Technical Note

Comparing Two Alternate Light Sources with Bluestar Forensic: Locating Blood in a Manipulated Crime Scene

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Abstract: An experiment was conducted during a training exercise with the goals of locating and photo documenting the presence of blood in a crime scene that had been cleaned up (manipulated). Blood was deposited on walls as transfer stains and as handprints, and the walls were then painted. Bloody footwear prints were deposited on a carpeted floor, and the carpet was then cleaned using an industrial carpet cleaner. The walls and carpet were searched with two alternate light sources (ALS) and Bluestar Forensic to determine whether the presence of blood could be detected. The bloodstains covered by paint were able to be visualized with both of the ALSs and the Bluestar Forensic. The bloodstains on the carpet were made visible only by the use of Bluestar Forensic. Bluestar Forensic provided the best photographic results.

Introduction

Blood is one of the most common bodily fluids located in crime scenes. Research has been conducted in which both an alternate light source (ALS) and luminol were used to detect blood through multiple layers of paint. Timmons [1] and Howard [2] primed and painted new drywall for their testing procedure. Timmons and Howard had success detecting blood through multiple layers of paint, up to eight. In the case of Timmons, researchers were able to recover a usable sample for DNA testing. These conditions (the use of new drywall, priming, and painting) have been a common standard for most of the past research in this area. However, these pristine conditions are not what the crime scene investigator (CSI) in the field will encounter a majority of the time.

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Most bloodletting events are dynamic in nature. When they occur in a confined space (e.g., a room), blood can and likely will be deposited on multiple surfaces. If a suspect is meticulous enough to paint over spatter on walls, it is believable that he or she would also replace or clean the flooring.

There are two common methods of detecting latent blood: (1) the use of an ALS and (2) chemical reagents sensitive to the properties in blood (i.e., luminol and Bluestar Forensic). Tobe et al. [3] examined six presumptive blood-testing reagents for their sensitivity and ability to maintain a DNA profile. Tobe's findings indicated that the sensitivity of Bluestar Forensic far exceeded the claims by its manufacturer of 1:1000 [4], while maintaining the DNA profile of the host.

Materials and Methods

The goal of this project was to simulate real-world conditions encountered by the CSI. After inspection of the residence, it was determined that there was no paint left over from the last time the residence had been painted, which would have been optimal for experimental conditions. In the absence of paint on site, several of the apartment complexes in the surrounding community were contacted and a city-wide survey was conducted as to which brand, color, and finish of paint was most commonly used. The city's housing authority and rental management companies were also contacted. It was determined through this survey that the most common paint was from Sherwin Williams, white in color, with a satin finish. For the purpose of this project, a donation of this paint was received. The donated paint was a half used five gallon bucket of Sherwin Williams Interior Contractor Satin Extra White paint (Sherwin Williams, South Bend, IN). A Rug Doctor (Rug Doctor Wide Track Carpet Cleaners) and the recommended cleaning chemicals (commonly used in the area; Rug Doctor Oxy-Steam Carpet Cleaning Solution) were rented or purchased, respectively, from the local Walmart. An attempt to acquire human blood was made, but because of a blood shortage in the local blood banks, there was no expired blood to be obtained, therefore, bovine blood was selected. The bovine blood (DC Meats, Osceola, IN) was anticoagulant free and had not been chemically altered. Coagulation potential was eliminated by the removal of the platelets from the blood at the slaughter house before shipment to local meat markets.

The front room of the residence was selected because of the ease in blocking out ambient light that would be transmitted through windows and doorways. Removing nearly all of the ambient light allowed for easier visualization of chemiluminescence from the Bluestar Forensic and visualization of the bloodstains with the ALS. (Both the ALS and the Bluestar Forensic require an area of near darkness to be the most effective.) The room was divided into four areas for experimentation on the walls as well as the floors. A fifth area of the floor was sectioned off as a "safe zone" (i.e., where no blood or chemicals would be deposited, leaving space for participants and equipment). The room was separated into four areas to accommodate four groups of local CSIs who would be using the discussed techniques to locate latent and cleaned up blood as part of a training exercise. Each wall area was subdivided into four sections. The subdivided sections included a control area (that would not be painted over) and three other areas receiving various layers of paint. Section 4 would completely conceal the blood, whereas sections 3 and 2 would have one and two less layers of paint, respectively.

