Bloodstain Patterns

Blood spatter patters, at the scene of a violent crime can indicate how the crime occurred. The shape of spots of blood can be used to determine an estimate of their velocity and/or impact angle and/or distance fallen. Elongated portions of the blood spatter indicates the direction that the blood drop was traveling when it impacted the surface.

Some of the variables used in blood spatter analysis are:

- Size of the blood spot
- Quantity of blood
- Shape of the blood spot
- Distribution of the blood in the crime scene
- Location of blood stains
- Angle of impact
- Texture of target surface

Blood that drips vertically from a stationary source onto a smooth, hard, flat surface is usually circular with crenated edges. Rough surfaces result in more spatter. (See Figure B-2)

The shape of a bloodstain indicates its direction of travel. Such bloodstains are shaped more like an exclamation point where the shape and length indicate the direction and speed of the drop. These can indicate the motion or violence of the crime and the pointed end of the bloodstain always faces its direction of travel. (See Figure B-1)

A line of blood spots on the ceiling or walls of a room in which violent murder has been committed could have been made by the killer wielding a weapon over his head or from the side. Similar patterns on walls could be the result of the victim being flung across the room. If the victim crawls on the floor or over a bed, or table, then smears and trails will be left. The same patterns can be the result of the assailant dragging the injured victim. Smudges and smears, fingerprints or handprints on furniture or doors can be a result of moving the victim or a result of a struggle in the room. Blood smears usually start as drops and are ragged in the direction of travel.

Due to health concerns, this investigation will use a simulated blood for the studies.

Simulated blood

Materials

Cornstarch
Corn syrup (Karo)
White glue (Elmer's or equivalent)
Food color, red, green, and blue
Water
Tablespoon measure
Teaspoon measure
Stirring rod
Measuring cup
Wide mouth jar, 16 oz plastic tumbler, or other container
3 oz or 5 oz plastic cups

Figure B-1. Blood spatter patterns from the Advanced Blood Pattern Institute in Corning, New York. The angle of impact is noted at the Lower right side of each drop.

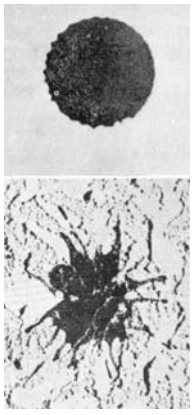

Figure B-2. Two blood drops. The top bloodstain resulted from a drop of blood falling onto a smooth surface. The bottom bloodstain resulted from a blood drop falling onto a piece of heavily textured wallpaper. Reference: Saferstein, **Criminalistics**, 7th Ed., Prentice Hall, 2001.

Safety Precautions

There are no safety hazards with any of the materials used in this procedure.

Procedure

Preparation of fake blood

Measure 2 tablespoons of cornstarch into a measuring cup or other wide mouth container. Add 1/3 cup of cold water and stir to mix well. Add 1/3 cup of corn syrup. Stir to mix.

Measure 3 teaspoons of the cornstarch-corn syrup mixture to a 3 oz or 5 oz plastic cup. Add 3 to 5 drops of red food color. Stir. The pink color of the mixture can be reduced by adding green food color one drop at a time until the proper color is obtained.

Add 1 teaspoon white glue to the colored mixture. Stir well. Check the flowability by stirring and rapidly lifting the teaspoon from the mixture. The fake blood should have a heavy, watery look and should drip from the spoon slowly. A drop of the fake blood falling onto a surface should form a spot with slight scallops around the edge. If the fake blood appears too thin, add a second teaspoon of the white glue to the mixture. If the consistency is still not correct, add small amounts of corn syrup or white glue to the mixture up to an additional teaspoon.

If necessary, adjust the color of the fake blood with additional food color. Real blood is dark red to reddish brown, however, it will be difficult to get an exact color for the fake blood.

Investigating Blood Droplets and Bloodstains

Materials

Simulated blood
Stirring rod
Dropper
White poster board or heavy paper stock. If desired, cut the poster board into smaller squares no smaller than about 5 inches square. Heavy paper such as Bristol Board or card stock, 90 or 110 lb weight works well for this procedure.
Rough textured paper, such as a textured wall paper. If desired, cut the wall paper into squares no smaller than 5 inches square.
Meter stick or tape measure
Protractor
Magnifier

Procedure

Effect of height on blood spatters

Using your finger, a stirring rod with a rounded end, or a dropper, drip simulated blood onto the poster board from different heights starting at about 15 cm (6 inches) and up to about 3 m (a little less than 10 feet).

Measure the blood spatters choosing one direction as the width and one as the length.

How does the size and appearance of the blood drops vary with height?

Repeat the procedure with some of the textured paper provided.

How does the size and appearance of the blood drops vary with the texture of the surface?

Effect of the fall angle on blood spatters

Use a protractor and some supports to create different impact angles for the poster board. Measuring from the floor or table top, set angles of 10° to 80° in 10° increments.

Using your finger, a stirring rod with a rounded end, or a dropper, drip simulated blood onto the poster board from different heights starting at about 15 cm and up to about 2 m. (Suggested heights: 15 cm [6 inches], 30 cm [1 foot], 100 cm [3 feet], and 200 cm [6 feet].)

How does the appearance of the blood drops vary with the angle of the poster board?

How does the appearance of the blood drops at the different angles vary with the height of the blood drop?

Blood splash patterns

The procedure must be done in a open area where there is sufficient space for make the splash patterns. The floor and walls must be covered with plastic or cloth drop cloths.

Materials

- Simulated blood
- Poster board
- Stirring rod with rounded end
- Drop cloths
- Tape

Procedure

Use drop cloths to protect the area where you are working. Tape the drop cloth in place to protect both the wall and the floor.

