

RESEARCH ARTICLE

Evaluation of Blood Deposition on Fabric: Distinguishing Spatter and Transfer Stains

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Abstract: The careful examination of blood stained clothing can potentially provide information regarding the movements and activities of the wearer during a bloodshed event. The goal of this study is to aid the bloodstain pattern analyst during such examinations. Spatter and transfer stains were created on eleven types of fabric used commonly in the manufacture of clothing. The physical characteristics of the resulting stains including size, shape and penetration of the fabric structure were compared. Results indicate that physical characteristics alone may not be sufficient for distinguishing spatter from transfer stains. Others factors such as the quantity and distribution of stains and case factors should be carefully considered when making this distinction.

Examination of blood stained clothing is a common request of the bloodstain pattern analyst. Given its potential to provide information about the movements and activities of the wearer, bloodstain pattern analysis may confirm or refute explanations for the presence of blood on his or her clothing. Of particular interest are spatter and transfer stains. These two broad categories of stains are commonly present in a bloodshed event, but are created by very different mechanisms. The ability to distinguish and correctly identify these stains is an important skill for any bloodstain pattern analyst who routinely examines clothing. The recent case of the *Indiana v. Camm* (1) brought this issue to the forefront of the bloodstain pattern community.

Much research has been published in other areas of bloodstain pattern analysis. However, the resources and reference material for examination of clothing are more limited. As with any other bloodstain, the target surface must be considered prior to evaluating the stain. Research has been published indicating that both texture and composition of a fabric will affect the resulting shape of a bloodstain. (2-4) This study will revisit the topic of fabric (5) as a target surface with a focus on spatter and distinguishing spatter from transfer.

Distinguishing Spatter from Transfer Stains on Dry Fabric

Methods:

Spatter was created on eleven different fabrics using one milliliter of human blood and a rat trap device at a distance of 24” perpendicular to a vertical target. Human whole blood was collected in vacuum tubes containing EDTA and warmed to body temperature prior to use. Clothing was purchased at a local second hand store and the manufacturer’s label was used for fabric composition. Each piece of fabric was secured to a separate poster board target with a portion of the smooth surface exposed to serve as a control. Each target was allowed to air dry

and the resulting spatter was examined microscopically. Approximately fifty individual spatters were chosen and measured on each target.

*Table 1. Size range of spatter observed on fabric samples**

FABRIC	min	max	min	max
100% Cotton	0.2	3.2	0.1	3.0
100% Polyester	1.0	6.0	0.1	3.0
100% Silk	0.1	3.0	0.1	2.8
100% Wool	0.3	3.0	0.2	3.0
100% Rayon	0.1	3.2	0.1	3.0
100% Nylon	0.1	3.0	0.1	3.3
100% Acrylic	0.1	3.2	0.1	3.1
Denim (98% Cotton/2% Spandex)	0.2	3.8	0.1	3.5
60% Cotton/40% Polyester Blend	0.1	3.4	0.1	3.3
65% Polyester/35% Cotton Blend	0.3	3.5	0.1	3.0
55% Ramie/45% Cotton Blend	0.2	3.0	0.1	3.1

*These measurements are for comparison purposes only. They represent the size range of spatter observed in this research and are not intended to establish a size range for this specific spatter producing mechanism.

Small volume transfer stains were created on the same eleven fabrics using various items to produce stains in the size range corresponding to the spatter. Each target was allowed to air dry. The resulting transfer stains were examined microscopically and compared to the spatter.

Results:

The size range of the spatter created on most fabric types was consistent with the spatter on the observed controls. Only 100% polyester was significantly different with some individual spatter measuring as large as 6.0 mm. Overall the most affected characteristic was not size, but shape of the stains.

Very little distortion of the round to oval shape was seen on the 100% rayon and 100% nylon. The appearance of the spatter was very similar to the control stains in both size and shape (Figures 1-4).

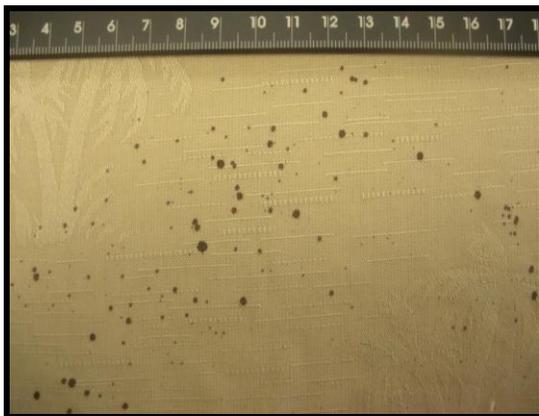


Figure 1. Spatter on 100% Rayon.



