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REVIEW ON COMMON BLOODSTAIN PATTERNS DOCUMENTED AT A CRIME SCENE

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ABSTRACT

The detailed study of bloodstain patterns obtained from a crime scene could prove to be invaluable evidence for part/full crime scene reconstruction, in testing the credibility of the statements of the victim, suspect, bystander/eyewitness (if any). Locard's exchange principle states that "every time an individual makes contact with another person, place or thing, it results in an exchange of physical materials" (Welding, S.2012). The study of evidence at a crime scene is particularly based on this principle. Bloodstain pattern analysis is defined as 'the scientific study of the static consequences resulting from dynamic blood shedding events' (Norby,J.J.2006). A reference database of bloodstain drip pattern on different types of fabric (i.e. fabrics made from natural fiber,man-made fiber, fabrics used for industrial purposes), is created. A bloodstain pattern is defined as 'a grouping or distribution of bloodstains that indicate through regular or repetitive form, order, or arrangement the manner in which the pattern was deposited'(Amin T.M. & Sirs, J.A.1985). Based on the different case studies presented at the IABPA conference (Barksdale, L Sims,E. &Vo, C,2004) the authors are of the view that of the different types of bloodstain patterns, the most common stain patterns visible at the crime scene, particularly in the case where the victim was found to suffer blunt force injuries, are saturation, impact, cast off and transfer stain patterns. This paper discussed various bloodstain patterns on difference surfaces in a crime scene.

Keywords: Blunt objects, Fabrics, Bystander, Perpetrator, Room and Victim, Foot Prints

Dataset of Blood drip patterns was created using fresh pig/porcine blood that was subsequently treated with two different types of anticoagulants (Warfarin (orally administered) and Heparin Injection (intravenous)) and the effects of different dosage of the anticoagulant medications on the stain pattern on non- absorbent paper surface was accordingly recorded by varying the angle of impact and fall height. The day temperature and humidity shall also be recorded during the experimentation by the use of a hygrometer. A statistical analysis highlighting if there is a statistically significant difference in the stain patterns cast when the dosage of anticoagulant is varied shall be carried out Weapon transfer stains in a crime scene are often difficult to interpret. Given the large number of hammer hit events that take place each year, this work is largely aimed at analyzing the different factors that influence and distort regular hammer transfer stains. Different physical mechanisms under identical conditions influence the formation of distinct transfer stain patterns. This is the basic highlight of this study. By experimentation, the authors are of the view that the quantity of blood attached to the surface area of a hammer, the surface area of the hammer exposed to blood, the dimensions of the hammer, the angle of inclination at the time of fall, hardness of the target surface, friction coefficient of the hammer material, texture of the target surface influence the transfer stain formed. Again the velocity of hit, the undulations in the hammer, the depth of blood pool, hammer weight all have significant effect on the transfer stain pattern formed. The significance of the height of fall and the edge that touches the target surface first, cannot be particularly ruled out in analyzing hammer transfer stain patterns. The relevance of the article lies in the fact that analysts having clear idea of how these different factors could affect the formation of different weapon transfer stain patterns, shall be in a better position at understanding the probable mechanism that might have led to the formation of the stain. This knowledge is transferable to the study of other murder weapon transfer stain interpretation and shall aid proper sequencing of segments in a criminal event.

Each particular type of fabric can be divided predominantly into two types – woven and knitted based on the weave of the cloth. We take the weave of the fabric into consideration because it has been previously noticed that the fabric type, weave of the fabric, position and volume of blood dropped influence the stain pattern formed. For each fabric type, fabrics of four shades in particular are obtained. They are – white, gray, maroon, black. The shades may vary depending on the availability of the cloth in a particular shade, variance due to weave of the cloth, natural color of the fiber etc. We intend to stain two light colored fabric pieces and two dark colored pieces, to record how the color of the fabric affects visibility of stains to the naked eye Also we plan to use 3 different types of the same cloth – new, worn out

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(washed 8 times), sweat stained cloth washed 2 times, to record the same type of stains. From previous research we expect these different types of clothes to have very different stains although the stains might have been dropped using the same mechanism, under similar temperature , humidity and wind condition keeping the volume of liquid dropped , blood column , fall height, angle of impact constant .

Many image processing techniques have been developed over the past two decades to help forensic scientist in detection of footprint image boundary. Most studies conducted have proven that measurement of parameters may help detection of crime scenario. Computer-aided recognition systems for footprint analysis have been the focus of several research endeavours and it based on the idea of processing and analysing Footprint images for a quick and accurate recognition. Footwear impressions are among the most commonly found evidence at crime scenes and present more frequently than finger prints. Identification is based on the physical match of random individual characteristics of the shoe has acquired during its life.

