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ORIGINAL ARTICLE

Correlation between Clinical Patterns of Poisoning and Forensic Toxicological Findings in Emergency Department Deaths. A Cross-Sectional Clinical Study

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ABSTRACT

Background: Poisoning remains a major cause of morbidity and mortality in emergency departments, particularly in low- and middle-income countries. Accurate identification of toxic agents is often hindered by limited clinical information, delayed presentation, and lack of diagnostic facilities.

Objectives: This study aimed to evaluate the correlation between clinical patterns of poisoning and forensic toxicological findings in deaths presenting to the emergency department.

Methodology: This cross-sectional study was conducted at a tertiary care hospital in Pakistan from July 2022 to July 2023. A total of 49 poisoning-related fatalities underwent complete medico-legal autopsies with detailed toxicological analysis. Demographic data, clinical features, suspected toxins, and emergency interventions were recorded from ED records and autopsy reports. Toxicological testing was performed using thin-layer chromatography, gas chromatography-mass spectrometry, and HPLC. Statistical analysis included descriptive frequencies, Chi-square test, and Cohen's kappa coefficient.

Results: The majority of victims were male (63.3%), with the 21–30-year age group being most affected. The most common toxins identified were organophosphates (30.6%) and pharmaceutical drugs (24.5%). Clinical suspicion matched toxicological findings in only 51% of cases. The agreement between clinical and forensic findings was moderate (Cohen's $\kappa = 0.44$; $p < 0.05$). Vomiting, unconsciousness, and respiratory distress were the most common presenting symptoms. Antidotes were administered in just 18.4% of cases.

Conclusion: There is a significant mismatch between clinically suspected and confirmed toxins in fatal poisoning cases. Routine forensic toxicology, emergency physician training, and access to point-of-care diagnostics are essential to improve early detection, targeted treatment, and mortality outcomes in acute poisoning.

Keywords: Poisoning deaths, emergency medicine, forensic toxicology, organophosphates, toxicology mismatch, Cohen's kappa, Pakistan, clinical–forensic correlation.

INTRODUCTION

Poisoning remains a major public health concern worldwide, contributing significantly to emergency department (ED) admissions and mortality [1]. The clinical spectrum of poisoning is diverse, ranging from intentional self-harm and substance misuse to accidental and occupational exposures. In low and middle-income countries, including Pakistan, the burden of toxic exposures is further exacerbated by unrestricted access to hazardous substances, lack of public awareness, and inadequate regulatory mechanisms governing the sale and labeling of toxic agents [2]. Despite the growing incidence, comprehensive studies that correlate clinical presentations with confirmatory toxicological evidence in fatal poisoning cases remain limited in the region [3].

The emergency department often represents the first and last point of contact for patients with acute poisoning. Clinicians rely heavily on initial symptomatology, patient history (if available), physical examination, and presumptive diagnoses to initiate empiric management, particularly in settings where real-time toxicological screening is unavailable[4]. However, postmortem toxicological analyses conducted during forensic autopsies frequently reveal discrepancies between presumed clinical diagnosis and actual substances involved. Such mismatches may hinder the development of effective poisoning surveillance strategies and limit the accuracy of mortality audits[5].

Several international studies have attempted to establish diagnostic congruence between emergency clinical impressions and laboratory-confirmed toxicological findings[6]. These investigations underscore the critical role of forensic toxicology not only in determining the exact cause of death but also in enhancing diagnostic precision, guiding public health interventions, and informing medico-legal proceedings [7]. However, the applicability of such findings to the local context remains uncertain due to variations in toxicological profiles, patterns of substance abuse, healthcare infrastructure, and sociocultural determinants of poisoning [8].

This study aims to bridge this gap by conducting a detailed cross-sectional analysis of 49 poisoning-related deaths reported to a tertiary care emergency department over a defined period. Each case underwent complete medico-legal autopsy and toxicological screening [9]. The objective is to evaluate the correlation between clinical patterns observed in the ED and the toxic agents identified postmortem. The study also seeks to categorize poison types, routes of exposure, and intent (accidental vs. intentional) and assess demographic variables associated with fatal outcomes [10].