Figure 2. Spatter on 100% Nylon.

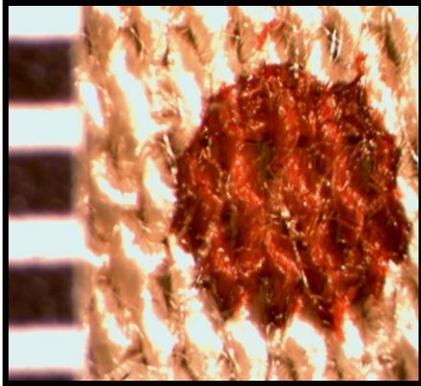


Figure 3. 100% Rayon (40x).



Figure 4. 100% Nylon (25x).

Spatter on absorbent fabrics including cotton, cotton blends, and 100% silk also retained a round to oval shape (Figures 5-11) similar to those on the control poster board target. This was specifically noted on fabrics with a dense weave construction. A concentrated stain with a diffused outer border, typical of passive stains on absorbent fabric, was not observed even with spatter at the larger end of the size range (>3.0 mm).



Figure 5. Spatter on Denim.

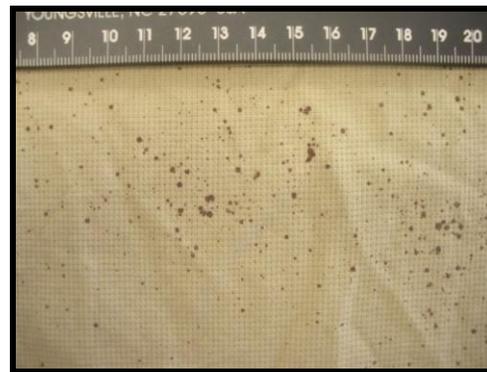


Figure 6. Spatter on 100% Silk.

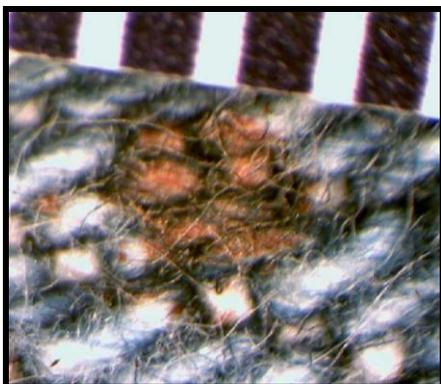


Figure 7. Spatter on Denim (25x).

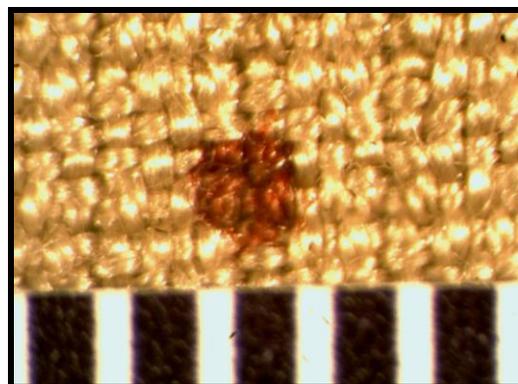


Figure 8. Spatter on 100% Silk (25x).



Figure 9. Spatter on 100% Cotton (25x).



Figure 10. Spatter on Poly/Cotton Blend 65% Polyester/35% Cotton (25x).

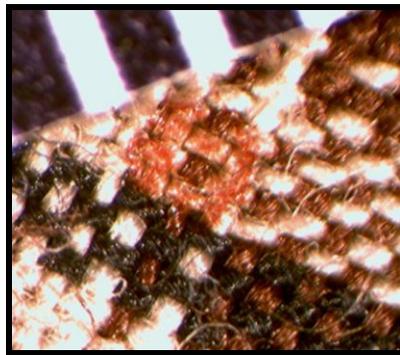


Figure 11. Spatter on Cotton/Polyester Blend 60% Cotton/40% Polyester (25x).

