

ORIGINAL ARTICLE

UTILITY OF FORENSIC TOXICOLOGY AND HISTOPATHOLOGICAL EXAMINATION IN COMMUNITY-RELATED DEATHS AT A TEACHING HOSPITAL IN INDIA - A RETROSPECTIVE STUDY

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ABSTRACT

Objectives: This retrospective study was undertaken to assess the utility of forensic toxicology and histopathological examination to determine the cause of death in community-related deaths that were brought dead to a teaching hospital in India.

Methods: All community deaths in 2020 were studied based on the inquest report, medico-legal autopsy report, histopathological examination report, and forensic toxicology report at RVRS Medical College, Rajasthan, India. The probable cause of death after the medicolegal autopsy and the final cause of death after receiving reports of forensic toxicology and histopathological examination were compared to assess the utility of chemical analysis and histopathological examination.

Results: Viscera were preserved for forensic toxicology in 171 cases. Out of these, 53 were cases of mechanical injuries, and in 4 cases, probable cause after a medico-legal autopsy was undetermined. Out of a total of 171 cases, viscera were preserved for histopathological examination in 54 cases. Out of these, 12 were cases of other natural causes, 2 were cases of snake bite, and 2 were cases of hanging as a probable cause after medico-legal autopsy. Histopathological examination was useful in 3 cases of other natural causes, 3 cases of undetermined causes, and 1 case of snake bite. Overall, forensic toxicology caused an impact on the cause of death in only 16 cases out of 171 cases, and histopathological examination caused an impact on the cause of death in only 7 cases out of a total of 54 cases.

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Conclusion: The current retrospective study suggests that microscopic examination and forensic toxicology investigations should be used, as and when needed, in specific circumstances, but are not necessary as a routine investigation in each and every case.

Keywords: Chemical analysis; community deaths; forensic toxicology, histopathological examination; India

INTRODUCTION

Medico-legal autopsy is essential in all types of unnatural deaths, as well as natural deaths when the cause of death cannot be ascertained by the treating physician¹. During autopsy, meticulous examination of all organs and preservation of necessary samples for forensic toxicology and histopathological examination are vital to determine the cause of death. Community-related deaths mean cases that were brought dead to the hospital without any positive history, and in such cases, preservation of viscera for forensic toxicology and histopathological examination is very crucial. To practice humanitarian forensics, judicious use of histopathological examination and forensic toxicology should be there². This study aims to find out the utility of forensic toxicology and histopathological examinations in community-related deaths during medico-legal autopsy by analysing retrospective data. The study performs a **functional audit** of how histopathology and toxicology can **confirm, refine, or change** the initial medico-legal opinion.

METHODS

This study was conducted retrospectively using stored data at RVRS Medical College, Rajasthan, India. The aim was to study the utility of forensic toxicology and histopathological examinations in community-related deaths where individuals were brought to the hospital deceased in the year 2020. RVRS Medical College is affiliated with the Rajasthan University of Health Sciences, Rajasthan, India, and is approved by the Medical Council of India (the National Medical Commission). All the community-related deaths where individuals were brought to the hospital deceased in the year 2020 were studied using the inquest report, medico-legal autopsy findings, histopathological examination report, and forensic toxicology report.

During the COVID-19 pandemic, all medico-legal autopsies were conducted with high precautions, strictly following guidelines, and using complete PPE kits. Decisions on conducting a thorough, meticulous autopsy or a minimally invasive autopsy, as well as the preservation of viscera, were made on a case-by-case basis. Major

organs, including the brain, heart, lungs, liver, spleen, and kidneys, were routinely preserved in 10% formalin during autopsy for histopathological examination, which was conducted by the Pathology Department. For forensic toxicology, three bottles were routinely used: the first contained the stomach and a loop of small intestine (first 30 cm) with its contents; the second contained sections from the liver (about 500 g with the gall bladder) and both kidneys (half of each); the third contained a sample of blood. The most common preservative used for forensic toxicology was a saturated solution of common salt. Though it is not an ideal preservative, it is routinely used in the Indian setup. The bottles were sealed, labelled, and handed over to the investigating officer (police personnel) for submission to the Forensic Science Laboratory for forensic toxicology analysis.

Forensic toxicology analysis was conducted following the standard protocols and procedures established by the Directorate of Forensic Science Services, Ministry of Home Affairs, Government of India, through the designated forensic science laboratory³. The probable cause of death after medico-legal autopsy and the final cause of death after receiving reports of forensic toxicology and histopathological examinations were compared in each case to assess the utility of forensic toxicology and histopathological examination.