Blood was deposited in each section in two different ways. An assistant was dressed in a Tyvek suit. Blood was applied to the left shoulder and scapular area using a standard dish sponge. The assistant then simulated being pushed into the wall, leaving behind a transfer stain. Also deposited on the wall was a handprint. Using the same sponge, a bare palm was covered in the blood and pressed against the wall in hopes that some ridge detail would be retained in the print (Figure 1). In order to deposit the footwear prints, blood was sponged onto the bottom of a shoe and a step was taken. Prior to each step being taken, blood was sponged onto the shoe again by an assistant. Two six-foot sections of footwear prints were created, each section containing both left and right footwear prints to simulate walking. The area of carpet containing the footwear prints was divided into four sections (Figure 2). All of the deposited blood was allowed 24 hours to dry, giving the hypothetical suspect time to dispose of the body and return. Figure 3 shows the complete room setup.

Figure 1
Transfer stain and handprint deposited in four sections of area 3.

Figure 2
Footwear prints deposited in a walking pattern.

Figure 3
Complete room setup showing areas 1 to 4 and deposited footwear prints.

The bloodstains on the wall were painted over using a 3/8" nap roller (Home Depot, South Bend, IN) and Sherwin Williams paint. In order to maintain a consistent painting method, the same person painted each area and each layer. Three layers of paint were needed to conceal the bloodstains. The wall sections were control (no paint), one layer, two layers, and three layers of paint (Figure 4).

The carpet was cleaned using a Rug Doctor carpet cleaning machine. The manufacturer's instructions were followed and the recommended Rug Doctor carpet cleaning chemicals were used. The carpet cleaner was repeatedly used to clean the left footwear prints until they were no longer visible. Usually, two passes were needed but some prints needed three or four. Once the cleaning was complete and the left footwear prints could no longer be seen, there were only right bloody footwear prints (control samples) for each of the four groups (Figure 5) that were visible. Lastly, all of the windows, doors, and openings to the room were covered in black plastic to minimize the ambient light that entered the room.

Three different instruments were selected to search the manipulated areas for the now latent bloodstains on the walls and the carpet. First to be used was a Battle Light (Arrow Head Forensics, Lenexa, KS) that is wavelength specific to 455 nm. (The Battle Light is an initial search tool used by South Bend Police CSIs and nearby agencies.) The second instrument was a Mini-Crimescope (Spex Forensics, Edison, NJ) with wavelengths between 400 to 500 nm. The Mini-Crimescope has more wavelength specificity (420 to 430 nm is the peak absorption for blood), thus providing a much more powerful light to penetrate the layers of paint and carpet. The third and final processing method was the application of Bluestar Forensic (Bluestar Forensic Mini Kit, Monte Carlo, Monaco). Bluestar Forensic was sprayed on the walls and flooring as a search tool and as a presumptive test for blood. The Bluestar Forensic used was new, out of the box, and mixed on scene using the manufacturer's instructions.

The resulting chemiluminesence observed in the three methods was photographed using a Nikon D7000 DSLR (Nikon Corporation, Tokyo, Japan) and a Tiffin Orange 21 Longpass filter (The Tiffen Co., Hauppauge, NY) when needed. The camera was mounted on a tripod head.

Figure 4

Covered blood stains in sections 2, 3, and 4 of area 3. Section 1 was a control with no paint, section 2 had one layer, section 3 had two layers, and section 4 had three layers of paint completely concealing the bloodstains.

Figure 5

The left footwear prints were cleaned with an industrial carpet cleaner. The total area was divided into four areas with blue tape. The right footwear prints were left unaltered as a control.

Results

Visualization of Bloodstains on Walls Using an Alternate Light Source

The 455 nm wavelength Battle Light yielded minimal results. A few darkened areas were visualized under the paint that were consistent with visual properties of blood, but the intensity and contrast were not significant enough to be documented in a photograph or definitively conclude that the areas were bloodstains. The use of the Battle Light did provide enough detection that would lead a CSI to use the higher intensity Mini-Crimescope to further investigate.

The Mini-Crimescope provided a light that was much more intense than that of the Battle Light, and it was able to penetrate the three layers of paint more easily. Two distinct areas with the visual characteristics of a bloodstain were visible. The area higher on the wall was determined to be a transfer stain. The area lower on the wall was consistent with a handprint. Fingers and the outline of a palmprint were visible. Enough detail was present to determine that the handprint was made by a left hand, but ridge detail was not present. There was limited pattern definition in the larger transfer stain, which only provided the ability to determine size, shape, and height from the floor.

Photography was attempted to record the results that could be seen with the use of both alternate light sources and orange colored glasses or filters. In some photographs, the presence of stains could be seen, but defining shape and size in the photographs proved difficult. In Figure 6, camera settings were aperture f/4.5, shutter speed of 10 seconds, and ISO 400; in Figure 7, camera settings were aperture f/4.5, shutter speed of 10 seconds, and ISO 200.