The appearance of spatter on some fabrics was also dependent upon the portion of the weave/knit on which the stain was deposited. Spatter stains smaller than the width of a single thread can retain a tight round shape. More distortion of shape was observed if the stain involved multiple threads making up the fabric construction. Figures 12 and 13, respectively, demonstrate this difference in a ramie/cotton blend. The 100% wool and 100% acrylic fabrics gave similar results.

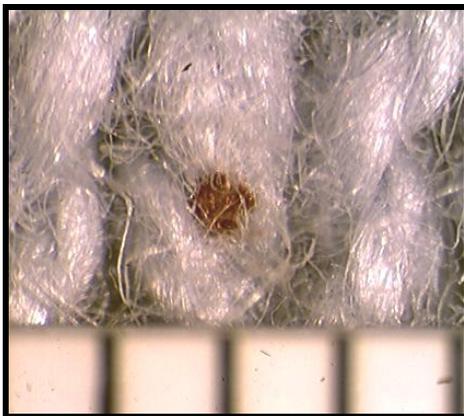


Figure 12. 55% Ramie/45% Cotton (25x).



Figure 13. 55% Ramie/45% Cotton (25x).

The most dramatic distortion of shape was observed on 100% polyester. The stains were elongated and typically larger than the control (Figure 14). The blood appeared to be absorbed along the threads in the lengthwise direction (warp) of the construction. This was the case with almost all spatter stains, regardless of size (Figures 15 and 16).

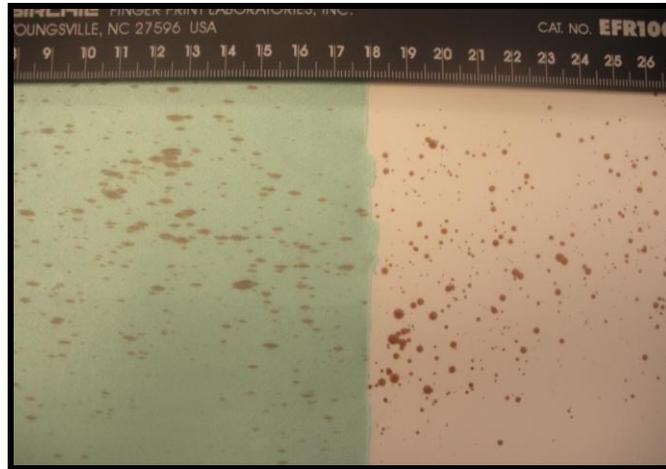


Figure 14. Spatter on 100% Polyester (left) and control poster board (right.)

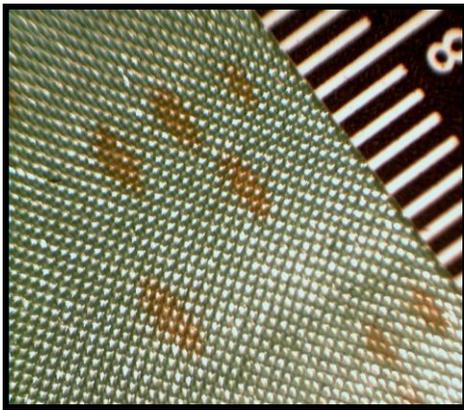


Figure 15. 100% Polyester (10x).

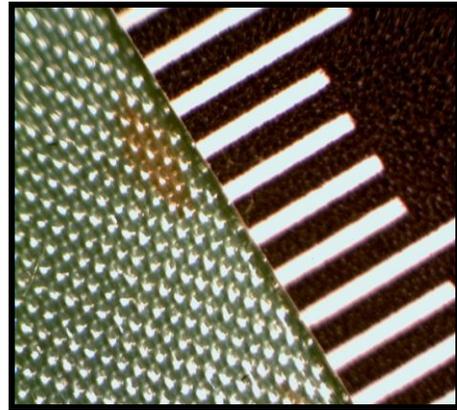


Figure 16. 100% Polyester (25x).

The transfer stains created with lateral movement, as in a swiping motion, were clearly identifiable as transfer. Figures 17 and 18 are photomicrographs of a transfer stain created by lightly swiping a bloody swab over 100% wool. Higher magnification shows the stain limited to the top of the weave/knit. Figures 19 - 24 are further examples of transfer stains created by lightly swiping a bloody swab over each fabric.