RESULTS

A total of 171 cases of community deaths were brought dead for medico-legal autopsy in the year 2020, in which viscera were preserved for forensic toxicology or histopathological examination. A total of 30.99% of the cases were from the 21-30 years age group, 24.56% of cases were in the 31-40 years age group, whereas only 2.34% were under ten years of age (Table 1).

Table 1: Age distribution of the study sample

Age group (years)	No. of cases (%)
≤10 years	4 (2.34)
11-20	21 (12.28)
21-30	53 (30.99)
31-40	42 (24.56)
41-50	23 (13.45)
51-60	17 (9.94)
>60	11 (6.44)
Total	171 (100)

Out of 171 cases, 61.99% were male, 38.01% were female, and no transgender cases were noted (Table 2). The male-to-female ratio was 1.6:1.

Table 2: Gender distribution of the study sample

Sex	No. of cases (%)
Male	106 (61.99)
Female	65 (38.01)
Total	171 (100)

Viscera were preserved for forensic toxicology in a total of 171 cases. This cohort consisted of 53 cases of mechanical injuries, 29 cases of hanging, 18 cases of drowning, 16 cases of snake bites, 14 cases of electrocution, 12 cases of other natural causes, 11 cases of burns, 8 cases of cardiac causes, 6 cases of poisoning, and 4 undetermined cases.

Out of the total of 171 cases, viscera were preserved for histopathological examination in 54 cases that, based on the probable cause of death, included 12 cases of other natural causes, 9 cases of electrocution, 8 cases of cardiac causes, 5 cases of burns, 4 undetermined cases, 3 cases of drowning, 2 cases of poisoning, 2 cases of snake bites, and 2 cases of hanging.

After a full medico-legal autopsy, including forensic toxicology and histopathological examinations, the preliminary cause of death has remained unchanged in 18 cases of drowning, 11 cases of burns, 14 cases of electrocution, and 6 cases of poisoning. This suggests that there is not much of an impact of chemical analysis and histopathological examination on the cause of

death. In poisoning cases, chemical analysis was useful to detect the type of poison by qualitative analysis, but quantitative analysis was not done.

Forensic toxicology was useful in 1 case of hanging, 2 cases of mechanical injuries, 2 cases of cardiac causes, 5 cases of other natural causes, 5 cases of snake bites, and 1 undetermined case. In these cases, forensic toxicology played a crucial role in determining the cause of death, which was not ascertained after medico-legal autopsy. Poisoning was detected in all the above cases after chemical analysis, which changed the probable cause of death as per the inquest, and poisoning was given as the new cause of death in the final report.

Histopathological examination was useful in 3 cases of other natural causes, 3 undetermined cases, and 1 case of snake bites. In these cases, histopathological examination played a crucial role in determining the cause of death, which was not ascertained during medico-legal autopsy. Cardiac pathology was detected in 6 cases, and lung pathology was detected in one case, which changed the probable cause of death; thus, histopathological examination helped to assign the new cause of death in the final report.

During the inquest, police wrongly identified fang marks over the body and gave probable cause of death as snake bite in 16 cases, but following a meticulous autopsy, only 10 cases were true snake bites, with features of envenomation. Forensic toxicology helped to identify poisoning as the cause of death in 5 cases, and histopathological examination helped to identify cardiac pathology as the cause of death in one case, which was wrongly considered a snake bite by the police.

Overall, forensic toxicology was useful for the cause of death in only 16 cases out of 171 cases, and histopathological examination for only 7 cases out of 54 cases (Table 3). The p-value (0.618) is greater than the conventional significance level (0.05), indicating that there is no statistically significant difference between the cause of death as determined at different forensic stages. This suggests that autopsy findings largely confirm the initial inquest conclusions, with only a few cases showing discrepancies between forensic and histopathological examinations.

Table 3: Impact of forensic toxicology and histopathological examinations on the cause of death.