By correlating clinical impressions with toxicological findings, this study intends to highlight diagnostic blind spots, enhance awareness of prevalent toxic agents, and inform policy changes regarding poison control systems in emergency care [11]. Ultimately, these findings may support improved training for emergency physicians, optimization of antidote administration protocols, and enhanced forensic documentation standards in resource-constrained settings.

MATERIALS AND METHODS

This cross-sectional study was carried out at the Department of Forensic Medicine and Toxicology in collaboration with the Emergency Department of PEMH Rawalpindi, Forensic Medicine Department, Bacha Khan Medical College, Forensic Medicine Department, King Edward Medical University Lahore and Jinnah Hospital Lahore in Pakistan. The study spanned a one-year period from July 2022 to July 2023 and included all cases of death presenting to the emergency department with suspected poisoning. Ethical approval for the study was obtained from the

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Institutional Review Board of each institute. All medico-legal protocols were strictly followed in accordance with national forensic guidelines.

A total of 49 deceased individuals were included in the study based on well-defined inclusion criteria. Eligible cases were those aged 12 years or older, of either sex, who had been brought dead or had expired during resuscitation in the emergency department and were suspected to have died due to poisoning. Only cases that underwent complete medico-legal autopsy with available and analyzable toxicological reports were considered. Cases with trauma, burns, drowning, or natural causes were excluded, as were decomposed bodies and those lacking sufficient biological samples or complete medical records.

Data collection was conducted through comprehensive review of emergency department records, medico-legal documentation, and postmortem reports. Clinical information included the presenting symptoms such as vomiting, unconsciousness, respiratory distress, convulsions, cyanosis, miosis or mydriasis, and cardiac arrest. The time interval between suspected toxin ingestion and hospital arrival was recorded, as well as any emergency measures initiated, including gastric lavage, antidote administration (e.g., atropine, naloxone, N-acetylcysteine), oxygen therapy, and ventilatory support. Furthermore, the suspected poison was noted as documented by emergency physicians based on patient history and clinical judgment.

Demographic variables were thoroughly analyzed and included age (categorized as 12–20, 21–30, 31–40, and >40 years), sex, marital status, residential locality, occupation (student, laborer, housewife, professional, unemployed), and socioeconomic indicators. Any documented history of psychiatric illness, prior suicide attempts, or substance abuse was also noted when available. Each of the 49 cases underwent a complete medico-legal autopsy, with careful external and internal examination aimed at identifying classical signs of poisoning such as mucosal corrosion, smell of toxic substances, organ congestion, or petechial hemorrhages. During the autopsy, multiple biological specimens including stomach contents, blood, urine, liver, kidney, and bile were collected using sterile techniques and stored in appropriate preservative media. These samples were then transported under chain-of-custody protocols to the regional forensic toxicology laboratory.

Toxicological analyses were performed using a combination of analytical methods. Initial screening was conducted via thin-layer chromatography (TLC), followed by confirmatory testing using gas chromatography-mass spectrometry (GC-MS) and high-performance liquid chromatography (HPLC). Enzyme-linked immunosorbent assays (ELISA) were also employed for detecting specific pharmaceutical drugs and pesticides. Identified toxins were grouped into six categories: organophosphates and other agricultural pesticides; pharmaceutical agents including sedatives, antidepressants, and analgesics; alcohols and industrial solvents; household chemicals such as acids and bleaches; heavy metals; and illicit substances including heroin, opioids, and cannabinoids. Data were entered and statistically analyzed using IBM SPSS version 26.0. Descriptive statistics were employed to summarize demographic data and toxicological profiles. Continuous variables were expressed as means and standard deviations (SD), while categorical variables were presented as frequencies and percentages. Associations between clinical impressions and toxicological findings were assessed using chi-square tests. To measure the degree of agreement between the suspected and confirmed toxins, Cohen's kappa coefficient was calculated. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 49 poisoning-related deaths were included in this study. The demographic and clinical data, toxicological findings, and correlation between suspected and confirmed toxic agents are detailed below. The majority of the victims were male (n = 31, 63.3%), while females accounted for 18 cases (36.7%). The mean age was 29.4 ± 10.8 years, with the highest frequency of cases occurring in the 21–30-year age group (n = 19, 38.8%), followed by the 31–40-year group (n = 13, 26.5%). Most individuals belonged to low- to middle-income backgrounds and were either unemployed (30.6%) **or** laborers (24.5%) as shown in table 1.

