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Research Paper

Bedside Toxidromic Evaluation and Qualitative Analytical Screening in Acute Poisoning Cases Presenting to a Tertiary Care Emergency Department: An Observational Cross-Sectional Study

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ABSTRACT

Background: Acute poisoning still represents a major health emergency and an important public health issue, especially in low- and middle-income countries where pesticides, pharmaceuticals, alcohol, and everyday household toxins are widely available. Early bedside recognition of a toxidrome can guide immediate lifesaving treatment, while qualitative analytical screening testing may provide presumptive laboratory support to the clinical diagnosis. To identify common poisoning agents based on bedside toxidromic assessment and to correlate toxidromic diagnosis with qualitative analytical screening test findings.

Methods: This prospective, hospital-based, observational, cross-sectional study was conducted in the Emergency Department and Department of Forensic Medicine and Toxicology of a tertiary care teaching hospital in North India. The study was conducted over a time period of 18 months from July 2024 to December 2025. Eighty-six adult patients with suspected acute poisoning were enrolled by consecutive sampling after obtaining informed consent from the patient or legally authorized representative. Demographic details, clinical features, toxidromic category, probable poison type, qualitative color-test findings, and immediate hospital outcome were recorded and analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0.

Results: The mean age of the patients was 32.90±11.31 years, and the commonest age group was 21-30 years (37.21%). Males constituted 67.44% of cases. Organophosphate (OP) poisoning was the most common type (41.86%), followed by drug overdose (23.26%), alcohol (13.95%), and other poisons (20.93%). Cholinergic toxidrome was the most common toxidrome (39.53%), followed by sedative (18.60%), sympathomimetic (16.28%), opioid (13.95%), and anticholinergic (11.63%). Toxidrome was significantly associated with outcome ($p = 0.011$), and the type of poison was also significantly associated with outcome ($p = 0.018$). Cholinergic toxidrome showed the highest qualitative test positivity, with 29 of 34 clinically suspected cases showing positive qualitative findings.

Conclusion: Bedside toxidromic assessment is a useful early clinical tool in acute poisoning, particularly in suspected organophosphate poisoning. Qualitative analytical tests provide only presumptive laboratory support, but they should be interpreted along with clinical findings and not as a substitute for definitive instrumental confirmation.

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Introduction

Acute poisoning is a common cause of emergency department attendance and continues to contribute substantially to morbidity and mortality worldwide, especially in low- and middle-income countries. The burden is amplified by the easy availability of pesticides, household chemicals, pharmaceuticals, and region-specific toxic agents, along with delayed access to emergency care [1-4].

In India, the epidemiology of poisoning reflects a mixed pattern involving agricultural pesticides, therapeutic drug overdoses, corrosives, alcohol, rodenticides, and household chemicals. However, pesticides, particularly organophosphates, continue to account for a major proportion of severe poisoning and poisoning-related deaths in many hospital-based studies. Young adults are frequently affected, reflecting psychosocial stress, occupational exposure, impulsive self-harm, and easy access to toxic substances[2, 3, 6-10].

The concept of a toxidrome refers to a constellation of clinical signs and symptoms that suggests exposure to a probable class of toxic substances. Recognition of cholinergic, anticholinergic, opioid, sedative-hypnotic, and sympathomimetic toxidromes can facilitate rapid diagnosis and immediate empirical management even before laboratory confirmation becomes available. Early toxidromic assessment is particularly useful when the history is absent, unreliable, or intentionally concealed [11-14].

Although bedside toxidromic diagnosis is extremely valuable in emergencies, it has inherent limitations. Delay of the patient's arrival, previous therapy received, mixed-poisoning, chronic use of a drug, co-existing illness, and variable doses all can cause atypical clinical presentations. Aside from these factors, some poisons can present both overlapping and unique syndromes. Thus, analytical toxicology is necessary to make definite confirmations of suspected agents, determine co-exposures, and improve the accuracy of both diagnosis and medico-legal documentation [14-17].