Cause of death	Probable cause of death as per inquest	Cause of death immediate after autopsy	The cause of death changed after receiving forensic toxicology report (New Cause of Death)	The cause of death changed after receiving histopathological examination report (New Cause of Death)
Hanging	29	28	1 (Poisoning)	0
Drowning	18	18	0	0
Burns	11	11	0	0
Electrocution	14	14	0	0
Mechanical injuries	53	51	2 (Poisoning)	0
Cardiac cause	8	6	2 (Poisoning)	0
Other natural causes	12	4	5 (Poisoning)	3 (2 Cardiac pathologies + 1 lung pathology)
Poisoning	6	6	0	0
Snake bite	16	10	5 (Poisoning)	1 (Cardiac pathology)
Undetermined	4	0	1 (Poisoning)	3 (Cardiac pathology)
Total	171	148	16	7

(Chi-Square Statistic (χ^2): 8.11, Degrees of Freedom (df): 10, p-value: 0.618)

DISCUSSION

From our study population, a majority of 30.99% of the cases were in the 21-30 years age group. It differs from a study by Yadiyapur U *et al.*, in which the majority of cases (25.86%) were in the age group of 51-60 years.⁴ N. L. Disania *et al.* reported that the maximum number of deaths (27.27%) belonged to the 3rd decade of life,⁵ whereas, Gupta *et al.* reported that the 31-50 years age group topped with 48.89% of cases from the total.⁶ The wide range of age groups in different studies indicates that community-related deaths, where the deceased were brought dead to the hospital, can occur in any age group.

In this study, the male-to-female ratio was 1.6:1, which differs from various studies like Yadiyapur U, *et al.*, N. L. Disania, *et al.*, Gupta, *et al.*, and Apurba Biswas, *et al.*, who reported male-to-female sex ratios of 4.88:1, 1:0.18, 5.92:1, and 4.40:1, respectively.^{4,5,6,7}

In our study, forensic toxicology was useful in 1 case of hanging, 2 cases of mechanical injuries, 2 cases of cardiac causes, 5 cases of other natural causes, 5 cases of snake bites, and 1 undetermined case.

Our study showed that histopathological examination was useful in 3 cases of other natural causes, 3 undetermined cases, and 1 case of snake bite. According to Langlois, histological analysis determined the cause of death in 49 out of 203 cases (24%), where macroscopic examination alone did not provide a definitive cause. The probable cause of death, which was decided after complete gross examination, was changed in 4.8% of the cases. However, the histological findings did not alter the determined manner of death.⁸ Another study by Molina *et al.* found that among 189 cases, microscopic examination influenced the cause of death in only one case and had no impact on the manner of death in any case. Therefore, we believe that routine microscopic examination, where histologic analysis is performed in all cases regardless of the cause and manner of death, is not essential in forensic autopsies. Microscopic examination of organs should be used, as and when needed, in certain circumstances on a case-by-case basis, and it is not mandatory to follow as a standard procedure in every case⁹.

Despite the statistical analysis not showing a significant association between ancillary tests and change in cause of death ($p=0.618$), it is crucial to interpret these findings with caution. In forensic medicine, even a small number of cases

where the cause or manner of death changes due to ancillary tests like toxicology or histopathology can have profound legal and ethical implications. For instance, in the present study, two cases initially recorded as mechanical injuries were later revised to poisoning based on forensic toxicology results. Similarly, two cases thought to be due to cardiac causes were ultimately attributed to poisoning. These findings underscore the indispensable role of ancillary investigations in refining or correcting initial assessments made at autopsy. This highlights the importance of a thorough and case-by-case evaluation before deciding to omit such tests, especially in equivocal or complex cases. While the routine use of these methods may not be resource-feasible, selective application guided by preliminary findings can substantially impact justice delivery and accuracy in cause of death determination.

Postmortem examinations are very much needed for several reasons for investigating authorities. Medical or pathological autopsies are conducted with the consent of the deceased's next of kin to assess the extent of a disease process or evaluate the effectiveness of treatment. In contrast, medico-legal autopsies are performed by a forensic pathologist or medical officers in India to determine the cause and manner of death, interpret injuries, diagnose infectious or natural diseases that lead to death, report to appropriate agencies, provide information to family members and investigating agencies, and give evidence in the courts. Medico-legal autopsies may include histological analysis, but unlike medical autopsies, it is not always performed.

In India, most of the autopsy work is done by medical officers, who are government employees at primary care centres or community health centres. In many places, there are no facilities for histopathological examination or nearby laboratories for forensic toxicology. Often, the medical officer has to make a prudent decision depending upon his autopsy skills, whether preservation of viscera is required or not, on a case-by-case basis. No rule of thumb can be applied to preserve viscera in all cases, given the constraints of resources and facilities in a developing country like India.