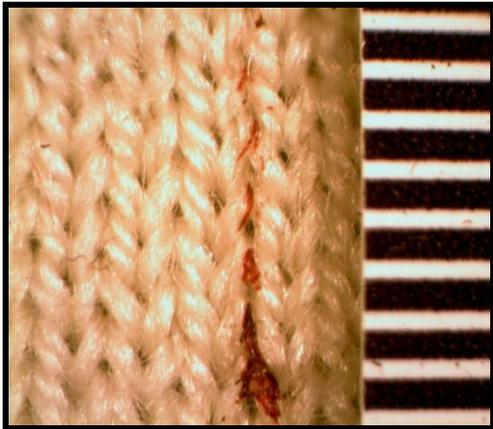


Figure 17. Transfer on 100% Wool (16x).

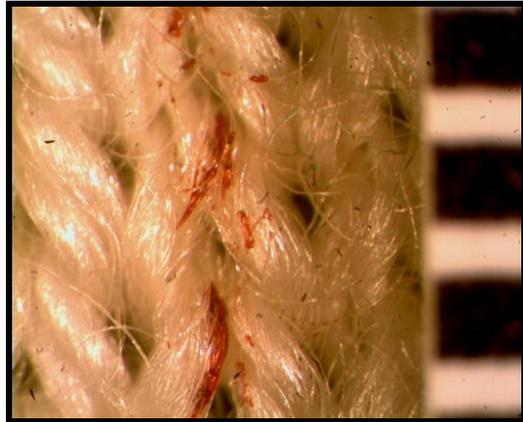


Figure 18. Transfer on 100% Wool (40x).

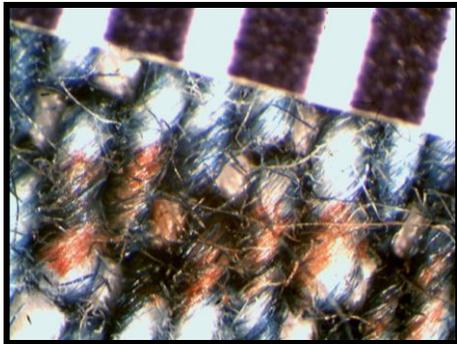


Figure 19 Transfer on Denim (40x).

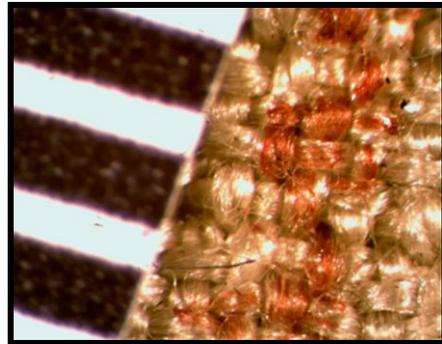


Figure 20. Transfer on 100% Silk (25x).

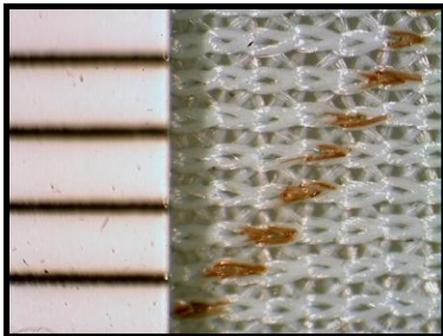


Figure 21. Transfer on 100% Nylon (25x).

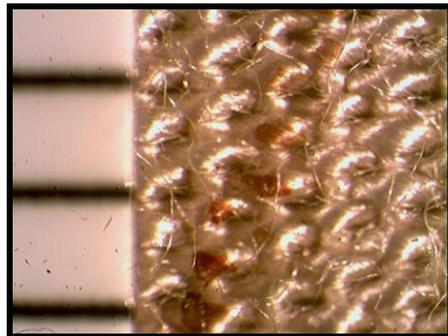


Figure 22. Transfer on 100% Rayon (25x).

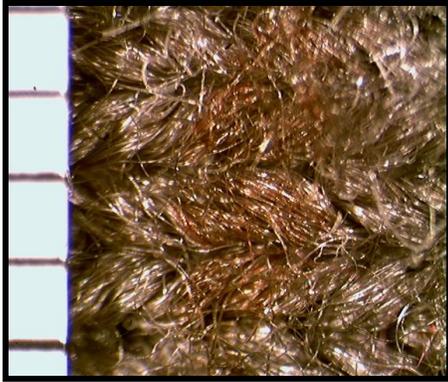


Figure 23. Transfer on 100% Acrylic (25x).

