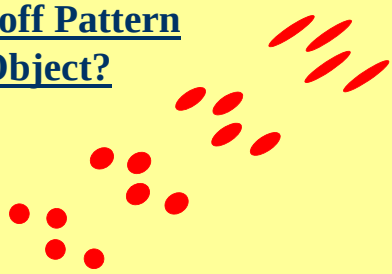
Cast off Pattern (2/2) Sequence?



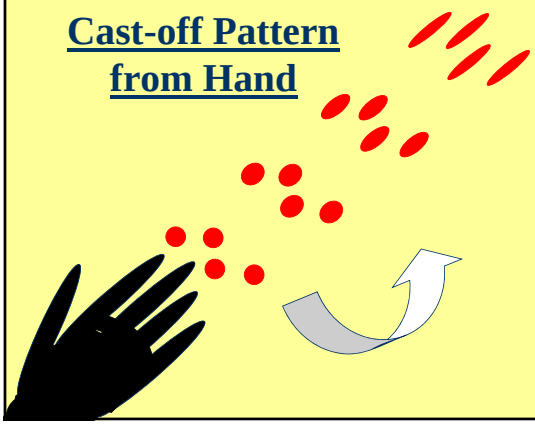
If weapon does not pick up more blood, the spatter from subsequent backswings becomes progressively less.
In practice weapon picks up more blood with each successful blow.

Three overhead swings with a hatchet
Direction? Sequence?

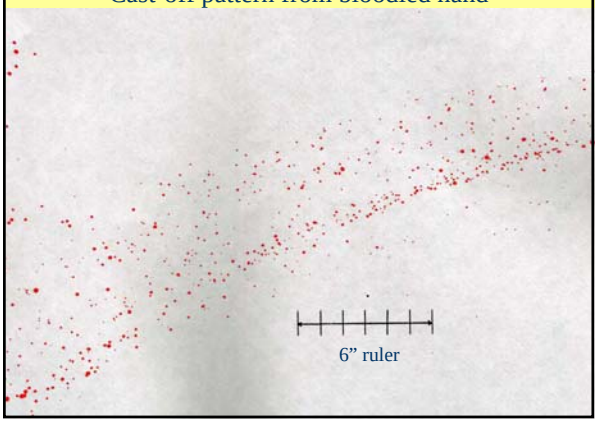
Cast-off Pattern Object?



Cast-off Pattern from Hand

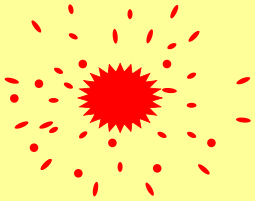


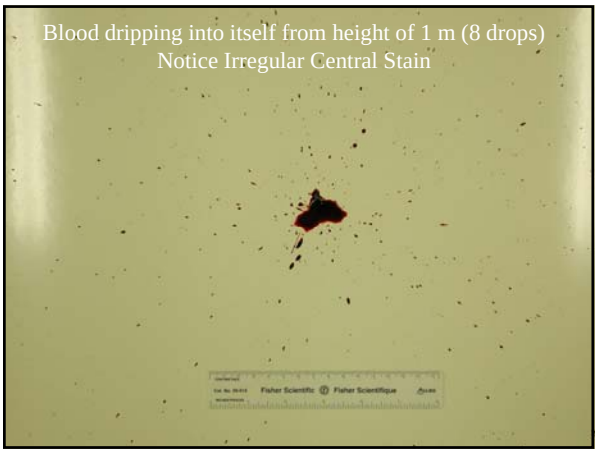
Cast-off pattern from bloodied hand



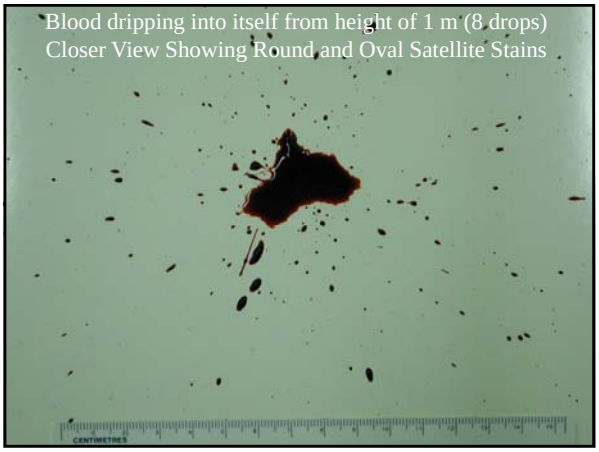
Dripping Pattern

- **Free-falling drops dripping into wet blood**
- **Falling from a stationary object**
- **Large irregular central stain**
- **Small round & oval satellite stains**