Analytical methods in poisoning range from rapid qualitative color tests to more specific confirmatory methods such as high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and liquid chromatography-tandem mass spectrometry (LC-MS/MS).In the present study, only qualitative color tests were used as presumptive analytical screening methods. These tests provide rapid preliminary support but do not replace definitive instrumental confirmation [16, 17].

Against this background, the present study was undertaken to evaluate the clinical toxidromic profile of acute poisoning patients presenting to a tertiary care emergency department and to examine its relationship with presumptive qualitative analytical screening findings in a North Indian hospital setting. To assess the bedside toxidromic profile of acute poisoning cases and to evaluate its concordance with presumptive qualitative analytical screening findings. To study the socio-demographic profile and common poisoning agents among acute poisoning cases. To describe the pattern of bedside toxidromic categorization among acute poisoning cases. To assess the concordance between bedside toxidromic categorization and presumptive qualitative color-test positivity. To study the association of toxidrome and type of poison with immediate hospital outcome.

Materials and Methods

This prospective hospital-based observational cross-sectional study was conducted in the Emergency Department and Department of Forensic Medicine and Toxicology of a tertiary care teaching hospital in North India. The study was conducted over a time period of 18 months from July 2024 to December 2025.

Sampling method and patient enrolment

All eligible adult patients presenting with suspected acute poisoning during the study period were enrolled by consecutive sampling after applying the inclusion and exclusion criteria and after obtaining informed consent from the patient or legally authorized representative.

Sample Size Calculation

The sample size was calculated using the standard formula for estimating a mean, based on the reference mean and standard deviation reported in a previous toxicological assessment study [15].

$$N = \frac{Z_{\alpha}^2 \times SD^2}{d^2}$$

Where Zα is the standard normal value at 95% confidence level, taken as 1.96; SD is the estimated standard deviation from the reference study, taken as 23.6; and d is the allowable error, taken as 5% of the mean. Based on the reference mean value of 55, the allowable error was calculated as 2.75. After applying these values in the formula, the calculated sample size was 85.58, which was rounded off to 86 patients. Therefore, a total of 86 patients with acute poisoning

were included in the study.

Inclusion criteria

All patients aged 18 years and above presenting to the Emergency Department with suspected acute poisoning during the study period were considered eligible after informed consent from the patient or legally authorized representative. Cases were included irrespective of whether the exact poison was known at presentation, provided that a clinical suspicion of acute poisoning was present.

Exclusion criteria

Patients below 18 years of age, chronic poisoning, isolated food poisoning, adverse drug reactions without intentional or accidental toxic exposure, isolated snakebite/scorpion sting, brought-dead cases, cases with incomplete clinical or laboratory records, and cases in which consent could not be obtained were excluded. Mixed poisoning cases were classified according to the dominant toxidromic presentation after senior clinical review.

Adult patients presenting with suspected acute poisoning were enrolled after informed consent. Data collection: Socio-demographic details, clinical features, probable poison type, toxidromic category, qualitative color-test findings, contributory risk factors, and immediate hospital outcome were recorded on a structured proforma

Toxidromic Classification

Each patient was assessed at the bedside for characteristic clinical features, including pupil size, secretions, sweating, pulse rate, blood pressure, temperature, respiratory pattern, bowel/bladder activity, level of consciousness, and neurological signs. Based on these findings, patients were classified into one of five major toxidromes: cholinergic, anticholinergic, opioid, sedative-hypnotic, or sympathomimetic. In cases with overlapping features, the dominant toxidrome was assigned according to the most characteristic clinical features after senior clinical review [11-15]. In cases with overlapping clinical features, the dominant toxidrome was assigned based on the most characteristic and clinically significant findings at presentation. The bedside toxidromic assessment was performed at initial presentation before the availability of qualitative analytical test results. Therefore, the clinician assigning the toxidromic category was blinded to the subsequent qualitative color-test findings (Table 1).

Samples such as gastric lavage/vomitus/urine/blood/poison container content were collected as per institutional protocol and analyzed for suspected poison groups. Presumptive qualitative screening was performed according to the suspected toxidrome using Ellman's/indophenyl acetate test for cholinergic, Vitali–Morin/Dragendorff's test for anticholinergic, Marquis/Mecke test for opioid, Dille–Koppanyi/Zimmermann test for sedative-hypnotic, and Marquis/Mandelin/Simon's/Scott test for sympathomimetic poisoning [5, 16, 17].