It is better to follow good medical practice by taking necessary tissue samples in most cases for future examination if ordered by a competent authority. In cases of sudden death or when the forensic diagnosis remains uncertain, histological examination should be conducted to accurately determine the cause of death. This approach would greatly minimise the risk of forensic medical malpractice¹⁰. There is a need to generate more evidence for the utility of forensic toxicology and histopathological examination on a case-by-case basis to practice evidence-based forensic medicine.

One study noticed that diagnostic discrepancies or refinements impacted the cause of death after microscopic examination of lung tissue¹¹. The quality of histological sampling is also a very important factor in getting a positive result. Whether necropsy can be completed without systematic histological sampling in every case is debatable. Reasons for limited sampling or lack of sampling are cost limitations, lack of time, high caseload, lack of interest in dealing with postmortem histology, increased turnaround times, and even as a reaction to the media or sentiments of the general public¹².

Determining the cause of death in cases of suspected poisoning becomes challenging when the toxicology report yields negative results, creating confusion for the doctor who conducted the autopsy, legal authorities, and the public. The inability to detect poison in preserved viscera in poisoning-related deaths is a common issue in India. Several factors contribute to this challenge, including delays in sample testing, improper preservation, use of incorrect analytical techniques, rapid decomposition of poisons, complete metabolism of toxins in the body, minimal quantities of poison present in the viscera, and the absence of appropriate chemical reagents for certain poisons.

The inability to detect poison in preserved viscera in poisoning-related deaths is a common issue in India. Although not mandatory in all cases, the Forensic Science Laboratory (FSL) report is crucial in cases where there are allegations of death due to poisoning. The absence of an FSL report or a negative FSL finding significantly weakens the prosecution's case, as not all cases have sufficient

circumstantial evidence to establish that the accused administered poison to the deceased¹³.

According to one study, 81.6% of the population is concerned about the removal of organs or body parts during an autopsy¹⁴. Considering the economic burden for the country and ethical principles¹⁵, the autopsy surgeons must decide on the need for chemical analysis and histopathological examination to help the judicial system. Extensive research via funding agencies¹⁶ and various educational programs via recent educational technologies like e-learning^{17,18,19}, case-based discussion²⁰, Google sites²¹, etc., may help to create awareness among autopsy surgeons. Analytical methods for poison detection and the protocol for viscera preservation should be aligned with international standards.

This kind of comparison is underexplored in forensic studies, particularly in the Indian context. It has implications for medical education, legal standards of death certification, accuracy of public health statistics, etc. The use of saturated salt solution (though suboptimal) reveals systemic issues in forensic preparedness. By stating this openly, the study invites discourse around the need for better preservatives (e.g., sodium fluoride for blood) and capacity-building in medico-legal infrastructure and practice.

CONCLUSION

Histopathology is used to aid in the diagnosis by confirming the macroscopic findings, while forensic toxicology is very useful in death due to poisoning. Routine microscopic examination and forensic toxicology in all cases, regardless of the cause and manner of death, are generally unnecessary in a highly populous country like India. Microscopic examination and forensic toxicology should be conducted when necessary in specific cases, but are not required as routine procedures in a developing country like India.

SUGGESTIONS

A facility for forensic toxicology and histopathological examinations must be developed within the Forensic Medicine Department, which is conducting medico-legal

autopsies in tertiary care hospitals, that can offer services to the peripheral centres of the concerned districts. In current practice, forensic toxicology samples are handed over to investigating police officers, who deliver them to a central forensic science laboratory, which is causing significant delays in analysis and in getting the final report. Forensic toxicology sample collection, preservation, and analysis must be done as per the standard international protocol and procedures of developed countries. In the same way, histopathological examination must be carried out in the Forensic Medicine Department instead of sending samples to the Pathology Department. An autopsy surgeon must be well-trained to decide when to preserve viscera to avoid unnecessary exercise of histopathological examination and forensic toxicology in every case.

LIMITATIONS

This study was conducted by retrospectively analysing data from one year from a single tertiary care forensic centre only.

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CONFLICTS OF INTEREST

The authors declared no conflicts of interest.

ETHICAL ISSUES

None.

SOURCES OF SUPPORT

None.

AUTHOR CONTRIBUTIONS

PB: Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and reviewing it critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **AKB:** Conception and design of the work; the acquisition, analysis, and interpretation of data for the work; drafting the work and reviewing it critically for important intellectual content; final approval of the version to be published; and

agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **PP:** Conception and design of the work; reviewing the work critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. **GR:** Acquisition, analysis, and interpretation of data for the work; reviewing the work critically for important intellectual content; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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