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Artificial Intelligence In Prediction Of Postmortem Interval(PMI) Through Blood Biomarkers In Forensic Examination-Aconcept

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Abstract:

An essential part of any forensic inquiry is finding the postmortem interval (PMI) or the exact moment of death.Forensic examiners have the essential duty of accurately estimating the PMI.Biochemical technology has advanced to the point that it is possible to detect PMI biomarkers in various bodily fluids, including blood and urine. According to studies that have looked at the usage of blood in PMI assessment, the biochemical components must be measured using blood obtained from the femoral vein. The field of forensic science is rapidly moving toward the use of AI, or intelligent computers that can learn and solve issues, in their investigations.This study presents a prototype for a device that can predict PMI by analyzing blood metabolite profiles, including those of lactate dehydrogenase (LDH), aspartate aminotransferase (AST), cholesterol, triglycerides, and others. Along with the measurement of blood pH. These biological markers show promise as potential tools for forensic investigations into deaths. Artificial intelligence, biological fluids, postmortem interval, time of death, triglycerides, cholesterols, lactate dehydrogenase, aspartate aminotransferase, pH

INTRODUCTION

Almost every industry, including forensic science, is investing in artificial intelligence (AI) development. The widespread availability of digital science is attracting people who want to know how AI will affect their daily lives. The primary objective of forensic investigators confronted with a dead corpse is to determine the duration between the moment of death and the body's discovery. One definition of postmortem interval (PMI) is the time since death.In order to aid the court process accept or reject the claims of witnesses and suspects, investigators might use an estimated time frame of death to establish a definitive conclusion about the correct time of death [1]. Despite a lot of progress in the field, PMI prediction remains one of the most difficult factors for forensic investigators to measure and establish [2].In the first century BC, the Egyptians and the Greeks performed autopsy on condemned prisoners. All subsequent approaches to PMI estimation were based on these earlier results [3].Studies that aim to pinpoint the exact moment of death fall into one of two categories: the immediate postmortem period and the extended postmortem period.The term "early postmortem period" refers to the time after death that occurs before tissue breakdown begins. Skeletonization, on the other hand, refers to changes to the bone matrix that occur in the immediately after death [4]. Depending on whether the PMI is short or lengthy, many methods have been developed to determine the time of death.The longer the PMI, the more difficult it is to determine the time of death [5]. Shocking skeletal muscles with an electrical current or a mechanical force a few hours after death has been tried [6].Entomology is regarded by other researchers as a top strategy for determining both short and long PMI [7].Morphological deterioration and PMI were linked in many investigations. The body begins a cascade of metabolic reactions within minutes after death. According to previous research, there are five distinct stages of decomposition that include these changes: fresh, bloat, active decay, advanced decay, and dried remnants [8], [9]. More recent research has focused on biochemical markers for PMI estimate by analyzing chemical compounds produced and accumulated in the body after death ([10], [11]). Various bodily tissues, including blood, brain, skeletal muscle, and pancreas, were investigated for their biochemical indicators in PMI assessment [12–14]. There are three factors that have been linked to biochemical alterations in blood biomarkers: the agonal phase of hypoxia, the prolongation of biochemical fluctuations in the early stages of premenstrual syndrome (PMS), and the redistribution of diffusible components between blood serum and red blood cells [15]. Proteins like lactate dehydrogenase (LDH) and aspartate aminotransferase (AST) and metabolites like sodium, chloride, potassium, ammonia, and urea make up the

two primary groups of blood indicators. Enzymes that break down macromolecules including proteins, lipids, and carbohydrates are released when cells are disrupted [16]. The body undergoes these transformations until it decomposes entirely [17].

Blood has been suggested as a potential optimal tissue for use in determining the time of death by many researchers ([10], [18]). An biomarker for PMI has been shown to be the total amount of protein in the blood, according to research [19]. Two enzymes that aid in the assessment of PMI are AST (an enzyme that converts aspartic acid to glutamate) and LDH (an enzyme that is normally limited to the cytoplasm of cells and released only after cell death).During the first three days after death, there was a rise in the blood concentration of these enzymes [20]. Although total protein concentrations are useful, many investigations have shown that estimating postmortem blood glucose levels does not provide any useful information for determining how long it has been since death [21]. A number of variables may affect the amount of postmortem blood glucose, which might explain why this is the case [22]. According to other research, the concentration of triglycerides and cholesterol in blood in vitro decreases with time after death [23]. Blood pH alterations in postmortem animal examinations have been documented by a few studies [24]. In this paper, the idea of using a device that measures various biomarkers in blood—the concentration of LDH and AST, which are protein biomarkers; triglycerides and cholesterols, which are lipid biomarkers; and the pH level—to estimate the time of death during a crime investigation is presented.

MATERIALS AND METHODS

Dosage of LDH LDH is a biomarker that may be used to estimate PMI at an early stage. It is responsible for converting pyruvate to lactate and NADH to NAD+ by catalysis. In the hours after death, LDH is released into the circulation by cells, where its content quickly rises. The concentration peaks following this phase in the postmortem period, after which it gradually increases over the next 48 to 72 hours at a lower rate [25].When liver dialysis (LDH) converts NADH to NAD+, a colorimetric assay can measure its blood concentration. In order to generate a color, the latter absorbs a certain probe (λmax = 340 nm).