Set up the poster board on both the wall and the floor.

Dip the stirring rod into the simulated blood. While it is still wet, splash blood onto the poster board using sideways motion, upswings and downswings.

Compare your results with the vertical and horizontal surfaces.

How does the splash pattern indicate the direction of travel?

How does the splash pattern indicate the rate of travel?

How does the splash pattern vary with different directions of travel?

How does the appearance of the blood drops at the different angles vary with the height of the blood drop?

Dectecting Blood Stains

Examination of a crime scene from a violent crime may uncover spots that appears to be dried bloodstains. A determination must be made if it really is blood. To do this, the Kastle-Meyer color test is used.

The Kastle-Meyer test is based on the observation that blood hemoglobin possesses enzymes known as peroxidases. Peroxidases will accelerate the oxidation of certain organic compounds by peroxides. Blood, and a number of vegetable materials, such as horseradish and potatoes, will all give positive tests, however, since it is unlikely that the vegetable substances are present in a crime scene, the Kastle-Meyer test is considered to be highly indicative of blood.

The Kastle-Meyer reagent is phenolphthalein, $C_{20}H_{14}O_4$, a common acid-base indicator. Phenolphthalein is colorless in acid or neutral solutions, but will turn pink in basic solutions with a pH of approximately 8 or higher.

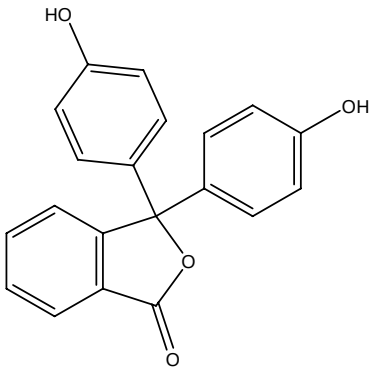

Figure B-3. The structure of phenolphthalein

The Kastle-Meyer Test

Materials needed

Kastle-Meyer reagent: 1% phenolphthalein in 100% ethanol
3% hydrogen peroxide, H_2O_2
Distilled or deionized water
Ethanol, C_2H_5OH, 100% in small dropper bottle
Disposable gloves
Samples of suspected blood (can use dried animal blood)

Safety precautions

Wear safety goggles at all times in the laboratory.

Dried blood samples are considered to be bio-hazards. Wear disposable gloves when handling the samples.

Disposal

Dispose of all samples in required containers.

Procedure

Add one drop of ethanol or distilled water to the suspected bloodstain.

Add one drop of phenolphthalein solution (the Kastle-Meyer reagent). If any color change occurs, then the test is considered negative.

Add one drop of 3% hydrogen peroxide solution.

A pink color indicates that the dried material is most likely blood.

Even if bloodstains at a crime scene have been cleaned up, there may be invisible reside left behind. These bloodstain residues can be detected by the luminol test. This test, performed in a darkened room will result in the production of light (luminescence). The luminol test is extremely sensitive and is capable of detecting bloodstains diluted up to 10,000.000 times.

The luminol reagent is a mixture of luminol (3-amino-phthalhydrazide), $C_8H_7O_3N_3$, and hydrogen peroxide. The iron in the hemoglobin of the blood acts as a catalyst, speeding up the reaction of luminol with hydrogen peroxide to produce light. The process is known as chemiluminescence, and is similar to the process that occurs in fireflies and lightsticks, but the chemicals in each case are different.

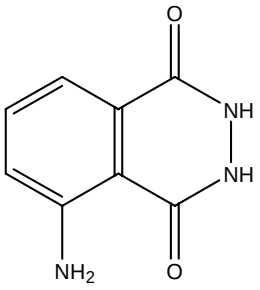

Figure B-4. The structure of luminol

Like the Kastle-Meyer test, the luminol test is only presumptive in the detection of blood. Other substances, such as household bleach, can interfere with the test.

The luminol test can destroy other evidence at the crime scene, so it is only used after all other evidence is collected and cataloged. It is important to note, however, that luminol will not interfere with any subsequent DNA testing.

The luminol test is only short-lived and must be photographed to preserve the results of the test.

The Luminol Test

Materials needed

Luminal reagent. Mix 0.1 g luminal (3-amino-phthalhydrazide) with 5.0 g sodium carbonate, Na_2CO_3 in 100 mL distilled water. Just before use, add 0.7 g sodium perborate, $NaBO_3 \cdot 4H_2O$ to the solution. Place in a small spray bottle. (NOTE: This solution should be prepared immediately before use.)

Disposable gloves

Samples of suspected blood (can use dried animal blood)

Safety precautions

Wear safety goggles at all times in the laboratory.

Dried blood samples are considered to be bio-hazards. Wear disposable gloves when handling the samples.

Disposal

Dispose of all samples in required containers.

Procedure

In a darkened room, spray the suspected bloodstain with the luminal reagent.

Suspected blood will result in a dim glow,

FORENSICS

Data and Results

Name _____ Course and Section _____

Partner(s) _____ Date _____

Bloodstain Patterns

How does height affect the appearance of blood drops and spatters? (Attach samples)

Distance of Fall cm	Drop length mm	Drop width mm	General shape of drop

Make a graph of the size of the blood drops (the *y*-axis) vs. the drop distance (the *x*-axis). Is there any apparent pattern?

Does the texture of the surface affect the blood spatters? (Attach samples)

Distance of Fall cm	Drop length mm	Drop width mm	General shape of drop

How does fall angle affect the appearance of blood drops and spatters? (Attach samples)

Summarize your results of blood splash patterns. (Attach samples)