The main outcomes included toxidromic classification, association between toxidrome and poison type, qualitative color-test positivity, and immediate patient outcome categorized as discharge, death, or referral. Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 24.0. Continuous variables were expressed as mean +/standard deviation, while categorical variables were expressed as frequency and percentage. Associations between categorical variables were assessed using the chi-square test. Fisher's exact test was applied where expected cell counts were less than 5. A p-value of less than 0.05 was considered statistically significant.

The study was approved by the Institutional Ethics Committee of the institute. Written informed consent was obtained from participants or their attendants, and confidentiality was maintained throughout the study.

Results

A total of 86 patients with acute poisoning were studied. The largest age group was 21-30 years (32 patients, 37.21%), followed by 31-40 years (24,

Table 1. Clinical Criteria for Bedside Toxidromic Classification.

Toxidrome	Typical bedside clinical features
Cholinergic	Miosis; salivation; lacrimation; sweating; bronchorrhea; bradycardia; vomiting/diarrhea; fasciculations; respiratory distress; altered sensorium
Anticholinergic	Mydriasis; dry mouth; dry skin; tachycardia; urinary retention; hyperthermia; agitation/delirium
Opioid	Miosis; respiratory depression; reduced consciousness; bradycardia/hypotension; reduced bowel sounds
Sedative-hypnotic	Drowsiness/coma; slurred speech; ataxia; hyporeflexia; respiratory depression in severe cases; usually normal pupils
Sympathomimetic	Mydriasis; tachycardia; hypertension; sweating; agitation; tremor; hyperthermia/seizures in severe cases

27.91%), >40 years (18, 20.93%), and <20 years (12, 13.95%). The mean age was 32.90±11.31 years. Males predominated (58, 67.44%) over females (28, 32.56%). Married individuals constituted 62.79% of cases. Most participants were Hindu (69.77%). Occupationally, laborers (20.93%) and homemakers (18.60%) were common, and most patients had education up to the

Table 2. Socio-demographic characteristics of study participants (n=86).

Variable	Category	n	%
Age Group	<20	12	13.95
	21–30	32	37.21
	31–40	24	27.91
	>40	18	20.93
	Mean±SD	32.90 ± 11.31	
Sex	Male	58	67.44
	Female	28	32.56
Marital Status	Married	54	62.79
	Unmarried	32	37.21
Religion	Hindu	60	69.77
	Muslim	22	25.58
	Other	4	4.65
Occupation	Farmer	10	11.63
	Homemaker	16	18.60
	Laborer	18	20.93
	Service	14	16.28
	Student	12	13.95
	Business	8	9.30
	Unemployed	8	9.30
Education	Illiterate	12	13.95
	Primary	18	20.93
	Secondary	32	37.21
	Graduate	20	23.26
	Postgraduate	4	4.65
Family Type	Nuclear	52	60.47
	Joint	34	39.53

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secondary level (37.21%). Nuclear families accounted for 60.47% of cases (Table 2).

Among contributory risk factors, tobacco chewing was present in 53.49% of patients, alcohol use in 48.84%, smoking in 45.35%, psychiatric illness in

Table 3. Distribution of contributory/risk factors among study participants (n = 86).

Risk factor	n	%
Tobacco chewing	46	53.49
Alcohol use	42	48.84
Smoking	39	45.35
Psychiatric illness	18	20.93
Drug abuse	12	13.95

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20.93%, and drug abuse in 13.95%. Contributory risk factors observed among the patients are presented in Table 3.

Organophosphate poisoning was the commonest type of poisoning, accounting for 36 cases (41.86%), followed by drug overdose in 20 (23.26%), alcohol-related poisoning in 12 (13.95%), and other poisons in 18 (20.93%) (Table 4).

Table 4. Distribution of type of poison among study participants (n = 86).

