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Review on Bloodstain Pattern Analysis on Fabric

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ABSTRACT: The texture, weave, absorption of fabric as also the volume of blood that drips onto a fabricoften lead to the distortion of stain patterns formed on the concerned fabric. The structure of textile has a profound effect on the formation of the bloodstain pattern. This paper presents a review work on Bloodstain Pattern analysis on fabric.

KEYWORDS: Anticoagulant, Fabrics, and t-test

I. INTRODUCTION

Atcrime scenes, in addition tothe various hard surfaces whereblood could be spattered, there are a number of textile materials that could be present, such as cotton jersey Tshirt or denimjeans worn by the victim or suspect, curtains or upholstery, and bedsheets.At a crime scene, the forensic investigators analse the event with the help of a series of physical evidencethat provide potential scenarios. Studies have been published on the interpretation on bloodstain patterns at a crime scene.It is often difficult to interpret bloodstains on Fabric. The texture, weave, absorption of fabric as also the volume of blood that drips onto a fabric often lead to the distortion of stain patterns formed on the concerned fabric. The structure of textile has a profound effect on the formation of the bloodstain pattern. Slemko in his work compared bloodstain patterns formed by similar physical mechanism on a collection of fabric that differ in terms of composition, texture, times worn (i.e. newness), chemical treatment on fabric[1]. But the majorityof them dealt with hard surfaces, such as walls, flooring, tables [1-5].For an analyst,these materials are important sources of information. The estimation of bloodstain distance from source is based upon the bloodstain sizes observed on fabric, which in its turn is directly dependent upon target surface composition and chemical fabric softening treatments[1].

Traditionally this has been analysed inthe same manner as bloodstains on hard surfaces even though these surfaces are verycomplex and do not replicate the bloodstain formed on hard surfaces.Thus, understandingthe pattern development on textile materials is critical. Bloodstains on clothing can provide some insight about the activity, position and movements of the wearer during and after the bloodshed. In the past few years, there have been several high profile homicide trials in which very small bloodstains on clothing have been the centre of the controversial arguments relating to the mechanism of its formation. There is not enough significant literature to contemplate how these individual patterns are produced. For example, how to distinguish the formation of a small drop created by transfer to a secondary layer of fabric or an impact after a drop hits the surface.

In line with Slemko's work the authors conducted an experiment to check how addition of an anticoagulant might alter the formation of stain patterns as compared to the stain patterns obtained from dripping of fresh blood. Given that porcine blood is similar to human blood, the authors used pig blood for the study. Blood was allowed to drip onto a 100% cotton cloth that has been used and washed for around 25 times through a period of 6 months. Blood from a freshly slaughtered pig (i.e. blood without any anticoagulant) was allowed to drip from a height of 20, 40 and 60 cms respectively at an impact angle of 90^o. In order to maintain the same volume of blood in the blood droplet, a drop of blood was allowed to drip from a needle-less subcutaneous syringe full to its capacity (2.5cc.). When a patient requires anticoagulant, Heparin injection is administered as it immediately mixes with blood. When Warfarin is orally ingested, it takes some time to prevent coagulation of blood. So after Warfarin is administered, blood is tested after 2-3 days[2].The final pattern will develop differently due to the wicking and absorbency in textile materials, which include woven, knitted, nonwoven and braided items, leading to a distorted final appearance.The basic study is to provide a fundamental understanding of the complex interaction between textile substrates and individual drops of blood.

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The authors selected Warfarin as an anticoagulant for the study. 4 mg of Warfarin(2 tablets of Warf 2 in powder form) was thoroughly mixed with 500 ml. of fresh pig blood by light stirring over a period of 1 day. The blood with anticoagulant was allowed to drop on a 100% cotton cloth surface from a height of 20, 40 and 60 cms at 90^o angle of impact. The piece of cloth was divided into 2 parts to record and hence compare the stain patterns from fresh pig blood and pig blood mixed with anticoagulant.

As a control case fresh pig blood was dropped at an impact angle of 90^o from a height of 20, 40 and 60 cms. on non absorbent paper surface to record the true dimension of the bloodstain pattern formed.

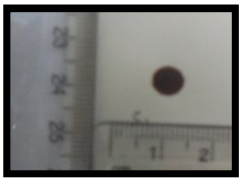
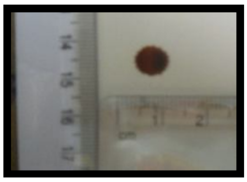
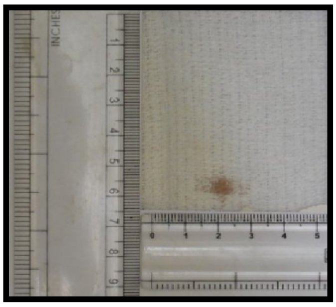
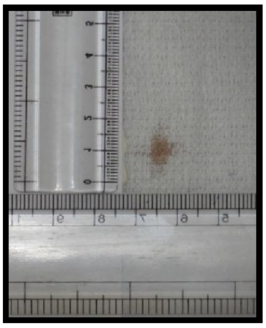
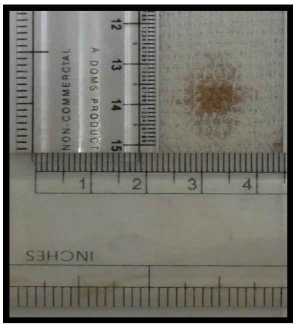
The experiment was performed at the Kolkata Municipal Pig Slaughter House in Tangra.

