ESTIMATION OF ORIGINAL VOLUME OF BLOODSTAINS

DR. HENRY C. LEE
Chief
Connecticut State Police
Forensic Laboratory

Bloodstain pattern evidence can be used in a variety of ways in crime scene reconstruction. Careful examination and documentation of bloodstain evidence will often yield detailed information about the nature of such bloodstains and the causes of certain stains. This information can in turn provide valuable leads in solving crimes. For example, by studying the size and shape of bloodstains the angle of incidence of these blood spots and the distance from the origin can be found. Impact or falling blood spatter can be projected by examining the dynamics of blood droplets and the patterns they produce. The approximate velocity of causation of a group of blood spatters can be learned through the size, density and distribution of these blood spatters; the type and means of production of a bloodstain can be determined by analyzing the shape, appearance and pattern of such bloodstains. In addition, certain facts related to the crime scene can also be reconstructed through bloodstain evidence. For example, reconstruction of the geometric and spatial relationships between people and objects can be determined from the distribution and location of various bloodstains, the sequence of events may also be determined by studying the direction and geometric relationship of various bloodstains. The significance of these bloodstain patterns in criminal investigation have been well documented during the past 40 years (1-12). However, in reviewing the literature it was found that very little has been discussed on the subject of determination of the original volume of a dry bloodstain. This type of determination can be important in crime scene reconstruction. The volume of bloodstains can yield information about the following issues:

(1) in determining whether a particular scene is a primary crime scene or a secondary crime scene;
(2) in proving or disproving a suspect's alibi;
(3) in confirming or dismissing a witnesses statement;
(4) in determining the force with which a group of blood spatters was produced;
(5) in determining whether or not the amount of blood is consistent with a type of injury.

The following are some of the methods used in the Connecticut State Police Forensic Science Laboratory for the estimation of the original volume of a dry bloodstain. These methods have been applied in several major case investigations and the results have shown it to be very useful in case reconstruction. Both direct and indirect procedures can be used for estimating the volume of a bloodstain. The selection of a procedure largely depends upon the type, nature and texture of the surface which the bloodstain is deposited on.

A. Direct method for bloodstain on a non-absorbent surface.

Bloodstains found on non-absorbent surfaces such as knife blades, broken glass, metal objects, rocks, floor tiles, ceramic surfaces, plastic or finished hardwood. The original volume of these bloodstains can be easily determined by a simple weighing procedure:

(1) carefully scrape or lift the bloodcrust from its surface;
(2) weigh the bloodcrust;
(3) original volume = weight x 4.167.

The original volume of a bloodstain is equal to the weight of the bloodcrust times the drying constant of the weight loss when liquid blood is completely dried. This constant has been determined by numerous experiments conducted over the years (11, 12). The wet weight of 1 ml liquid blood was found to be 10.2 mg. The dry weight of 1 ml blood was found to be 2.4 mg. The weight lost during drying process is 7.8 mg. Therefore, the constant of weight loss is 7.8/2.4 = 4.167.

B. Direct Method for Bloodstain on an Absorbent Surface.

When blood is deposited on an absorbent surface such as paper, cloth, textile, soil, etc. it is impossible to recover all the dried bloodcrust from the matrix since the blood has been absorbed into the matrix. Under these conditions the original volume of blood can be estimated by:

(1) weigh the bloodstain with the matrix (Wb);
(2) weigh a same sized sample of the blank matrix (Wm);
(3) weight of the bloodcrust = Wb - Wm;
(4) volume of blood = (Wb-Wm) x 4.167.

II. Indirect Methods

Occasionally direct weighing methods are not feasible due to circumstances. Two indirect methods can be used to estimate the original volume of blood.

A. Indirect Overlay Conversion.

When a large bloodstain was found on a large absorbent object such as a blanket, quilt, bedsheet, coat or carpet, the volume of such bloodstains can be estimated by indirectly weighting a unit of the bloodstain according to the following procedures:

(1) prepare a ruled overlay
(2) place the overlay over bloodstain
(3) Count numbers of units over stain
(4) Weigh 1 unit of bloodstain (Wb)
(5) Weigh 1 unit of surface blank (Ws).
(6) UW (unit weight of blood) = Wb - Ws
(7) Total weight of blood (Tw) = number of units x UW.
(8) Volume = TW x 4.167.