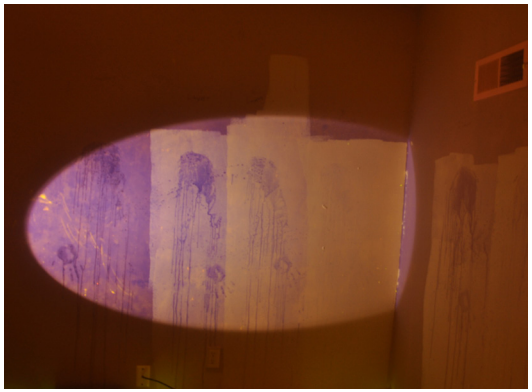

Figure 6

Overall view of area 3 using an alternate light source with a 420 nm wavelength light and a Tiffin orange 21 filter to view and photograph the bloodstains through the paint in sections 1 to 4.

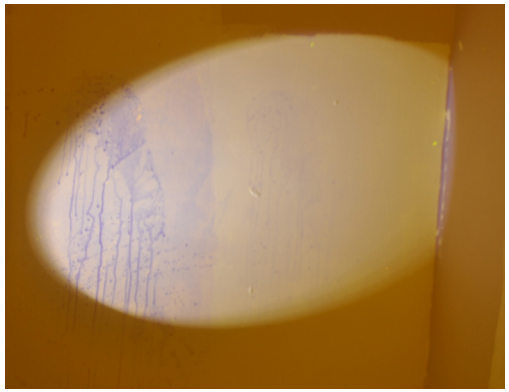

Figure 7

Sections 3 and 4 of area 3 illuminated with an alternate light source with wavelength of 420 nm viewed through a Tiffin orange 21 filter. Section 4 shows darker areas where light was absorbed because of the biological materials that were not visible in regular daylight conditions.

Visualization of Bloodstains on Walls Using Bluestar Forensic

It took approximately 10 seconds for the Bluestar Forensic to penetrate the three layers of paint and to begin to display a chemiluminescence. Bluestar Forensic provided some distinct patterns (e.g., the handprint and initial point of contact for the transfer stain). The use of Bluestar Forensic allowed for class characteristic determinations (e.g., size and shape) to be made. Fine detail needed for individualizing characteristics or bloodstain pattern reconstruction was not present. The results obtained with Bluestar Forensic were easier to photograph than were the results obtained with the ALS. In Figure 8, camera settings were aperture f/4.5, shutter speed 10 seconds, and ISO 200; in Figure 9, camera settings were aperture f/4.5, shutter speed 10 seconds, and ISO 2000.

Visualization of Bloodstains on Carpet Using an Alternate Light Source

Two forms of ALSs were used to detect bloodstains on the cleaned sections of carpet. First was a 455 nm Battle Light, which yielded negative results. Second was a Crime Scope with wavelengths between 420 to 430 nm, also yielding negative results.

Visualization of Bloodstains on Carpet Using Bluestar Forensic

Bluestar Forensic was applied in the same areas previously searched using the ALS. The chemical reaction with the latent bloodstains was almost immediate and resulted in a brilliant blue chemiluminescence. In this instance, the application of Bluestar Forensic allowed for size, shape, and left or right shoe to be determined. Some of the tread pattern was distinguishable. There was enough detail present to determine class characteristics (e.g., size and manufacturer of shoe). However, there was not enough detail for individual characteristics to be recorded. Camera settings for Figure 10 (a) were aperture f/4.5, shutter speed 10 seconds, and ISO 200; camera settings for Figure 11 (a) were aperture f/5, shutter speed 15 seconds, and ISO 1000. Figures 10 (b) and 11 (b) were enhanced in Adobe Photoshop to distinguish between the control area and the cleaned area more easily.

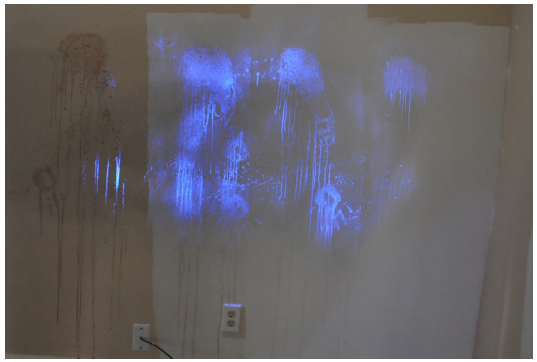

Figure 8

Bluestar Forensic was applied to sections 2, 3, and 4 of area 3. Bluestar was allowed time to penetrate the multiple layers of paint and to react with the blood underneath, resulting in the brilliant blue chemiluminesence.