Type of poison	n	%
Organophosphate	36	41.86
Drug overdose	20	23.26
Alcohol-related poisoning	12	13.95
Other poisons	18	20.93

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The most common toxidrome was cholinergic, observed in 34 patients (39.53%), followed by sedative-hypnotic in 16 (18.60%), sympathomimetic in 14 (16.28%), opioid in 12 (13.95%), and anticholinergic in 10 (11.63%) (Table 5).

Table 5. Distribution of toxidrome identified among study participants (n=86).

Toxidrome Identified	n	%
Cholinergic	34	39.53
Sedative	16	18.60
Sympathomimetic	14	16.28
Opioid	12	13.95
Anticholinergic	10	11.63

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The association between the type of poison and toxidrome identified is shown in Table 6. Cholinergic toxidrome was predominantly associated with organophosphate poisoning, while sedative-hypnotic toxidrome was commonly associated with alcohol-related poisoning and drug overdose. Opioid and anticholinergic toxidromes were mainly observed among drug overdose cases (Table 6).

Table 7 shows the association between toxidrome and patient outcome. The table shows a statistically significant association between toxidrome and patient outcome ($\chi^2 = 19.89$, $p = 0.011$), indicating that the type of toxidrome influences the outcome of poisoning cases. This group had the highest mortality, suggesting that cholinergic poisoning (mainly organophosphate) is associated with more severe outcomes.

A statistically significant association was observed

Table 6. Association between type of poison and toxidrome identified (n = 86).

Type of poison	Predominant toxidrome	Toxidromic distribution (n)	Total
Organophosphate	Cholinergic	Cholinergic 34; Sedative-hypnotic 1; Sympathomimetic 1	36
Drug overdose	Opioid/Anticholinergic	Sedative-hypnotic 2; Sympathomimetic 4; Opioid 8; Anticholinergic 6	20
Alcohol-related poisoning	Sedative-hypnotic	Sedative-hypnotic 11; Sympathomimetic 1	12
Other poisons	Sympathomimetic	Sedative-hypnotic 2; Sympathomimetic 8; Opioid 4; Anticholinergic 4	18

Table 7. Association between Toxidrome and Patient Outcome (N=86).

Toxidrome	Discharge, N (%)	Death, N (%)	Referred, N (%)	χ^2 Value	p-value
Cholinergic	24 (70.59)	10 (29.41)	0 (0.00)	19.89	0.011
Sedative	13 (81.25)	0 (0.00)	3 (18.75)		
Sympathomimetic	11 (78.57)	2 (14.29)	1 (7.14)		
Opioid	10 (83.33)	0 (0.00)	2 (16.67)		
Anticholinergic	10 (100.00)	0 (0.00)	0 (0.00)		

between the type of poison and patient outcome (χ^2=18.50, p=0.018). Organophosphate poisoning had the highest mortality (30.56%), while drug overdose and alcohol-related poisoning showed comparatively better survival (Table 8).

Table 8. Association between Type of Poison and Patient Outcome (N=86).

	Discharge, N (%)	Death, N (%)	Referred, N (%)	χ^2 Value	p-value
Organophosphate	25 (69.44)	11 (30.56)	0 (0.00)	18.50	0.018
Drug Overdose	18 (90.00)	0 (0.00)	2 (10.00)		
Alcohol	10 (83.33)	0 (0.00)	2 (16.67)		
Other	15 (83.33)	1 (5.56)	2 (11.11)		

Presumptive qualitative color-test positivity was observed in 62 of 86 cases (72.1%). The highest test positivity rate was observed in cholinergic toxidrome, where 29 of 34 clinically suspected cases showed positive qualitative color-test findings (85.3%) (Table 9).

Table 9. Toxidromic diagnosis and qualitative colour-test positivity.