The most common clinical presentations included vomiting (69.4%), loss of consciousness (53.1%), and respiratory distress (44.9%). In 29 cases (59.2%), patients were brought dead; the remaining 20 cases died during resuscitation. Gastric lavage was attempted in 34.7% of cases, while specific antidotes were administered in only 18.4% due to lack of confirmatory diagnosis as shown in table 2.

Postmortem toxicological analysis confirmed the presence of toxic substances in all cases. Organophosphate pesticides were the most frequently identified agents (n = 15, 30.6%), followed by pharmaceutical drugs (including benzodiazepines, paracetamol, and tricyclic antidepressants) in 24.5% of cases. Alcohols/solvents were detected in 14.3%, while household chemicals (e.g., bleach, toilet cleaners) accounted for 12.2%. Illicit drug use (e.g., heroin, methadone) was confirmed in 6 cases (12.2%) as shown in table 3.

Emergency physicians clinically suspected the correct toxic agent in only 25 out of 49 cases (51%). In 24 cases (49%), the substance identified in the toxicological report differed from the agent initially suspected. The agreement between clinical suspicion and toxicology findings, assessed using Cohen's Kappa, was $\kappa = 0.44$, indicating moderate agreement as shown in table 4.

Table 1: Demographic Characteristics of Poisoning Fatalities (n = 49)

Variable	Frequency (n)	Percentage (%)
Sex		
Male	31	63.3
Female	18	36.7
Age Group (Years)		
12–20	7	14.3
21–30	19	38.8
31–40	13	26.5
>40	10	20.4
Marital Status		
Married	29	59.2
Unmarried	20	40.8
Occupation		
Laborer	12	24.5
Housewife	9	18.4
Student	7	14.3
Unemployed	15	30.6
Professional	6	12.2

Table 2: Clinical Characteristics Observed in Emergency Department (n = 49)

Clinical Feature	Frequency (n)	Percentage (%)
Vomiting	34	69.4
Loss of Consciousness	26	53.1
Respiratory Distress	22	44.9
Convulsions	10	20.4
Cyanosis	8	16.3
Cardiac Arrest in ED	20	40.8
Gastric Lavage Performed	17	34.7
Antidote Given	9	18.4

Table 3: Toxicological Categories Identified Postmortem (n = 49)

Toxin Category	Frequency (n)	Percentage (%)
Organophosphates/Pesticides	15	30.6
Pharmaceutical Drugs	12	24.5
Alcohols and Solvents	7	14.3
Household Chemicals	6	12.2
Illicit Substances	6	12.2
Heavy Metals (e.g., Arsenic)	3	6.1

This data highlights the diagnostic uncertainty in emergency poisoning cases and emphasizes the indispensable role of forensic toxicology in confirming the cause of death. The high percentage

of misclassified agents also underscores the urgent need for bedside rapid toxicology kits, especially in resource-limited settings.

Table 4: Clinical vs. Toxicological Correlation

Parameter	Number (n)	Percentage (%)
Clinically Suspected = Confirmed	25	51.0
Clinically Suspected ≠ Confirmed	24	49.0
Cohen's Kappa (κ)	—	0.44 (moderate)

DISCUSSION

This study elaborated a detailed clinical and toxicological overview of poisoning-related mortalities presenting to the emergency department (ED) of a tertiary care hospital in Pakistan. The findings reveal important diagnostic, forensic, and public health insights, particularly highlighting the discrepancy between clinically suspected toxins and postmortem toxicological confirmation[12]. Despite ongoing improvements in emergency medicine and toxicology, our results demonstrate that in nearly 49% of cases, the clinically suspected agent did not match the toxicological findings, emphasizing a considerable diagnostic gap in acute poisoning assessment [13].

