

Review Article

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Blood as an Important Tool in Forensic Medicine in Sub-Saharan Africa: Nigeria as a Perception

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ABSTRACT

Blood is one of the most important biological tools in forensic medicine used to resolve and investigate crime-related cases because it contains useful details. It entails an analysis of various aspects of bloodstains that contribute to the clarification of some violent criminal cases.

The knowledge of forensic medicine is essential to provide answers about a series of events and mechanisms of the creation of specific groups of bloodstains on the crime scene. This includes investigation towards the analysis of bloodstains. This knowledge enables the interpretation of results and makes it possible to get closer to the truth, solve particular crimes and ensure accuracy in the legal determination of criminal offences which helps in a proper penalty when making a judgment for the offender.

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Introduction

Forensic pathology is a term used to describe forensic medicine also known as medical jurisprudence or legal medicine [1-3]. In the subject of forensic medicine, medical evidence (samples) are gathered and examined to generate factual data for use in the legal system. Forensic medicine entails the application of scientific medical knowledge to the administration of justice, the advancement of justice, and the legal responsibilities of the medical profession [2,3]. It is most prominent sub-field of forensic science that deals with the examination of human body using various components found at the crime scene. It is extensive and covers crimes against patients committed in relation to consent to treatment, therapeutic intervention, emergency care, legal actions, tissue and organ removal and transplantation, needless surgery, cosmetic surgery, scientific experimentation, and sexual acts, as well as issues relating to maternity, paternity, homicide, wrong practices, the recognition, effective documentation, gathering, proper preservation and interpretation of evidence, and the application of authorized law to medicine [1].

Given that various specimens can be used in forensic medicine including faecal matter, semen, vomit, saliva, blood, hair, nails, parts of the skin and other organs found at the crime scene. Blood

is the most significant biological remnant frequently discovered at crime scenes [1].

It is viewed as a crucial forensic tool because of the rich information it contains. Also according to Helmus et al., remnant of DNA contained in the blood is still retained even after the fourth hand-washing step [2]. Analyzing the chemical composition of a single drop of blood as well as the quantifiable morphological traits of the resulting bloodstains can yield a wealth of relevant information. By examining the chemical composition of the blood as well as the quantifiable morphological properties of the resulting bloodstains, a great pool of important information can be obtained from only one drop of blood [3].

Properties of Blood

A vital liquid connective tissue organ is blood which totals 4-5 litres for women and 5-6 litres for males or around 7% of the average person's body weight [3]. Plasma, colloids, crystalloids, and cellular components- erythrocytes, leucocytes and thrombocytes all make up the whole blood. Distinct blood components can be separated by centrifugal force because they have different relative densities, sediment rates, and sizes. The specific gravity of blood components increases from lowest to highest with plasma, platelets, white blood cells, and packed red blood cells (PRBCs) [4]. Plasma is the pale yellow-coloured liquid in which the cellular elements of blood are suspended, 91% of

plasma is made up of water and the remaining volume consists of nutrients, hormones, gases, plasma proteins, inorganic substances and waste products. The platelets are anucleated, disk-shaped remnants of megakaryocytes have a diameter of 2-4microns. The leucocytes have average diameter of 12-17microns and are vital for creating immune response against foreign agents in the body. The erythrocytes are the anucleated bi-concave shaped cells which have various antigens on the surface. Red blood cells have diameter of 7.8 microns and it helps in transporting oxygen round the body with haemoglobin molecule present in it [5].

Preliminary Tests for Blood Identification at a Crime Scene

The wet blood recovered at the crime scene is clearly blood merely by looking at it. If dried blood is discovered at the scene of the crime, it could be difficult to determine if it is blood or not. Additionally, preliminary tests must be carried out to determine whether the sample discovered is a blood sample or something else if the bloodstain is not obvious or if it is found on a dark material. There are three sorts of chemical approaches for detecting blood:

1. **The crystal test-** This relies on the ability of hemoglobin molecules to crystallize when they interact with specific chemicals, such as pyridine.
2. **Catalytic test-** This test is based on the ability of hemoglobin molecules to catalyze the oxidation of hydrogen peroxide.
3. **Instrumental techniques-** Chromatography is employed in these techniques to identify blood by detecting the presence of hemoglobin [6].