Review of Bloodstain Patterns Documented

The authors used porcine blood for the experiments because porcine blood is quite similar to human blood (Christman, DV, 1996 and Amin TM, & Sirs JA, 1985). Blood was legally procured from Kolkata Municipal Pig Slaughter House, Tangra Kolkata, India. Given that fresh blood coagulates over time, 1100 IU of Heparin Injection was added to fresh pig blood to preserve the colloidal consistency of blood. It might be interesting to mention that adding anticoagulant does not alter the viscosity and specificity of the Non-Newtonian fluid,blood.

While Daniel Holstein, senior crime scene analyst in Metro police and a certified expert in bloodstain pattern analysis, gave the case a new dimension by focusing on the hammer imprint that matched the size of the hammer that lay close to the apparent victim's hand, Thomas Pitaro the defense attorney clearly marked out that the hammer imprint theory was not mentioned in the police report and was only added much later (Toplikar, D. 2010). There are two lessons to be learnt from the juridical proceedings of this particular case. Firstly, transfer stains often go unattended and hence unrecorded by most law enforcement officials. Secondly, when analyzed in relation to suspect, eyewitness testimony or other relevant circumstantial evidence, weapon transfer stains could actually give criminal juridical proceedings a new dimension (Toplikar, D. 2010), a new perspective. Along with the study of the variation of bloodstain patterns formed on different textured surfaces (i.e. plain/smooth, rough, porous etc.) they have also provided valuable insights on how bloodstain patterns vary with difference in impact angle, fall height, target surface properties, quantity of blood etc. (Bevel, T, & Gardner, RM, 2002). Apart from briefing on the importance of the target surface texture and murder weapon dimensions in the formation of a stain, they have also provided important aids for sequencing available stain patterns at a crime scene in accordance with other relevant circumstantial evidence (Bevel, T, & Gardner, RM, 2002).

To be more precise, when the target substance is softer and the initial impact force exceeds the normalforce, cracks and dents are formed. Hence bloodstaintransfer pattern is particularly affected by the variationin the quantity of blood attached to the edge, initialimpact velocity, and relative hardness/softness of thetarget surface material(Bevel, T, & Gardner, RM, 2002).When the same amount of blood was allowed todrop from a height of 10 cms and a height of 100 cms,a difference in the size/diameter of the blood drop wasrecorded. From practical experience, the authors are of the opinion that in the absence of a murder weapon at the crime scene, study of other circumstantial evidence such as wound analysis, absence/presence of objects at a crime scene, cast off patterns, drip trails, impact spatter etc. in correlation with weapon transfer stain patterns (if any) shall help analysts in identifying the most probable tool that has been used for the murder or for injuring the victim who might not be in a position to narrate the sequence of events. Based on analysis of weapon transfer stain patterns, the factors highlighted in this study shall help pattern analysts in part/full sequencing of probable events that might have occurred at the crime scene. Hence, this study shall aid effective part reconstruction of criminal events.

In the IABPA Conference held in Tucson, Arizona, 2004, Peter Lamb presented the investigation report of the late night assault of a young man who was intoxicated at the time of attack and could only recollect part of the savagery that he had been subjected to (SWGBPA,2009). Due to rain drop that had soaked the garment at the time of the assault it was difficult to examine the bloodstains on the soaked garment. However there was evidence of kicking and stomping. Based on the evidence the case finally proceeded for trial and the accused was proved guilty and hence imprisoned. In his review of the Windsor city homicide case Scott Lamont pointed out that barefoot transfer impressions and footwear transfer impressions were found on the floor[6(SWGBPA,

2009)]. In a violent crime scene with sufficient amount of bloodshed, bloodstain pattern analysis often plays a significant role in proving or refuting the statements of the suspect, victim, bystander/eyewitness(if any) within the juridical setting. The stains along with the wound suffered by the victim/s could also be used for part/full reconstruction of crime scenes. These case studies particularly set out the background for this review paper. By way of experience, an individual can clearly understand the difficulty of visualizing bloodstain patterns on dark coloured fabric. Researchers assess the contrast between bloodstains and different dark colored fabrics at defined wavelengths over the visible and near infrared range. The automated software that the authors intend to build shall take as input digital as also infrared images and be able to automatically trace out bloodstain patterns thereby improving the toolkits in use for locating and enhancement of bloodstain patterns, visible or latent, on all types of difficult surfaces.the stain type we can see or might expect to see on the clothes of an individual.