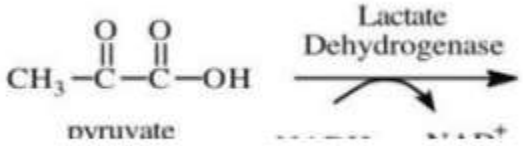

Fig. 1. Mechanism for the reaction catalyzed by LDH.

In our device design, a certain amount of blood serum is diluted and then applied to a strip inside the device to determine the blood dose of LDH. Pyruvate and NADH make up this strip. The rate of NADH disappearance at 340 nm, in relation to a calibration curve that utilizes LDH calibration, is used to quantify the activity of LDH. The reaction takes a few minutes to complete, with the temperature maintained at 370 C. (2–3 minutes). After a person dies, their ASTAST dosage is released into the extracellular space. Within the first sixty hours after death, there is an increase in AST in the blood [26].The colorimetric approach allows for the quantification of AST in blood by measuring glutamate by the production of a blue color product through an enzyme-coupled reaction cycle (λmax= 510nm).

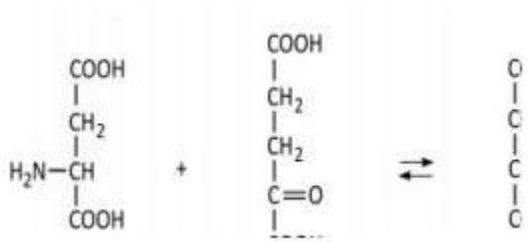

Fig. 2. Mechanism for the reaction catalyzed by AST.

Using this equipment, the colorimetric approach developed by Reitman and Frankel (1957) at 370 C may be used to determine the dose of AST in the blood of a dead person [27]. Triglyceride dosage Enzymatic hydrolysis by a lipase liberates glycerol and free fatty acids, allowing for the quantification of total triglycerides in blood (1). The next step involves phosphorylation of glycerol by a kinase, which produces glycerol-3-phosphate (2). Glycerol phosphate oxidase then undergoes the oxidation reaction. Hydrogen peroxide is a byproduct of this process (3). In the next step, peroxidase facilitates the redox-coupled reaction between H2O2, 4-aminoantipyrine, and N-Ethyl-N-(3-sulfopropyl)-manisidine (ESPA), resulting in the production of a purple hue (4) with a maximum absorption wavelength of 530-550 um.

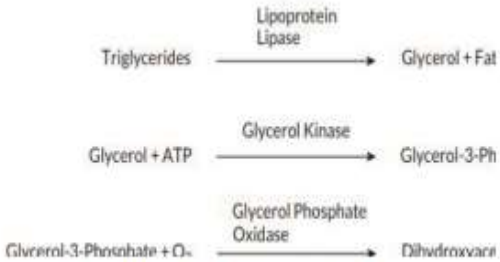

Fig. 3. Dosage of total blood triglyceride.

Based on the work of Fossati and Principe (1982) [28], we provide a direct colorimetric method for measuring total serum triglycerides. The enzymatic colorimetric technique is used to assess total blood cholesterol levels. This approach involves the following steps: (1) cholesteryl esterase hydrolyzes cholesteryl esters; (2) cholesterol oxidase produces hydrogen peroxide; and (3) peroxidase plus a dye forms a colored product (λmax= 620nm).

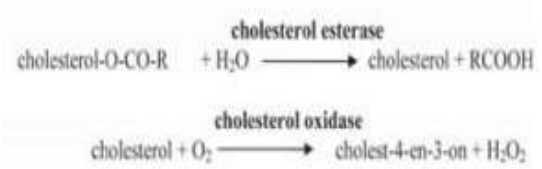

Fig. 4. Dosage of total blood Cholesterol

In this study, we used the methodology proposed by Allain et al. (1974) [29] to determine the optimal total blood cholesterol dose. According to Lloyd and Felton (1921) [30], a colorimetric method may be used to accurately detect the concentration of H+ ions in single drops of fluids, which allows for the determination of the pH level of blood.

DISCUSSION

In recent years, there has been a lot of research on finding the PMI by analyzing changes in the biochemical components of various bodily fluids, such blood. We provide a notion for the simultaneous dosing of many blood metabolites in this work, including LDH, AST, triglycerides, cholesterol, and pH.The typical range for blood pH levels is 7.35 to 7.45. Death may occur at alkaline pH levels above 7.45 and acidic pH levels below 7 [31]. There was a shift in blood pH upon death [24]. Twenty hours after death, blood pH changed from 7 to 5.5, according to studies [32]. The blood pH drops when acidic compounds, notably lactic acid, build up. Blood lactate dehydrogenase (LDH) levels rise after death, which causes the body to produce more lactic acid. There was a 20-fold rise in lactate content in cardiac blood one hour after death and a 70-fold increase twenty-four hours after death, according to newly published research [33]. Two blood enzymes, LDH and AST, are primarily thought of as possible biomarkers for PMI assessments, and our research idea is centered on exploring their implications.Triglycerides and cholesterols, which are lipid metabolites in the blood, are another set of biochemical indicators that might be helpful in postmortem assessment.

CONCLUSION

Blood samples may be taken from the femoral vein when a murder victim is discovered at the crime scene.The suggested AI device may then monitor blood levels of LDH, AST, triglycerides, and cholesterols without the need to measure glucose levels beforehand. Blood pH levels may also be determined. We may estimate the PMI by combining these data, interpreting them, and comparing them to other databases. Before deciding to use this technology, its feasibility should be assessed on an institutional basis.

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