In order to avoid sample preparation involved in the methods above an advancement has been made to identify bodily liquids including blood samples and estimate the age of the fluids. The possibility of quick in situ identification and age assessment of physiological fluids without the need for risky presumptive testing or laborious sample processing is carried out using a thermal desorption surface sample probe paired with a small mass spectrometer for the direct measurement of volatile organic compound (VOC) profiles of human body fluid [7].

Identification of Blood Group for Various Individuals

The surface of red blood cells contains various antigens which helps in differentiating and characterizing blood- this phenomenon is termed Blood grouping or Blood typing. The International Society of Blood Transfusion now maintains a list of 33 blood group systems that correspond to more than 300 antigens. The antigens can be glycoproteins (such as ABO), glycolipids, or integral proteins with variations in the amino acid sequence (such as rhesus [Rh], Kell), among others. ABO and rhesus systems are the most important blood group systems [8]. In the ABO blood group system there are 6 blood types which includes: A₁, A₂, B, A₁B, A₂B and O. The A₁ and A₂ are the two distinct subgroup of A blood group with 80% of the population carrying A₁ and the remaining 20% carrying A₂. The A₁B and A₂B are also the distinct sub-types of blood group AB [6].

The ABO and rhesus blood group of an individual is determined by the reactions given by typing blood against specific antisera [8]. Blood typing is not very effective in ascertaining guilt of individuals in relation to crimes because it does not allow individualization of the blood type seen at the crime scene owing to the fact that a number of the population is carry the blood type seen at the crime scene although blood typing can be used to ascertain the innocence of suspected individuals if blood type of suspected individuals is not found at the crime scene [6,9].

Due to the inadequacy of blood typing process, DNA profiling analysis has been found to be more effective and to provide accurate information better than that of the conventional blood typing. Since it was initially used to solve a forensic case in the 1980s, a lot of forensic kits with high sensitivity have been produced, and they produce astounding results even with old and partially destroyed blood. Some of these include SGM, Identifiler, NGM, or Mini kits, which are frequently used to identify biological traces on crime scenes as well as DNA profiles of blood donors. The results of DNA profiling analysis prove that a particular bloodstain or blood splatter is indeed from the offender or the victim, or it may even be some sort of mixture made up of blood from both the victim and the offender. The link between bloodstains at the crime scene and injuries from the postmortem report is crucial, and this can be done based on the results of DNA analysis. After that, morphological tests can be carried out [3].

Asides determining the perpetrator of a crime DNA profiling has become widely employed in a variety of fields, including paternity testing, disaster victim identification, bone marrow transplant monitoring, finding fetal cells in a mother's blood, tracking human history, and many others.

Bloodstain Pattern Analysis in Forensic Medicine

By utilizing the physical characteristics of bloodstains, bloodstain pattern analysis aims to define the facts surrounding an inquiry. Bloodstain pattern analysis is the process of reconstructing a bloodshed event using the size, form, and distribution patterns of bloodstains obtained at a crime scene(s). Bloodstain patterns provide information on the circumstances of the bloodshed rather than the individual involved and the equipment used [10].

Blood stains are the remnants of blood left at the crime scene. Blood is a complex fluid that does not follow the Newton principle and has viscoelastic behavior, a yield stress, and shear-thinning characteristics. When blood leaves the body or when there is an increase in shear stress, it begins to coagulate. The atomization process, which is fundamentally important for blood pattern analysis since it controls the distribution of drop sizes and velocities, and consequently the resulting blood spatter, could be impacted by the rheology of blood [11]. In order to interpret bloodstain patterns left behind by violent crimes, physics, biology and arithmetic are applied in bloodstain pattern analysis. The investigation's ability to ascertain what transpired, the chronology of events, and the identification of people who may have been present during the blood spatter incident can be helped by the study of the bloodstains and patterns [12].

Types of Bloodstains

Passive stains, transfer stains, and projected or impact stains are the three main categories used to categorize bloodstains [12]. Passive stains can take the form of drops, flows, and pools and are frequently brought on by weight pressing on an injured body. Transfer stains are the consequence of things contacting bloodstains that leave wipes, swipes, or pattern transfers behind, such a bloody shoe print or a smear from dragging a body. Impact stains are caused by blood that projects through the air and are typically visible as splatter, although they can also take the form of gushes, splashes, and arterial spurts [13].