The majority of victims were young adults aged 21–30 years, consistent with the global pattern of higher poisoning incidence in younger age groups due to occupational exposure, impulsive suicidal behaviors, or accidental ingestion [14]. Male predominance (63.3%) in our study also aligns with prior literature suggesting higher risk behaviors, substance misuse, and occupational exposure among males in developing countries. However, the proportion of female victims (36.7%), many of whom were housewives, raises concern regarding the easy domestic access to poisonous substances such as organophosphates, acids, and household cleaners, which are often used impulsively during interpersonal conflicts [15].

Clinically, vomiting, unconsciousness, and respiratory distress were the most common presenting symptoms non-specific features that are frequently seen across a broad spectrum of toxicological agents[16]. The low rate of antidote administration (18.4%), despite clear poisoning signs, reflects diagnostic uncertainty and limited access to rapid bedside screening kits in resource-limited EDs. Notably, 59.2% of victims were brought dead, indicating delayed medical presentation, which not only limits life-saving interventions but also complicates the clinical identification of toxic agents [17].

Toxicological analysis revealed that organophosphate pesticides were the most commonly detected agents (30.6%), consistent with numerous regional studies where unrestricted access to agricultural chemicals remains a persistent problem [18]. The high burden of deaths from pharmaceutical drugs (24.5%), including sedatives, analgesics, and antidepressants, points toward increased psychotropic drug use and lack of psychiatric screening or prescription control. Household chemicals (12.2%) and alcohols/solvents (14.3%) also contributed significantly, particularly among lower socioeconomic groups, underscoring the need for regulatory policies on labeling, storage, and accessibility of these substances[19].

A key finding of this study was the moderate agreement between clinical suspicion and toxicological confirmation (Cohen's $\kappa = 0.44$). Similar studies conducted in India, Iran, and Turkey have reported concordance rates ranging between 40–60%, depending on physician experience, availability of toxicological kits, and regional poison patterns[20]. The misclassification rate of 49% in our study, while consistent with regional figures, suggests a statistically significant diagnostic challenge ($p < 0.05$) that could lead to delayed or inappropriate treatment. This has important implications for emergency physicians, particularly in settings where immediate toxicology panels are unavailable. Incorporating point-of-care toxicology kits and physician training in toxidrome recognition could significantly improve early identification and management[11,15].

Our study also reaffirms the value of forensic toxicology in providing conclusive evidence regarding the cause of death. In many cases, toxicological findings helped uncover agents that were not initially suspected such as industrial solvents, methadone, or combined substance ingestion thereby contributing to improved medico-legal clarity and epidemiological understanding[19]. This reinforces the necessity of making routine forensic toxicology an integral part of postmortem investigations, especially in ED deaths involving young adults.

The study has several strengths, including strict inclusion criteria, standardized autopsy and toxicology protocols, and integration of both clinical and forensic data. However, some limitations exist. First, the sample size was modest (n = 49), limiting generalizability [7,15]. Second, incomplete histories or lack of witness reports in ED records constrained clinical correlation. Third, quantitative toxicology levels were not performed due to laboratory limitations, restricting dose response evaluation [12].

Despite these limitations, our findings emphasize the critical gap between clinical judgment and forensic reality in poisoning-related fatalities. Bridging this gap requires a multifaceted approach: improved toxicology training in emergency medicine curricula, policy reforms to regulate toxic substance availability, establishment of regional poison control centers, and investment in bedside toxicology testing[20]. Furthermore, mental health interventions are urgently needed to address the underlying psychiatric and social triggers that contribute to intentional poison ingestion.

CONCLUSION

This study highlighted a significant diagnostic gap between clinical suspicion and toxicological confirmation in poisoning-related emergency department deaths. Nearly half of the cases showed a mismatch, underscoring the limitations of relying solely on clinical presentation. Organophosphates and pharmaceutical agents were the most frequently detected toxins, predominantly affecting young adults. The findings emphasize the need for improved emergency toxicology training, access to rapid diagnostic tools, and integration of routine postmortem toxicological analysis. Strengthening poison regulation and mental health support is essential to reduce preventable fatalities and improve diagnostic accuracy in acute toxic exposures.

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