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A time period study on the efficiency of luminol in the detection of bloodstains concealed by paint on different surfaces

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ABSTRACT

Forensic Science is the application of science to the criminal and civil laws that are enforced by police agencies in a criminal justice system. It is a science which relies on physical evidence; one of the important physical evidences being blood. The purpose of this research was to determine the efficacy of luminol reagent in detecting bloodstains on different surfaces, concealed by multiple layers of paint, over a period of time and also to compare the intensities of chemiluminescence exhibited by them. In this study, dry wall, wooden planks and metal surfaces were identified as commonly encountered surfaces at crime scenes and hence 25 of each surface were simulated and blood was spattered, which were then concealed by progressive layers of paint specific to each surface. Thereafter, each surface was critically observed for the intensity of chemiluminescence, following the application of luminol and the results were documented as photographs. The research was conducted for duration of 50 days, in order to study the effect of ageing of concealment upon detection of bloodstains using luminol. Varying intensities of chemiluminescence were displayed by all the three simulated surfaces deposited with paint over bloodstains up to three layers of concealment, depending on the nature of the surface which were captured using photography. The highest intensity of chemiluminescence was shown by concealed bloodstains on dry wall and metal surfaces, despite the number of layers of concealment. However, an increase in the number of layers of concealment produced a significant decrease in the intensity of chemiluminescenece displayed by the bloodstains concealed by paint upon reacting with luminol on metal sheets, which was not found to be uniform and consistent on the other surfaces. These findings highlight the fact that bloodstains concealed by paint could be effectively detected by luminol reagent, despite the nature and ageing of concealment and thereby provide a lead to the investigation.

1. Introduction

Forensic science is an umbrella term that covers many areas of traditional science and melds them together. Although most of the techniques used here have been borrowed from other science [12], many of them have been developed and perfected principally for forensic purposes [18].

Physical evidence is the most crucial aspect, which forms the basis of forensic science. Different types of physical evidences can be encountered at the scene of crime; any of which could contribute as an important factor in solving the crime [6]. The various types of evidences encountered often include documents, glass, fibers, hair, paint, fingerprints, blood, tool marks, etc.; blood being the most commonly encountered evidences specifically in violent crimes such as murder and assault [10,19]. Blood can be encountered in the form of stains, pools, prints, spatter, etc [3].

Visible blood stains can be identified using preliminary tests such as Benzidine test [21], Kastle Meyer test [8], which cannot be directly applied to invisible or cleaned off bloodstains as they need to be detected prior to identification [13]. One of the most commonly used techniques by the perpetrators to conceal bloodstains is using paint [4]. It would be a challenging task to detect the presence of blood stain under multiple layers of paint concealment. However, a specific reagent can be used to overcome this challenge of concealment or cleaning up of blood evidence, which is known as luminol [2].

Luminol is a chemiluminescent reagent that can be utilized both as a presumptive test for blood as well as a method of chemical enhancement of impressions in blood on various surfaces [14]. It is an excellent search technique for latent blood stains at

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crime scenes or those scenes where it is suspected that attempts have been made to clean or conceal blood stains from an area [11]. Luminol is a powerful reagent having the ability to detect any traces of blood irrespective of concealment and cleaning efforts. Luminol is highly sensitive that blood can be detected even at a dilution of $1:10^6$ [9]. The reagent reacts with blood to give a bluish chemiluminescence, which aids in the detection of blood traces.

Many studies have been conducted on the best photographic method to document luminol chemiluminescenece [7,15] common interferences by domestic and environmental agents for the luminol test [17,5], restoration of bloodstains detected under paint using luminol [1], effect of ageing of bloodstains on luminol test [16]. This study intends to study the effectiveness of luminol test by taking into consideration the nature of substrate, the extent of concealment as well as the ageing of concealment and the bloodstains.