Blood dripping into itself from height of 1 m (8 drops)
Notice Irregular Central Stain



Blood dripping into itself from height of 1 m (8 drops)
Closer View Showing Round and Oval Satellite Stains

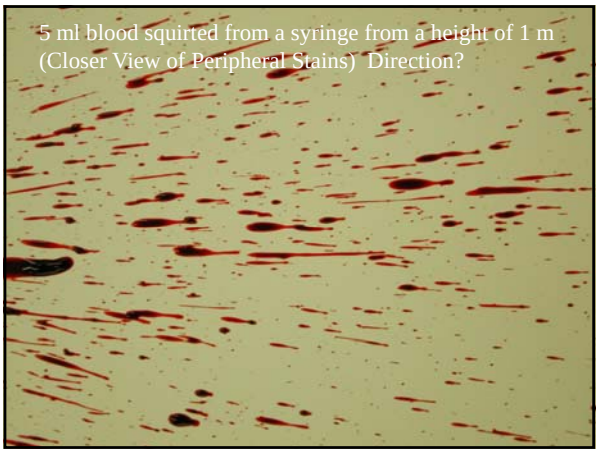
Splash Pattern

- **Volume > 1 ml**
  - Subjected to LV impact
  - Thrown
  - Tipped
- **Large central irregular area surrounded by elongated peripheral spatter pattern**

5 ml blood squirted from a syringe from a height of 1m

5 ml blood squirted from a syringe from a height of 1 m (Closer View of Central Stain)

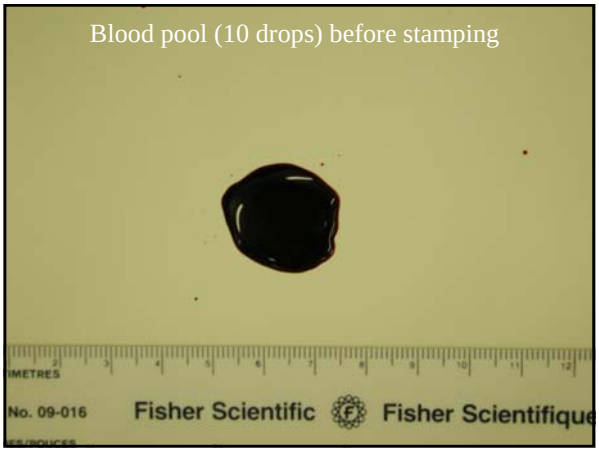
5 ml blood squirted from a syringe from a height of 1 m (Closer View of Peripheral Stains) Direction?