Challenges of Blood Stains Pattern Analysis in Forensic Medicine

In blood pattern analysis some issues are considered as important as a lot of speculation are made which can therefore reduce the

accuracy of the result when used alone, it should not be used alone rather in conjunction with other identification methods in crime investigation. Some of the issues include estimation of region of origin; rheological behavior of blood in relation to the surface on which it lands also the angle of impact is another issue [14]. Estimation of region of origin can be done using either of these methods including: using the idea that blood drop paths follow straight lines as inferred from stain examination, or retrospective reconstruction of ballistic trajectories while taking gravity and drag factors into account also by taking into account fluid dynamics and statistical uncertainty while rebuilding the region of origin [15].

Another problem is as regarding the impacted surface, rough surfaces distorts the shape of the blood drop whereas smooth surfaces imparts little distortion to the spherical shape of the blood drop, this is greatly influenced by the liquid's elasticity and viscosity. Therefore, the rheological behavior of blood must be taken into account in any accurate reconstruction of a crime scene from a crime involving blood spatter [10].

Angle of impact is also considered. One drop of blood can stick to the slick perpendicular surface by taking the form of a spherical object with sharp edges. The bloodstain that results will be slightly more elliptical if the angle of impact is not vertical. It is possible to calculate impact angle using simple mathematical equations because it is essential for identifying the location of the bleeding source [16]. This is highly essential to determine if an attack is planned, suicide or as a result of mishap [17].

Advancement in research in the areas of forensic medicine has led to the development of 3D scanning approach [6]. A 3D image of the crime scene can help with bloodstain pattern analysis so that the scene can be recorded, examined, and the incident can be reconstructed. Traditional measurements for analyzing bloodstain patterns must still be gathered, photographed, and evaluated in addition to any 3D scanning that may be used [18].

Forensic Medicine in Nigeria

In Nigeria, the field of forensic medicine is still in its early stages of development. Even though there are only about five universities in Nigeria that offer forensic science, the developing nation has shown a significant interest in the field. As an example, some murders and accidents have been successfully investigated, and those responsible have been punished after being found guilty of the charges leveled against them. Only two states have shown progressive interest in forensic medicine- Lagos State and Rivers State [19].

Forensic pathologists or experts or medical examiners are specially trained physicians who examines the bodies, fluid and blood of people who are involved in a murder case, violence and crime scene. The experts include namely the histopathologists, then others are forensic hematologist, toxicologist, forensic dentist, forensic microbiologist although most of these other experts are lacking in forensic medicine in Nigeria.

Limitations and Challenges

- ❖ The rate of growth is quite slow due to some reasons like; insufficient funds to purchase the required equipment and to maintain the needed technology and infrastructure, research.
- ❖ There is drawback in the training of forensic experts in our environment such as forensic hematologist, forensic radiologist, forensic histopathologists and forensic toxicologist. These sub-specialties are lacking.

- ❖ Financial constraint prevents the government security agencies from bringing in knowledgeable experts into the country.
- ❖ The gap in technological development and infrastructural facilities in Nigeria is also contributing to the slow growth of forensic medicine in Nigeria
- ❖ Another reason for the slow growth of forensic medicine in Nigeria is due to non-uniformity of curriculum.
- ❖ Studying forensic medicine as a course without having the needed exposure required to grow interest and work in the said field.
- ❖ Lack of comprehensive national database.
- ❖ Religion objections can be another challenge in this practice

Conclusion

Blood is a highly important tool in forensic medicine which is still in its formative years in Nigeria but following the above recommendations will help the nation to discharge a lot of just people held in custody for the crimes not committed by them and it will further help to apprehend the true perpetrators of the crime and this will further lead to the decrease of crime rate in Nigeria. All owing to the fact that blood can be maximized to know how an event occurred, the people present at the crime scene and the materials employed during the event. In order to arrest the situation and breach the gap in forensic medicine in Nigeria, the following are recommended:

- ❖ Appropriate implementation of human right policies.
- ❖ Promoting the study of forensic science in educational institutions across Nigeria.
- ❖ Funding forensic medical analysis laboratory by both governmental and non-governmental bodies.
- ❖ Training of national law enforcement personnel in forensic analysis as an alternative source of investigation.
- ❖ There should be a comprehensive National database from which forensic results can be compared.
- ❖ International collaborations with counterparts in developed countries in the area of forensic science must be encouraged.
- ❖ Nigeria and other world bodies should continue to raise the profile of, invest in and recognize the absolute necessity for independent, impartial skilled practitioners of clinical forensic medicine

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Conceptualization, supervision, study design and writing – review and editing.

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Resources and writing - Original draft

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