2. Objectives of the study

The research involved a time-duration study of 50 days which was conducted:

- To determine the efficiency of luminol formulation to detect bloodstains concealed by multiple layers of paint.
- To observe and compare the intensities of chemiluminescence produced when bloodstain on different surfaces reacts with luminol.
- To observe if the nature of the surface (porous/non-porous) had any impact on the intensity of chemiluminescence produced during luminol test
- To study if "time since concealment" affected the intensity of chemiluminescence produced by luminol.
- To observe if the type of paint on the surface containing the blood stain would affect the intensity of chemiluminescence produced.
- To do a comparative study of the chemiluminescence produced by surfaces coated with increasing layers of paint for concealment.

3. Materials and methods

3.1. Materials

- **Concrete blocks**: Cement blocks made of portland cement and aggregate.
- **Wooden planks**: Plywood sheets.
- **Metal sheets**: Stainless steel sheets.
- **Paint**:
  a) White distemper for cement blocks.
- White enamel paint for wooden planks (Asian paint).
- White automotive paint for metal sheets (Asian paint).
- Wood primer (Asian paint).
- **Blood:** Animal (fowl) blood was taken as the main aim of the study was to determine the efficacy of a presumptive (luminol) test only.
- **Luminol:** Grodsky formulation.
- **Camera:** Digital single lens reflex camera with a tripod stand was used.

4. Methodology

4.1. Phase 0: schedule of the study

The study was scheduled to be conducted for a period of 50 days; in order to study the effect of ageing of bloodstain as well as the concealment on the chemiluminescence displayed. The observation of chemiluminescence by application of luminol was scheduled to be made on days 3, 8, 15, 30, 40 and 50; with the intent to study the influence of increasing span of time interval between the painting of the substrate and photography on the intensity and persistence of chemiluminescence.

4.2. Phase 1: preparation of the surfaces

Three surfaces which are very often encountered at the crime scenes were selected for the study; namely, **cement blocks** to simulate brick wall, **wood planks** simulating any kind of furniture or doors and **metal sheets** to simulate vehicle surfaces. 25 pieces of each surface were collected. All the three surfaces were cut into pieces of comparable dimension and were prepared as follows:

- Cement blocks:

All the 25 cement blocks were coated uniformly with white distemper paint. Care was taken to cover the entire surface area with paint and hence covering the crevices if present. The blocks were then allowed to dry overnight.

- Wooden planks:

All the wood planks (plywood) were initially primed with wood primer. The planks were then allowed to dry overnight. They were then coated uniformly with white wood enamel paint using a brush and were dried for 48 h.

- Metal sheets:

The metal sheets (stainless steel) were coated with white automotive spray paint and allowed to dry for 24 h.

Each surface was then divided into six sets, with each set containing four blocks.

4.3. Phase 2: application of blood

All the surfaces were spattered with the same amount of blood and were allowed to dry for 24 h.

4.4. Phase 3: concealment using paint

The spattered bloodstain on all the surfaces was concealed using paint specific to the surface. A single layer of paint concealment was applied over the surface of three blocks of each set and was allowed to dry for 30 min (first layer). An additional layer was painted on the surface of two blocks from each set (second layer). Another layer of paint was applied over the surface of one block from each set (third layer). This procedure ensured that each set of surfaces contained one block representing single, double and triple layers of paint concealment. All the layers of paint were then allowed to dry for 48 h.

Note: One block from each set was used as a positive control and one block of each surface was used as a negative control.

4.5. Phase 4: preparation and application of Luminol (Grodsky formulation)

A basic solution of luminol was prepared by dissolving 5.0 g of sodium carbonate in 100 mL of distilled water. 0.1 g of luminol was then added to it and swirled to dissolve. The contents were transfered to a spray bottle. 0.7 g of sodium perborate catalyst was swirled to dissolve in the 100 mL of prepared luminol solution in the spray bottle just before application owing to the instability of sodium perborate [20].

The blocks to be observed were placed in a dark room and luminol solution was sprayed uniformly on the surface in a