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Effects of Disease States on Forensic Body Fluid Analysis

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ABSTRACT

In criminal investigations, forensic bodily fluid analysis is essential since it provides evidence for identifying suspects, reconstructing crimes, and other legal situations. However, a person's disease states can have a significant impact on bodily fluids' physical, chemical, and biological characteristics, which could change the results of forensic tests. Diabetes, infections, metabolic diseases, and chronic illnesses are examples of pathological situations that alter the quantities of biomarkers, proteins, DNA, and metabolites, which in turn affect the composition of fluids such as blood, saliva, semen, and urine. These modifications may put traditional forensic techniques to the test, which could result in less reliable results and possibly incorrect evidence interpretation.

Accurate DNA profiling may be hampered, for instance, by high blood glucose levels in diabetics or damaged DNA from infections. Similar to this, changes in salivary proteins brought on by oral infections or decreased seminal volume as a result of reproductive diseases might make it more difficult to identify bodily fluids in forensic investigations. Analyte concentrations in fluids are also impacted by illnesses such as liver and renal disease, which might have an impact on toxicological and biochemical tests.

By highlighting particular difficulties and their consequences for legal decisions, this study summarizes previous studies to investigate how disease states affect the forensic investigation of bodily fluids. It also looks at new developments in forensic methods that promise to address these issues, like metabolomics and next-generation sequencing. The integrity of evidentiary procedures can be preserved and analytical accuracy increased by forensic science through the comprehension and management of disease-related variability. In order to adapt forensic procedures to the complications imposed by disease states, this research emphasizes the necessity of interdisciplinary collaboration and creative approaches.

KEYWORDS

• Forensic body fluid analysis • Disease states • DNA degradation • Blood analysis • Saliva analysis • Semen analysis • Urine analysis

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INTRODUCTION

A fundamental component of contemporary forensic science, forensic body fluid analysis provides vital evidence in criminal investigations, paternity disputes, and the identification of disaster victims. DNA profiling, biomarker identification, and toxicological evaluations are frequently performed on biological fluids, including blood, saliva, semen, and urine. The premise of these investigations is that, in normal circumstances, the composition of bodily fluids is comparatively constant. However, the biochemical, physical, and molecular properties of bodily fluids can be drastically changed by disease conditions, which presents special difficulties for forensic investigations. Pathological disorders such as diabetes, infections, cancer, and kidney disease can influence the composition of fluids, including the concentration of metabolites, proteins, and nucleic acids.

These changes could impair DNA quality, cause cross-reactivity in immunological tests, or interfere with presumptive and confirmatory testing. For example, oral infections can break down salivary DNA, and high blood glucose levels in diabetics may make DNA extraction less effective. Analyzing seminal fluid in situations of sexual assault is also made more difficult by azoospermia brought on by reproductive health problems.

Improving the accuracy and dependability of forensic results requires an understanding of how illness states impact forensic body fluid analysis. This review looks at recent studies on how pathological circumstances affect the examination of bodily fluids, highlighting the difficulties they provide and potential solutions. In order to provide strong analytical procedures and preserve the integrity of forensic evidence, forensic science can adjust to the unpredictability brought about by illness states by tackling these problems. The significance of multidisciplinary co-operation between medical researchers and forensic scientists is further shown by this investigation.

Disease States and their Impact on Body Fluids in the Context of Pre-existing Research

For a variety of investigative reasons, forensic examination of bodily fluids, including blood, saliva, semen, and urine, is essential. However, the chemical, physical, and biological characteristics of these fluids can be drastically changed by disease conditions, which could affect the precision and dependability of forensic analyses. The impact of medical disorders on bodily fluid composition and its consequences for forensic science have been the subject of numerous investigations. The main illness conditions and how they affect the analysis of bodily fluids are discussed here, with evidence from previous studies.

Blood

One of the main bodily fluids examined in forensic investigations is blood. Its composition can be impacted by conditions including diabetes, anemia, and liver illnesses, which can therefore have an impact on forensic results.