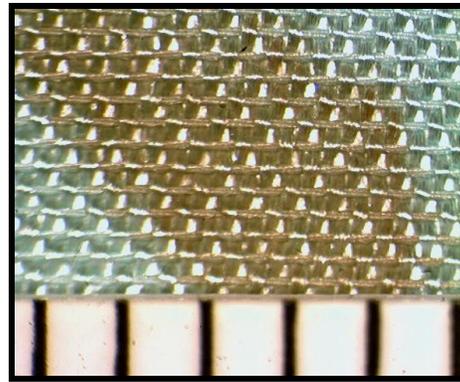


Figure 24. Transfer on 100% Polyester (25x).

The distinction between transfer and spatter became less obvious when the size of the spatter was very small. As shown in Table 1, spatter smaller than 1.0 mm was created on some of the fabrics. Although created in the same dynamic event, this small spatter may not exhibit penetration into the weave/knit that can be seen in larger spatter. Figures 25 and 26 are photomicrographs of spatter on 100% nylon. The stains were created on the same piece of fabric during the same event. Notice that the sub-millimeter spatter in Figure 26 is limited to the top of the weave/knit. This was not a function of the mechanism, but of the volume of the droplet in combination with the location on which it struck the surface texture.



Figure 25. 100% Nylon (25x).

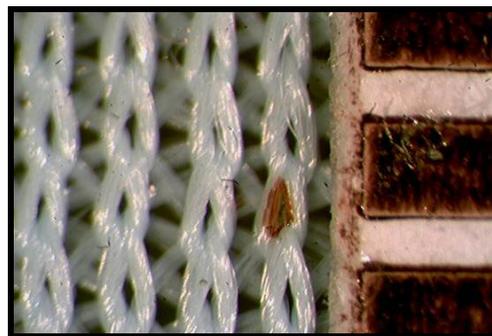


Figure 26. 100% Nylon (40x).

Figures 27 and 28 are photomicrographs of 100% wool. The fabric construction is different than the 100% nylon, but the same issues are present regarding the size of individual spatters. When the stain size was smaller than the width of an individual yarn it appeared to sit on top. The obvious penetration into the weave/knit associated with spatter was not always present when examining individual stains. Compare Figure 27 with the transfer stains in Figures 17 and 18.

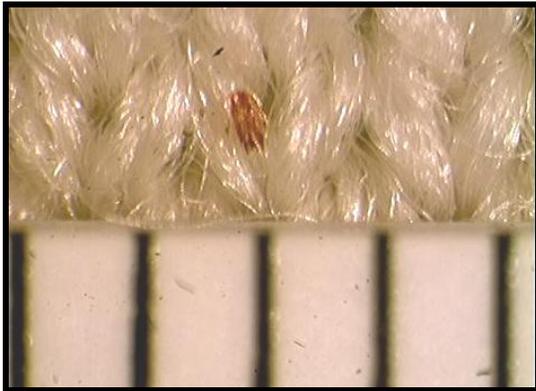


Figure 27. 100% Wool (25x).

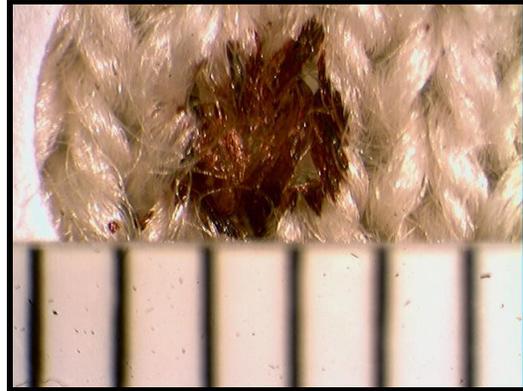


Figure 28. 100% Wool (25x).

Some transfer stains were of sufficient volume to saturate through the thickness of the fabric giving the appearance of spatter. This distinction can be especially difficult when examining fabrics with dense construction. The stains on the silk in Figures 29 and 30 were created by compressing the fabric with the end of a bloody paperclip.

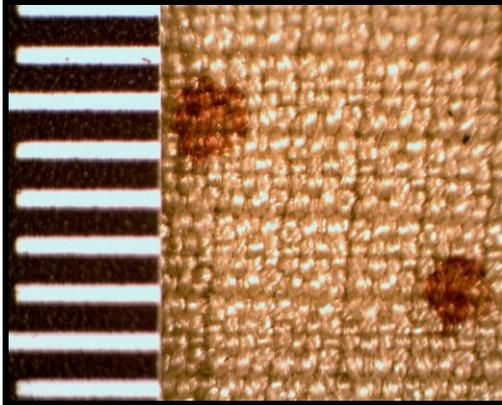


Figure 29. Transfer on 100% Silk (16x).