Figure 9

A second application of Bluestar Forensic was applied to section 4 of area 3. The additional time and Bluestar allowed for better visualization of the handprint in section 4.

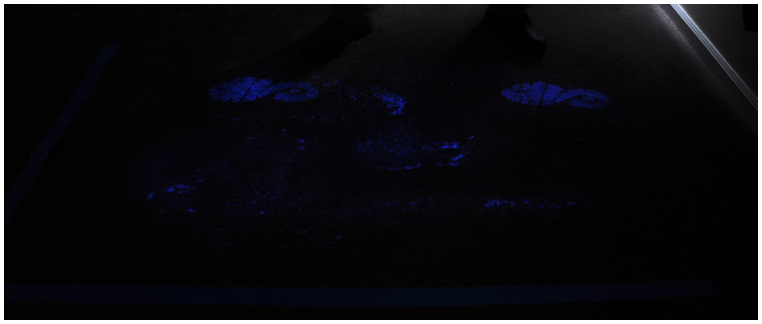

Figure 10 (a)

The control area of bloody footwear prints can be seen above the cleaned and latent section of bloody footwear prints. In the cleaned areas, Bluestar was able not only to detect the presence of blood but was also able to provide class characteristics of the cleaned prints.

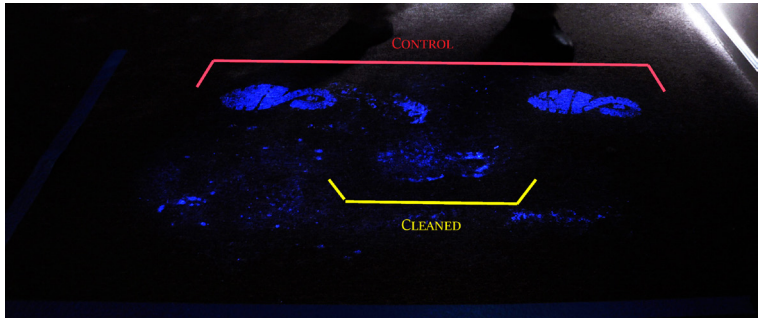

Figure 10 (b)

Same image as Figure 10 (a) but has been annotated to label areas of the control and cleaned prints. The histogram was adjusted (using Adobe Photoshop) to better visualize the bloody footwear prints.

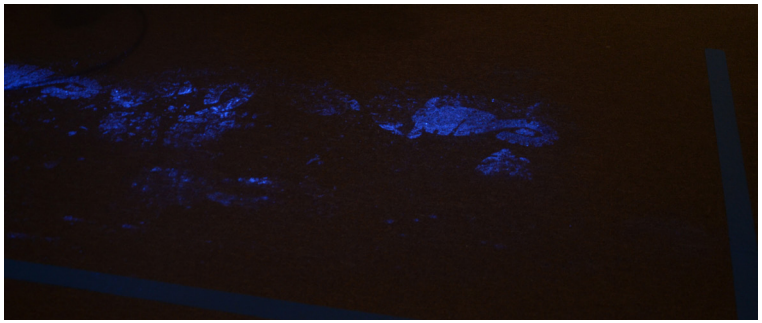

Figure 11 (a)

Area of carpet where not only the control and cleaned sections became visible with the application of Bluestar but also another print that was previously latent and not cleaned came into full view.

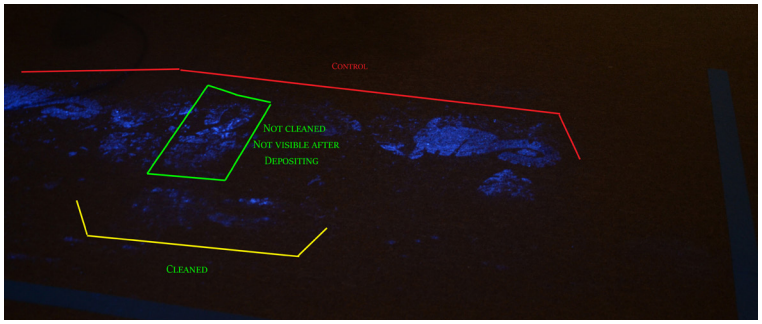

Figure 11 (b)

Same image as Figure 11 (a) but has been annotated to label areas of the control, cleaned prints, and the discovered latent print. The histogram was also adjusted (using Adobe Photoshop) to better visualize the characteristics in the cleaned prints.