- **Anemia**: Reduced hemoglobin and red blood cell counts caused by anemia, especially iron-deficiency anemia, might make blood sample identification and blood typing more difficult (Giardina *et al*., 2008). Because of the decreased cellular content in cases of severe anemia, forensic blood analysis may produce results that are unclear or insufficient.
- **Diabetes**: It has been demonstrated that high blood glucose levels in diabetics impair enzymatic activity and DNA extraction, resulting in lower quality DNA samples (Keshavarz *et al*., 2022). Furthermore, it can be challenging to extract accurate genetic profiles from blood samples due to the acceleration of DNA destruction caused by high glucose (Brennan & Robertson, 2009).
- **Liver Disease**: Liver disorders such as cirrhosis or hepatitis modify blood clotting factors, which can complicate the identification of blood stains at crime scenes, as prolonged clotting periods may affect the blood's viscosity and appearance (Kharoshah *et al*., 2015). In addition to changing blood color and interfering with presumptive testing, elevated bilirubin levels, which arise in liver disease, can cause misidentification (Rutty *et al*., 2011).

Saliva

Saliva is an important bodily fluid for enzyme detection and DNA profiling. Nonetheless, a number of medical conditions, such as autoimmune disorders and oral infections, can change the makeup of saliva.

- **Sjogren's Syndrome**: This autoimmune condition might make it more difficult to analyze salivary samples in forensic situations since it causes a decrease in saliva output. According to research, a lesser salivary volume results in a lower DNA production and may affect how sensitive biochemical assays are (de Almeida *et al*., 2008).
- **Oral Infections**: Saliva's protein and microbial composition can change due to infections like gingivitis or oral candidiasis, which might impact the saliva's biochemical profile. Research has shown that viral illnesses, such as hepatitis B and C, can change the profiles of salivary enzymes, making it more difficult to find common indicators in forensic analysis (Desai & Leekha, 2016). Furthermore, the composition of salivary proteins might alter significantly as a result of HIV infection, which may skew the results of enzyme-based testing (Pfeiffer *et al*., 2009).

Semen

In forensic investigations, semen is often examined, especially in sexual assault cases. However, sperm count and seminal fluid composition can be impacted by disorders that affect the male reproductive system.

- **Azoospermia and Oligospermia**: Biological evidence for identification and paternity testing is diminished in circumstances such oligospermia (low sperm count) and azoospermia (lack of sperm), which can make forensic analysis of semen more difficult (Donlon & Kirkbride, 2015).
- **Prostatitis and Sexually Transmitted Infections (STIs)**: Seminal fluid's amount and content can be changed by prostatitis, an inflammation of the prostate gland. According to Johnston *et al*. (2017), STIs like chlamydia and gonorrhea also alter the composition of semen by altering sperm motility, protein levels, and the presence of inflammatory markers. These changes may affect forensic analysis's precision, particularly when it comes to distinguishing semen from other body fluids.

Urine

Forensic toxicology and metabolic profiling frequently employ urine. Urine's biochemical makeup can be drastically changed by kidney disease and other metabolic conditions, which may have an impact on forensic and toxicological analyses.

- **Chronic Kidney Disease (CKD)**: According to research, CKD can change the levels of a number of chemicals in urine, such as urea, creatinine, and electrolytes, which can have an impact on forensic examinations (Hara *et al*., 2011). Kidney dysfunction-related protein in the urine can also change the outcome of protein-based tests, thus causing misunderstandings.
- **Metabolic Disorders**: Atypical urine compositions, such as elevated glucose and ketones, as well as changed pH levels, can be caused by diseases including diabetes and metabolic syndrome. These modifications may complicate forensic toxicology tests by affecting the detection of certain drugs in urine (Manoli *et al*., 2016).

Impact on DNA Analysis

The quality and amount of DNA retrieved from bodily fluids can also be impacted by a variety of illness conditions, especially infections and metabolic disorders.

- **Infectious Diseases**: The likelihood of successful DNA profiling is decreased by pathogens like bacteria and viruses that can break down DNA in bodily fluids. Lee *et al*. (2013) showed that viral infections and sepsis cause DNA fragmentation, which makes it challenging to extract useful genetic material from biological samples.
- **Environmental Factors**: Changes in the content of bodily fluids brought on by disease may also have an impact on how bodily fluids interact with external elements like humidity and temperature, which are crucial for maintaining DNA during forensic examinations.

CONCLUSION

Disease states change the biochemical,

physical, and molecular characteristics of bodily fluids, which makes forensic body fluid analysis extremely difficult. Forensic investigations can become more difficult when pathological illnesses including diabetes, infections, and reproductive problems impact the identification and analysis of blood, saliva, semen, and urine. In circumstances when illness states may be present, it is essential to comprehend these consequences in order to modify forensic methodologies and guarantee the accuracy of results. To solve these issues and raise the accuracy of forensic body fluid analysis, forensic science must continue its research and technical developments.

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