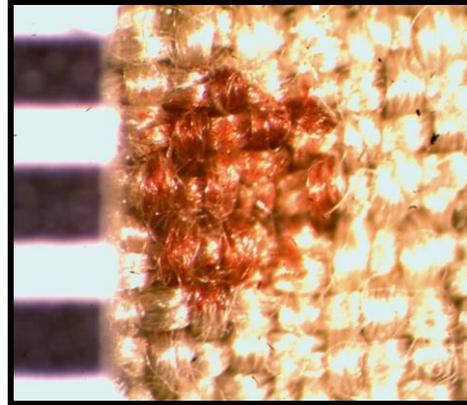


Figure 30. Transfer on 100% Silk (40x).

The “spatter-like” stains in Figures 31, 32 and 33 were created by compressing the fabric with the end of a swab stick saturated with blood. Similar results were obtained with the cotton/polyester blends.

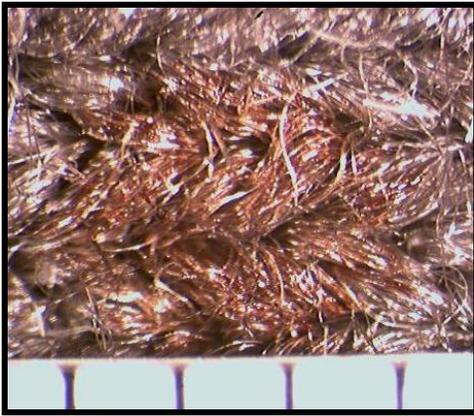


Figure 31. Transfer on 100% Acrylic (25x).



Figure 32. Transfer on 100% Acrylic (25x).

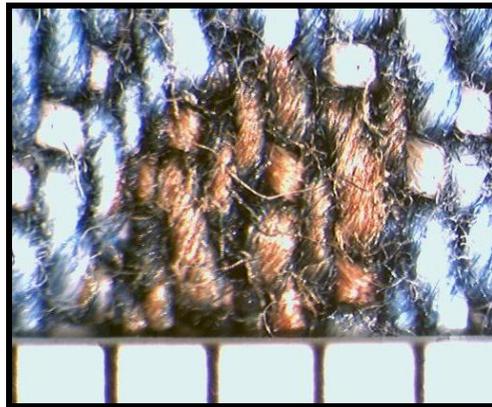


Figure 33. Transfer on Denim (25x).

Discussion

When examining bloodstains on clothing, penetration into the weave/knit of the fabric is considered characteristic of spatter, while transfer stains created by simple contact with a bloody object or surface are typically limited to the top of the weave/knit. (3) This study demonstrated that the size of the spatter was also a factor in the location of deposition of individual stains. Sub-millimeter spatter can routinely be deposited only on the top of the weave/knit. This is a function of droplet volume, not the mechanism by which the stain was created. Therefore, caution should be used when evaluating very small (small volume) stains. Examination of multiple stains of various sizes should be performed prior to determining the mechanism by which the stains were created.

Consideration must be given to the quantity of stains and their distribution. Spatter and transfer stains mimicking one another were easily created in this study. When individual spatters are examined alone, the chance of misidentification is greater. Again, examination of multiple stains should be performed prior to determining the potential mechanism. As the number of stains (data points) increases the more confidently the analyst can state his or her opinion.

Making the distinction between spatter and transfer stains on items of clothing should be done with caution. The overall appearance of individual stains including size, shape, and penetration of the weave/knit, should be considered together with the characteristics of the fabric on which they are deposited. These physical characteristics along with the overall distribution of the stains should be evaluated in the context of the factors of the specific case. Experimentation with fabric of similar type and condition is certainly encouraged when examining items specific to case work.

This study found that the appearance of blood stains on clothing is influenced in part by the construction of the fabric. Both absorbency and texture appear to be factors. The role that each characteristic plays independently is beyond the scope of this study. Limited to eleven fabrics, this study is a very small representative of surface textures potentially encountered in forensic case work. Examination of upholstery and other common household fabrics, including fabrics with “stain repellent” treatments are areas for further study.

REFERENCES

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