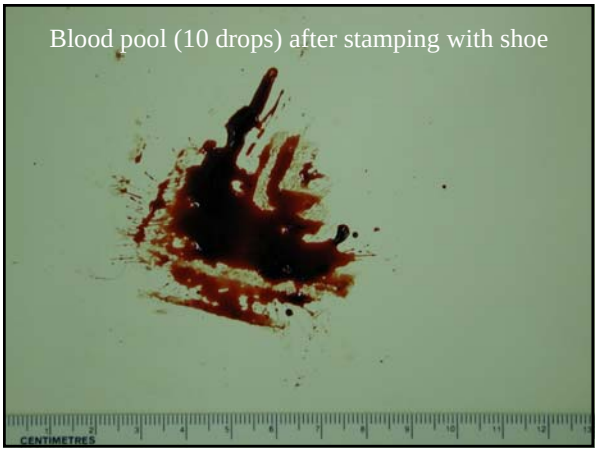
Splashing on a vertical surface

10 ml blood thrown 1 m onto a vertical surface

Blood pool (10 drops) before stamping

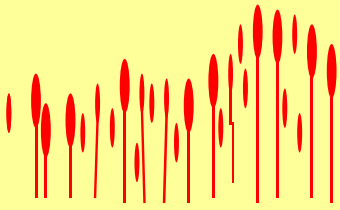


Blood pool (10 drops) after stamping with shoe

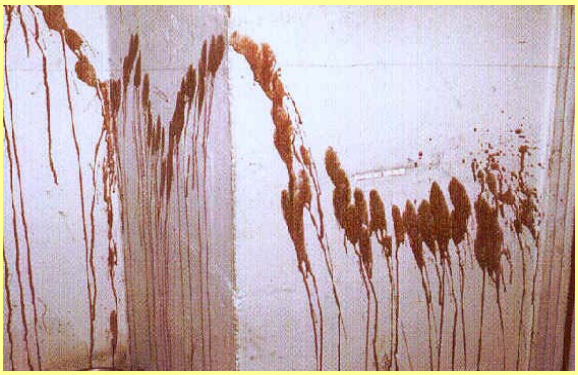


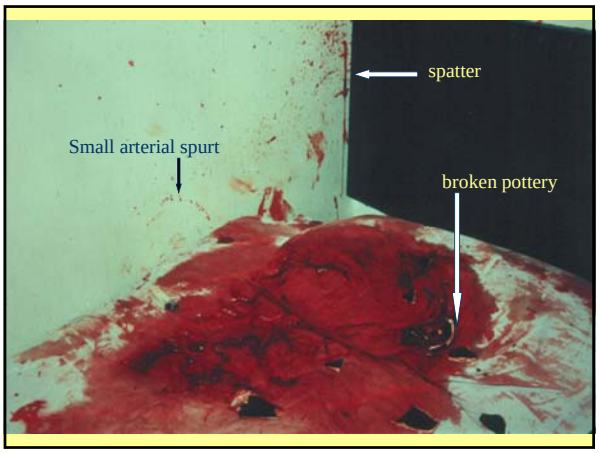
Arterial Spurt Pattern

- **Blood exiting body under arterial pressure (120 mm Hg); corresponds to heart beating**
- **Large stains with downward flow on vertical surfaces; air bubbles present if lung was punctured**
- **Creates a wave-like appearance**



Arterial Spurt Pattern





Medium Velocity Blood Spatter

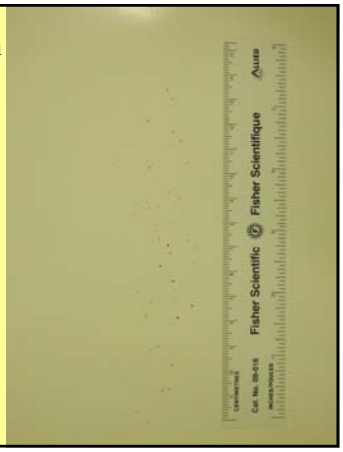
- **Blood source subjected to MV impact**
  - **(25 - 100 f/s, 7.5 - 30 m/s)**
- **Spot diameter: mostly 1 - 4 mm**
- **Blows with weapon (baseball bat, etc)**

Medium Velocity Blood Spatter.
Point of impact 15 cm in front of vertical target surface

Blood flicked between middle finger & thumb onto a vertical smooth surface from a distance of 15 cm

Notice Spot Diameter (1 - 4mm)

Which way was hand oriented?

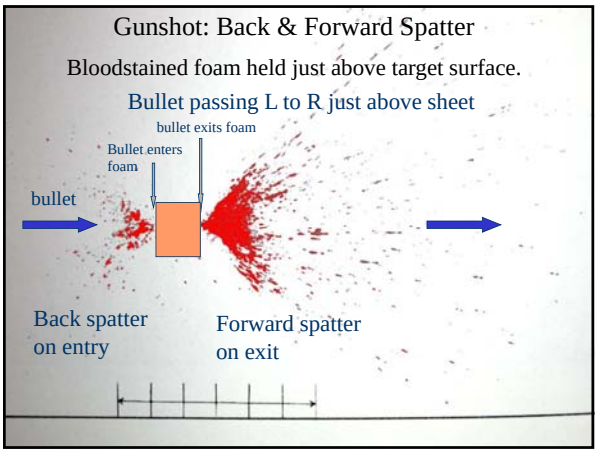


Cast-off (LV) & Medium Velocity Spatter

Cast-off & Medium Velocity Spatter (Close-up)

High Velocity Blood Spatter

- **Blood source subjected to HV impact**
  - **> 100 f/s, 30 m/s**
- **Fine mist: spot size < 0.1 mm**
- **Small mass limits spread to 1 m**
- **Some larger droplets reach further**
- **Gunshot**
  - back-spatter from entry wound
  - forward spatter from exit wound
- **High speed machinery**