when he is a victim, perpetrator or a simple bystander in the event of a head hit of a victim using a stick, rod, axe etc. (The instruments of head hit shall be decided in discussion and study of court proceedings of several violent cases that have so far been solved) in an indoor setting. Based on the velocity of hit, stain type on cloth of an individual, number of hits, distance between the victim , perpetrator and bystander, relative position of the three at the time of hit, movement of any party before probable subsequent hits, direction of movement of weapons and people, room temperature, humidity, room dimensions, person height ,weight ,using Bayesian networks, correlation and regression we would try to probabilistically infer the position of an individual (victim, perpetrator, bystander(if any)).

Identification is based on the physical match of random individual characteristics of the shoe has acquired during its life. The only thing consistent about crime scenes is their inconsistency. Because of their diversity, crime scenes can be classified in many ways. First, crime scenes can be classified according to the location of the original criminal activity. This classification of the crime scene labels the site of the original or first criminal activity as the primary crime scene and any subsequent crime scenes as secondary. This classification does not infer any priority or importance to the scene, but is simply a designation of sequence of locations. If the outsole pattern of a shoe can be determined from its mark, then this can significantly narrow the search for a particular suspect. The current practice is that forensic examiner collects and preserves footwear and tire tread impression evidence for makes examinations, comparisons, and analyses in order to identify or eliminate a shoe, or type of outsole, as the source of an impression, determine the brand or manufacturer of theoutsole or footwear, link scenes of crime, and write reports and provide testimony as needed.

A study of the variation of bloodstain patterns formed by footwear impression on different extured surfaces (i.e. plain/smooth, rough, porous etc.) they have also provided valuable insights on how bloodstain patterns vary with difference in impact angle , fall height , target surface properties, quantity of blood etc. Footwear impression evidence could also be effectively used to support or contradict the probable reconstruction put forward by an expert witness. Based on photographic impression Forensic analyst requires comparison of this image against specific databases. These databases include: (i) marks made by shoes currently and previously available on the market and (ii) marks found at other crime scenes. Normally an image of a shoe mark can be obtained using photography, gel, or electrostatic lifting or by making a cast when the impression is in soil. Footwear imagescollected directly from crime scenes are of poor quality. Theenvironment under which the questioned shoe print is lifted at
the crime scene is different from those available in the knownprints. One approach is to design digital image enhancementtechniques, such as contextual thresholding, to enhance thequality of questioned shoe-prints to achieve feasibility ofmatching shoe-prints in the database. Debris and shadows andother artifacts in the crime scene impressions are difficult toalter out from footwear impressions. They have interferedwith attempts to store and search in the database. Therefore,after digital image enhancement, some algorithms are desiredto be able to classify different regions of footwear impressionto be one of two types: useful regions (impressed by footwear)and discard able regions (impressed by other artifacts such asdebris).

CONCLUSIONS

The fact that blood follows the laws of fluid mechanics and reacts similarly under similar physical conditions forms the basis of bloodstain pattern analysis. From the literature and from case study experience the authors conclude that the basic most common bloodstain patterns that an individual can expect to see when an individual is hit by a blunt ended object are– transfer stain patterns from fingers, weapon, saturation stain patterns, impact spatter, cast off pattern and even expirated stain patterns on certain occasions. These can be accompanied by drip trail patterns, flow, wipe and swipe patterns as well. But this work is particularly focused at studying the most common

pattern stain associated with blunt force hit. From literature review it can be safely concluded that various surfaces, concrete, fabric react differently to bloodstain dropped by similar physical mechanisms. There also exist intra- surface differences that impact or rather influence the formation of bloodstain pattern formation. For example, fabrics based on texture, porosity, absorbing power impact the formation of the bloodstain pattern. Again, study shows volume of blood , impact force as also fall height have significant effect on bloodstain pattern formation. On a very loose connect it might be said that when killing an individual with a hammer hit thecriminal might take away the murder weapon with him but at the same time he might end up leaving behind bloody stains of theblood bearing hammer at the crime scene .It is time consuming for analyzing wide variety of footwear impression because of different types of footwear outsole designs. The basic crime scene procedures are physical evidence recognition, documentation, proper collection, packaging, preservation, and, finally, scene reconstruction. Every crime scene is unique and, with experience, a crime scene investigator will be able to use this logical and systematic approach to investigate even the most challenging crime scenes to a successful conclusion.

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