II. REVIEW WORKS

Dr. Eduard Piotrowski delivered one of the first comprehensive studies in the field of bloodstain pattern analysis (BPA) in 1895 at the University of Vienna entitled “ConcerningOrigin, Shape, Direction and Distribution of Bloodstains Following Blow Injuries to the Head” which stated that blood flung from a weapon would create a specific parabolic arc that would help in determining the direction in which the weapon was being moved [1-2, 6-8].This research was followed by a number of other researchers world-wide, leading up to Dr.Ernest Ziemke’s book chapter “The Examination of Blood Tracks” which stated the importance of bloodstained clothing [1]. Many assert Herbert MacDonell as the father of modern bloodstain pattern analysis. Three significant articles were published in the year 1970 and revised in 1982 after extensive research. MacDonell completed a third work titled Bloodstain Patterns in 1993 [1]. In 1983, the International Association of Bloodstain Pattern Analysis (IABPA) was formed to promote education, training and research in this field [7, 9].A dataset of wipe and swipe bloodstain patterns formed on non-absorbent surfaces (such as non- absorbent paper surface, non- absorbent floor surface, non- absorbent wood surface etc.) shall be developed and an attempt shall be made to understand if thereare any marked stain characteristics that can help analysts to distinguish swipe patterns from wipe patterns. Whether the difference(if any) between the two sets of stains statistically significant shall then be analyzed using t-test, correlation significance values.

III. EXPERIMENTS AND RESULTS

Table 1 represents the bloodstain patterns formed when blood was dropped on 100% cotton fabric surface from a height of 20, 40 and 60 cms at 90^o impact angle in comparison to the control sample formed on non-absorbent paper surface. In line with Slemko’s work, Table 1 represents the distortions in the stain pattern formed using similar physical mechanisms owing to difference in surface texture, composition and absorbency.In 2005, there was a need to combine the existing knowledge about drop size and impact velocity with fluid dynamics and thus, the objective of the research was to develop a method of deducing drop velocity and diameter from bloodstains of known droplet volume and impact height. It was observed that stain diameter and the number of spines on the substrate increases with the increase in impact velocity and droplet diameter

Surface Type	A single drop dripped from a needle-less subcutaneous syringe from a height of **20 cms** at an impact angle of 90°	A single drop dripped from a needle-less subcutaneous syringe from a height of **40 cms** at an impact angle of 90°	A single drop dripped from a needle-less subcutaneous syringe from a height of 6**0 cms** at an impact angle of 90°
Paper			
100% Cotton fabric (Worn)			

C1

F1

Table 1: A comparative representation of bloodstain drops formed when same volume of blood was dropped on non-absorbent paper surface and 100% cotton cloth from a height of 20, 40 and 60 cms respectively[(Stain formed on paper surface -C1(fall height -20 cms) , C2(fall height -40 cms), C3(fall height -60 cms) ;(Stain formed on 100% cotton fabric surface -F1(fall height -20 cms) , F2(fall height -40 cms), F3(fall height -60 cms)]

F2 F3

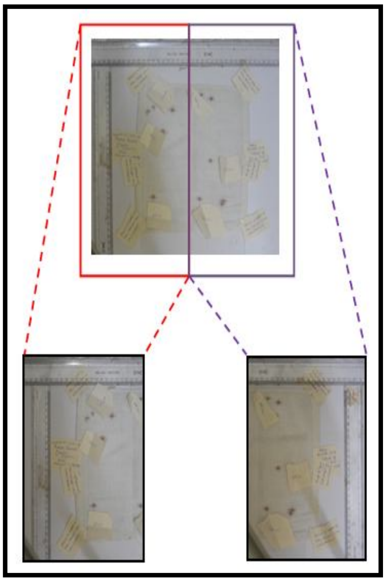


Figure 1: The overall view of the cotton cloth on which the stains were taken.

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The left side contains stains created with fresh pig. The right half of the cloth contains bloodstains created from pig blood thoroughly mixed with anticoagulant as shown in Figure1.

IV. CONCLUSIONS

The work concludes that addition of an anticoagulant does not alter the characteristics of a stain pattern formed, when the anticoagulant is added in controlled proportions. Given that the surface texture, surface absorption capacity, fabric composition together with volume of blood, fall height, velocity at which the droplet hits the surface affect the stain pattern characteristics, the authors intend to develop a database of how absorbent surfaces(i.e. fabric surfaces) react to or rather affect stain formation.

With respect to the control sample that was recorded on non-absorbent paper, noticeable distortion was observed on the fabric surface in both cases. For example, stain dimensions were found to increase with increase in height even on fabric surface. However, no significant difference was recorded between the stain patterns formed with freshly slaughtered pig blood and pig blood thoroughly mixed with Warfarin(4mg) when they were dropped on similar fabric surface even when the stain images were magnified 50 times. Similar experiments were recorded with Heparin injection (130I.U. = 1mg) and similar results were noted. So, in line with Slemko and White's[4] work it can be safely concluded that height of fall, fabric texture, fabric composition, newness, absorption capacity of target surface , volume of blood in droplet does affect the pattern of the stain, but addition of an anticoagulant in controlled proportions does not affect the pattern characteristics .

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