B. Indirect Photo Weighing Method

Occasionally the original bloodstain is not available for examination. The only available evidence are crime scene photos or crime scene notes and sketches. In several cases the volume of the original bloodstain became a crucial issue during the trial, making the estimation of the volume of the bloodstain necessary. Although this procedure will not yield an accurate result it will produce a good estimation.

(1) cut 1 unit area of the photo
(2) weigh the unit area of photo (Wp);
(3) cut the bloodstained area of the photo
(4) weigh the bloodstained area of the photo (Wb)

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(5) total bloodstained area (TA) = Wb/Wp x unit area
(6) obtain same type of blank surface material shown in photo
(7) prepare 1 unit of blank surface material equivalent to the size of 1 unit area in photo
(8) deposit liquid blood onto the unit area of blank surface
(9) determine the volume of liquid blood used to deposit on the 1 unit blank surface (Vb);
(10) volume of original bloodstain = TA x VB.

In conclusion, the above methods can be used for estimation of the original volume of a bloodstain. However, these procedures should not be considered as techniques for accurate determination. These procedures only provide the crime scene investigator with additional tools for crime scene reconstruction.

BLOODSTAIN PATTERN INTERPRETATION
Selected References

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ALWAYS LOOK TWICE

(cont. from page 3)

After the Medical Examiners had completed their examination of the body, the Crime Scene Technicians meticulously examined the body for trace evidence. Friction ridge detail was observed in blood on the left and right ankles of the victim. These areas were photographed and the feet were bagged to protect the area during transportation to the Medical Examiner's facility.

At the Medical Examiner's office, the victim was examined again. The body was now on a tray with direct overhead lighting. Under these conditions a patent fingerprint impression was observed that had not been noticed on the scene.

It was decided that the patent impression was of sufficient quality for an identification and no chemical enhancement techniques were initiated. The patent blood print was lifted directly from the body, after first photographing it with a Polaroid CU-5 camera. The lifting of this patent blood print was accomplished with the use of frosted transparent lifting tape. The tape was placed over the patent print and smoothed with a pencil eraser, then lifted and placed on a 3"x5" chrome coated latent lift card (Exhibit I).

The patent print was examined by members of the Latent Print Detail and matched to the alleged offender Alberto Mesa (Exhibit II).

The offender, Alberto Mesa, was subsequently tried and found to be innocent due to insanity at the time of the commission of this crime.