Discussion

Great care and time were taken for this experiment and training to as closely mimic real-world crime scene conditions as possible. The intention was to place new and veteran CSIs in an environment that they could face in the field. New products were not purchased (paint, drywall, carpet) and the scene was set up as if the "suspect" used what was already available at the residence to clean up or hide evidence. The largest concession made was the type of blood used. Because of the volume needed for the training, human blood could not be obtained, and bovine was used as an analog. Although the reaction of bovine blood with the ALS and Bluestar Forensic was equivalent to the way human blood would react, the physical viscosity of the bloods differed. Bovine blood is naturally more viscous than human blood, making it difficult to simulate blood spatter patterns and obtain ridge detail in finger- and handprints. In order to prevent coagulation, the platelets had been removed from the bovine blood. This also allowed for it to remain USDA approved for use in foods such as blood sausage. The removal of the platelets added to the viscosity of the bovine blood. For the parameters set out for this training–locating and documentation of the presence of blood–the bovine substitute was acceptable.

We were not able to visualize individualizing characteristics in the handprints that were deposited on the wall. This is not to say that it is not possible, but rather the viscosity of the bovine blood may have played a significant factor. Because the clotting factors had been removed from the bovine blood, it did not have the ability to begin to coagulate on the hand and stay in place on a vertical surface. Once deposited, the vertical surface also played a factor in eliminating individualizing characteristics. In this case, gravity, combined with the viscosity, caused one ridge to flow into another, eliminating the ridge detail needed for comparison. The control section, as well as the others that were visible through the paint, provided visual proof that the detail and characteristics of the transfer stains were consistent across all four sections, and the act of painting over a dried stain did not affect its characteristics. The benefit for the local CSIs was the greatest for those having little experience detecting blood with an ALS. The multiple paint layers allowed the CSIs to see the progression, and at the end of the training, they were able to recognize the areas that should be further tested as possible concealed blood evidence.

The footwear prints on the floor retained more of their original size, shape, and tread pattern than did the transfer stains on the wall. In the application of the footwear prints, gravity did not play a factor in reducing the fine detail in the prints although viscosity did still play a factor. Carpet is a porous, hydrophilic material that will wick liquids into and from fiber to fiber. As the blood was absorbed into the carpet fibers, the fibers next to those that had been stained began to wick the blood away from the original location. The wicking caused the fine detail and individualizing characteristics to be filled in. The use of the carpet cleaner drastically altered the amount of detail present in the latent prints. The amount of detail in the latent prints was far less than the detail found in the control prints, however, size, right or left shoe, and some tread pattern could still be visualized and documented.

Limitations of the Battle Light as a preliminary search tool were discovered. For scenes that have not been manipulated, it is a good preliminary search tool for fibers, blood, semen, and other biological fluids. In a manipulated scene, the CSI needs to rely on his or her training and experience to assist in the identification of latent blood or bodily fluids. The intensity of the light emitted from the Battle Light was the largest inhibiting factor. Enough energy was not produced to penetrate the paint and to react with the blood underneath the paint.

The Mini-Crimescope worked well in visualizing the covered bloodstains on the walls but was unsuccessful in detecting latent blood on the carpet. Perhaps this was because of the carpet itself. Blood does not provide fluorescence. Blood absorbs light and appears as a darkened area. The carpet was a moderate brown with specks of darker colors woven into it, which could have created enough background noise so that the darker bloodstains could not be visualized. Also, the carpet was severely worn and dirty. The thickness of the carpet and any underlying padding and material were very thin, which could have allowed for the industrial carpet cleaner to dilute the blood to the point where it simply could not be visualized using an ALS.

Bluestar Forensic was successful in detecting latent blood. However, Bluestar Forensic is a liquid and is affected by gravity, making it difficult to concentrate the chemical on the areas of interest on a vertical surface. It was not possible to determine a point of convergence or origin of the bloodstains because of the fluidity of the Bluestar Forensic and the viscosity of the blood. On a flat surface (e.g., the carpeting), Bluestar Forensic worked well.

Conclusion

A Mimi-Crimescope and a bottle of Bluestar Forensic can be easily taken to a scene by CSIs or a dedicated unit. The use of Bluestar Forensic provided the best results for easy photography and visualization even with the challenges of the vertical wall. With a moderate amount of training in the use of a DSLR camera, ALS, and Bluestar Forensic, CSIs will be able to use the discussed techniques to locate and document biological evidence in a manipulated crime scene.

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