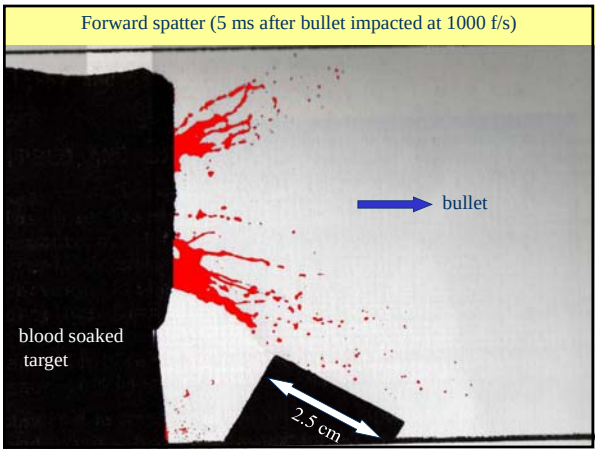


Gunshot Back Spatter

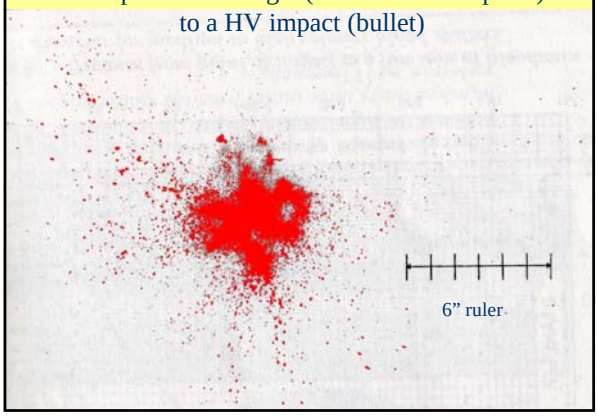
- **Arises from entrance wound**
- **Passes back towards weapon & shooter**
- **Seen only at close range of fire**
- **Seen on:**
  - inside of barrel
  - exterior of weapon
  - hand, arm, chest of shooter

Gunshot Forward Spatter

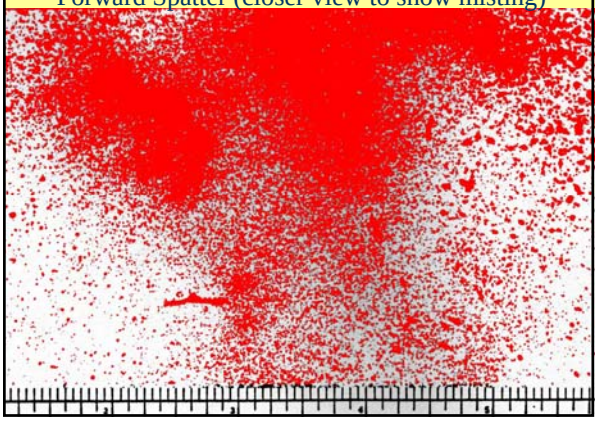
- **Arises from exit wound**
- **Passes forward in same direction as shot**
- **More copious than back-spatter**
- **Can be seen at any range of fire**
- **Seen on nearby surfaces, objects, persons**
  - especially on wall behind victim



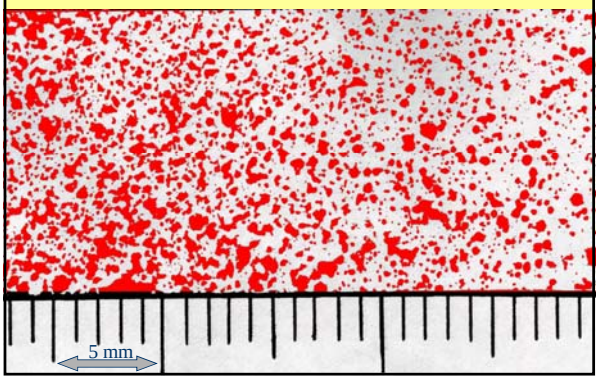
Forward spatter on a target (15cm from exit point) due to a HV impact (bullet)



Forward Spatter (closer view to show misting)



Forward Spatter (closest view) Droplet Size 0.1mm



Other Patterns

- Bloodstain patterns that have been altered
  - Altered by objects, gravity, others
- Include:
  - Wipe Patterns
  - Swipe Patterns
  - Transfer Patterns
  - Flow Patterns

Wipe and Swipe Patterns

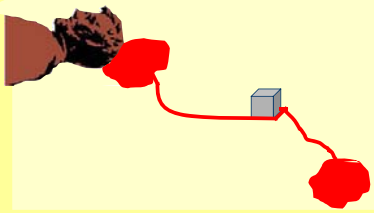
- **Wipe**
  - Object moves through a wet bloodstain
  - **Removes** and/or alters bloodstain appearance
  - Does not require a swipe pattern be present
- **Swipe**
  - **Transfer** of blood to an **unstained surface**
  - Direction may be determined by feathered edge
  - A wipe pattern must also be present

Transfer Patterns

- **Wet, bloodied object contacts a secondary surface**
- **Transfer from:**
  - hand, fingers
  - shoes, weapon
  - hair
- **Transfer to:**
  - walls, ceilings
  - clothing, bedding
- **Produces mirror-image of bloodied object**

Flow Patterns

- Blood flows horizontally & vertically
- Altered by contours, obstacles
- Often ends in pool



Flow Pattern Showing Pooling of Blood

Blood flow on shirt

Flowed to right side

Can be used to show position of body

Put It All Together