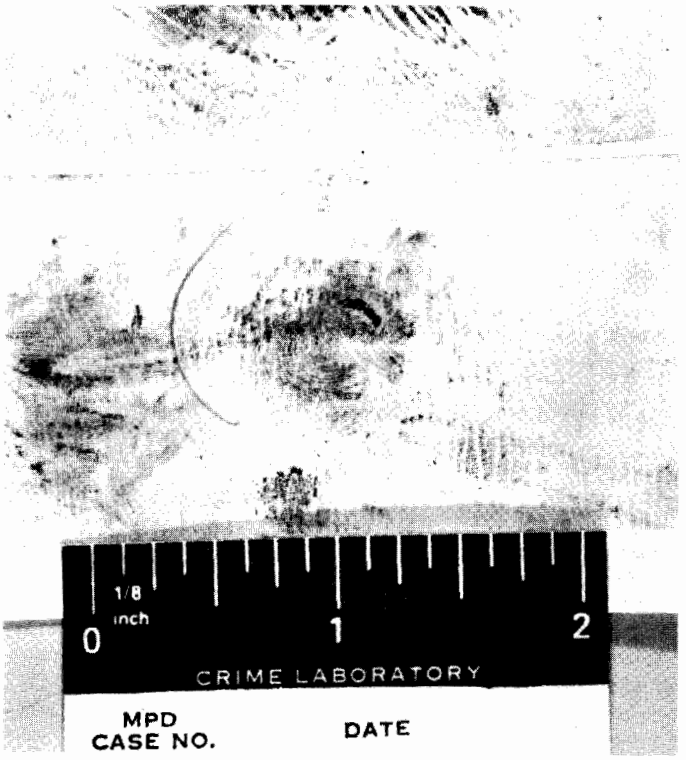

EXHIBIT I

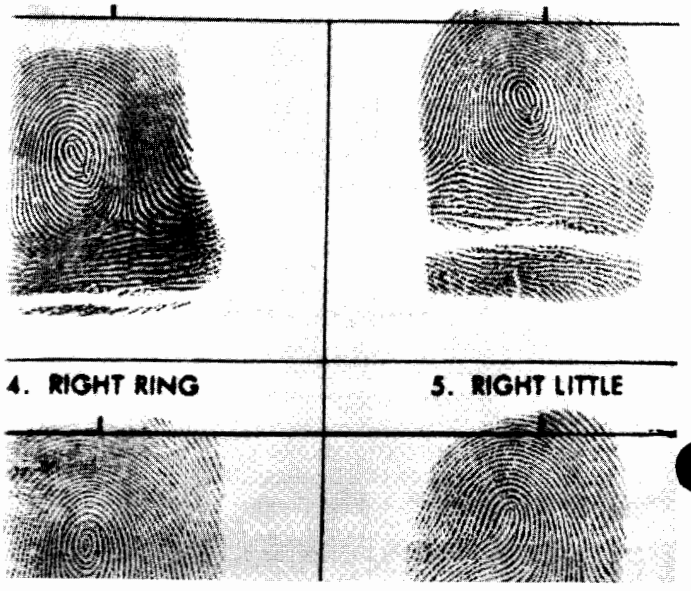

EXHIBIT II

CORRECTION ON THE ESTIMATION OF ORIGINAL VOLUME OF BLOODSTAINS

Dr. Henry C. Lee
Chief - Forensic Science Laboratory
Connecticut State Police

Several questions regarding my recent article, "Estimation of Original Volume of Bloodstains", (IAI News, Number 7, pp. 11-12, July, 1986) have arisen in recent weeks. I would like to take this opportunity to clarify the means by which the final equation was derived.

Known volumes of blood were weighed and allowed to dry at room temperature. Table One is a typical set of experimental data showing the dry weight and wet weight of a known volume of blood.

TABLE 1

Volume vs Weight

VOLUME	WET WEIGHT	DRY WEIGHT	W-D mg	mg/ul
0.01 ml	10.4 mg	2.3 mg	8.1	2.3
0.02 ml	20.5 mg	4.8 mg	15.7	2.4
0.04 ml	40.2 mg	9.6 mg	30.6	2.4
0.05 ml	51.6 mg	12.1 mg	39.5	2.4
0.06 ml	61.4 mg	14.1 mg	47.3	2.4
0.08 ml	81.8 mg	19.7 mg	62.1	2.4
0.10 ml	101.8 mg	24.1 mg	77.7	2.4
0.20 ml	203.9 mg	48.0 mg	155.9	2.4
0.40 ml	408.1 mg	96.1 mg	312.0	2.4
0.50 ml	503.5 mg	122.4 mg	381.1	2.4
1.00 ml	1024.3 mg	241.3 mg	783.0	2.4

TABLE 2

Volume vs Weight
0.04 ml of Blood (fresh) from Four Different Donors

DONOR	WET WEIGHT	DRY WEIGHT	Ww-Wd	mg
HCL	0.03651	0.00928	0.02723	9.3
HCL	0.04089	0.00992	0.03097	9.9
HCL	0.03741	0.00940	0.02801	9.4
REG	0.04092	0.00867	0.03225	8.7
REG	0.04030	0.00910	0.03120	9.1
REG	0.04035	0.00925	0.03110	9.3
JCR	0.03651	0.00928	0.02723	9.3
JCR	0.03780	0.00890	0.02840	8.9
JCR	0.03841	0.00941	0.02900	9.4
MSL	0.03752	0.00924	0.02828	9.2
MSL	0.04019	0.00967	0.03052	9.7
MSL	0.03957	0.00943	0.03014	9.4

A plot of the data from Table 1 showed the linear relationship between the dry weight of blood and the original volume. Specifically the slope of the dry weight vs. volume plot was found to be 4.167 ml/0.1 mg. This value, termed the dry-blood constant, also held true for blood samples of constant volume from four different donors (Table 2). By using this constant in a simple mathematical relationship (i.e., original volume = weight x 4.167 ml/0.1 mg), the more complex calculations involving densities can be avoided.

Due to a typing error, the unit of the constant was not included. The author would like to thank those who pointed out this omission. The correct version of the formula should be volume = weight x 4.167 ml/0.1 mg or volume = weight x 0.4167 ml/mg (i.e. the original volume of the bloodstain is equal to the dry crust weight times the drying constant of 0.4167 ml/mg or 4.167 ml/0.1 mg.). Also, the constant of weight loss should be 7.8/2.4 = 3.25 not 4.167.