ESTIMATION OF ORIGINAL VOLUME OF BLOODSTAINS

(1) in determining whether a particular scene is a primary crime scene or a secondary crime scene;
(2) proving or disproving a suspect's alibi;
(3) in confirming or dismissing a theory of blood spatter;
(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 surface such as knife blade, 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 bloodstain from its surface;
(2) Weigh the bloodstain;
(3) Original volume = weight x 4.167

The original volume of a bloodstain is equal to the weight of the bloodstain 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 (1-12). The weight loss of 1 ml liquid blood was found to be 10.2%. 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 bloodstain 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) Subtract weight of the bloodstain:

\[ W_{dry} = W_b - W_m \]

(4) Volume of blood = \( W_{dry} \times 4.167 \)

II. Indirect Methods

Occasionally indirect weighing method is 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, sheet, 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 number of units over overlay
(4) Weight 1 unit of bloodstain (Wb)
(5) Weight 1 unit of surface blank (Wsp)
(6) LW (unit weight of blood) = \( \frac{W_b}{W_{sp}} \)
(7) Total weight of bloodstain (Tw) = LW x number of units x LW

B. Indirect Photo Weighing Method

Occasionally the original volume of a 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 become a crucial issue during the trial. Making the estimates of the volume of the bloodstain necessary. Although this procedure will not yield in accurate result it will produce a good estimate:

(1) cut 1 unit area of the photo
(2) weigh the unit area of photo (Wmg)
(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 x Hb x unit area

(6) obtain sample type of blank surface material shown in photo

(7) prepare 1 unit of blank surface material equivalent to the size of 1 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 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:

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 details were 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-U camera. The lifting of this patent blood print was accomplished with the use of frosted transparent lifting tape. The tape was peeled over the patent print and smoothed with a pencil eraser, then lifted and placed on a 3" x 5" chrome coated latent lift card (Exhibit II).

The latent 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.
CORRECTION ON THE ESTIMATION OF ORIGINAL VOLUME OF BLOODSTAINS

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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>
<thead>
<tr>
<th>VOLUME (ml)</th>
<th>WET WEIGHT (mg)</th>
<th>DRY WEIGHT (mg)</th>
<th>W-D diff (mg)</th>
<th>mg/ml</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 ml</td>
<td>10.4 mg</td>
<td>2.3 mg</td>
<td>8.1 mg</td>
<td>2.3</td>
</tr>
<tr>
<td>0.02 ml</td>
<td>20.5 mg</td>
<td>4.8 mg</td>
<td>15.7 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.04 ml</td>
<td>40.2 mg</td>
<td>9.6 mg</td>
<td>30.6 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.05 ml</td>
<td>51.6 mg</td>
<td>12.1 mg</td>
<td>39.5 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.06 ml</td>
<td>61.4 mg</td>
<td>14.1 mg</td>
<td>47.3 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.08 ml</td>
<td>87.8 mg</td>
<td>19.7 mg</td>
<td>68.1 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.10 ml</td>
<td>101.8 mg</td>
<td>24.1 mg</td>
<td>77.7 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.20 ml</td>
<td>303.9 mg</td>
<td>48.0 mg</td>
<td>155.9 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.40 ml</td>
<td>608.1 mg</td>
<td>96.1 mg</td>
<td>312.0 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>0.50 ml</td>
<td>503.5 mg</td>
<td>122.4 mg</td>
<td>381.1 mg</td>
<td>2.4</td>
</tr>
<tr>
<td>1.00 ml</td>
<td>1024.3 mg</td>
<td>241.3 mg</td>
<td>783.0 mg</td>
<td>2.4</td>
</tr>
</tbody>
</table>

Table Two:

<table>
<thead>
<tr>
<th>DONOR</th>
<th>WET WEIGHT (mg)</th>
<th>DRY WEIGHT (mg)</th>
<th>Ww-Wt (mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>HCL</td>
<td>0.03651</td>
<td>0.00928</td>
<td>0.02723</td>
</tr>
<tr>
<td>HCL</td>
<td>0.0409</td>
<td>0.00992</td>
<td>0.03097</td>
</tr>
<tr>
<td>HCL</td>
<td>0.03741</td>
<td>0.00940</td>
<td>0.02801</td>
</tr>
<tr>
<td>REG</td>
<td>0.04092</td>
<td>0.00867</td>
<td>0.03225</td>
</tr>
<tr>
<td>REG</td>
<td>0.04030</td>
<td>0.00910</td>
<td>0.03130</td>
</tr>
<tr>
<td>REG</td>
<td>0.04056</td>
<td>0.00975</td>
<td>0.03115</td>
</tr>
<tr>
<td>JCR</td>
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<td>0.00928</td>
<td>0.02723</td>
</tr>
<tr>
<td>JCR</td>
<td>0.03980</td>
<td>0.00880</td>
<td>0.03100</td>
</tr>
<tr>
<td>JCR</td>
<td>0.03941</td>
<td>0.00941</td>
<td>0.02900</td>
</tr>
<tr>
<td>MSL</td>
<td>0.03752</td>
<td>0.00924</td>
<td>0.02828</td>
</tr>
<tr>
<td>MSL</td>
<td>0.04019</td>
<td>0.00987</td>
<td>0.03052</td>
</tr>
<tr>
<td>MSL</td>
<td>0.03857</td>
<td>0.00943</td>
<td>0.03014</td>
</tr>
</tbody>
</table>

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 7.0/2.4 = 3.25 not 4.167.

4. IDENTIFICATION NEWS - SEPTEMBER, 1986