Toxidrome identified	Total clinically suspected cases (n)	Positive by qualitative colour test (n)	Qualitative test positivity rate (%)
Cholinergic	34	29	85.3
Sedative	16	11	68.8
Sympathomimetic	14	9	64.3
Opioid	12	7	58.3
Anticholinergic	10	6	60.0
Total	**86**	**62**	**72.1**

Discussion

The present prospective observational cross-sectional study evaluated bedside toxidromic assessment and presumptive qualitative analytical screening in acute poisoning cases that came to a tertiary care hospital's emergency room. Acute poisoning is still a major clinical and medico-legal emergency in India, where alcohol, insecticides, home chemicals, and pharmaceutical agents are easily accessible. The majority of acute poisoning cases in the current study occurred in young males, especially those between the ages of 21 and 30 [3, 6-10]. This result is similar to that of Ramesha et al., Kumar et al., Chaudhary et al., Todi et al., and Muhammad et al., who similarly noted a greater percentage of male patients in cases of acute poisoning [6–10]. The higher incidence among young men could be linked to increased exposure to the outdoors, interaction with

chemicals or pesticides at work, alcohol or drug use, and risk-taking. However, depending on local sociocultural norms, access to poisonous chemicals, and domestic circumstances, the gender distribution of poisoning may differ by region. The most often found toxic agents in the current investigation were organophosphate chemicals. This result is consistent with the widespread poisoning pattern observed in many South Asian and Indian environments, where pesticides are readily accessible and commonly utilized for self-poisoning. Organophosphates and other pesticides have also been identified by Maheswari et al., Mittal et al., Ramesha et al., Kumar et al., Chaudhary et al., and Chhetri et al. as significant causes of acute poisoning morbidity and mortality [2, 3, 6-8, 20]. The results emphasize the ongoing need for public awareness, limited access, safe pesticide storage, and prompt referral in cases of suspected organophosphate poisoning. Bedside toxidromic evaluation was a crucial part of the current investigation. The most common toxidrome among those found was the cholinergic toxidrome. This was anticipated since a significant percentage of cases had organophosphate poisoning. Choudhury et al. [15] also highlighted the usefulness of toxidrome-based evaluation in poisoning cases that come to a tertiary hospital. The use of toxidromic assessment as an early bedside method is supported by standard toxicology references by Brent et al., Olson, Tintinalli et al., and Goldfrank's Manual of Toxicologic Emergencies [1, 12–14]. This is especially true when the specific poison is unknown at presentation. In emergencies, it is particularly crucial to recognize cholinergic toxidrome. Clinical signs of organophosphate poisoning include miosis, excessive salivation, lacrimation, bronchorrhea, bradycardia, fasciculations, vomiting, diarrhea, and respiratory difficulties. Before test confirmation is obtained, atropine and oxime therapy can be started as soon as this toxidrome is identified. Waiting for confirming results in these situations could delay life-saving care. The current investigation also found other toxidromes, such as opioid, sympathomimetic, sedative, and anticholinergic toxidromes. Alcohol or sedative drug exposure was frequently linked to sedative toxidrome, drug overdose to opioid toxidrome, and pharmaceutical or plant-related poisoning to anticholinergic toxidrome. These results validate the value of a toxidrome-based strategy in situations where the history is ambiguous, inconsistent, or lacking. This method aids medical professionals in identifying the most likely toxin category and starting early supportive care in emergencies. The prognosis of acute poisoning seems to be more related to the type of poison, clinical severity, toxidromic presentation, delay in reaching the hospital, and demand for intensive care unit therapy rather than demographic features. Ramesha et al., Kumar et al., Chaudhary et al., and Todi et al. [6–9] identified clinical severity and type of poison as more important predictors of outcome than age or sex alone.

Qualitative color tests and other analytical procedures provided useful confirmation information, supporting the toxidromic diagnosis. Analytical testing improves diagnostic certainty, and toxidromic evaluation facilitates early clinical decision-making in emergency scenarios. According to Kabera et al. [16], qualitative and instrumental toxicological techniques are crucial tools in forensic toxicology, particularly in suspected poisoning situations. According to Shi et al., toxicological analysis is effective in patients with acute poisoning with uncertain exposure histories because it assists clinical interpretation and defines the nature of exposure [23].

Qualitative color tests were very effective in this study in cases of dubious history, unavailability of poison container or suspicion of mixed poisoning. Although these tests are not a replacement for sophisticated analytical procedures, they provide a rapid presumptive indication and increase confidence in the clinical diagnosis. The role of analytical approaches in confirming harmful exposure and improving toxicological interpretation has also been stressed by Vaheru et al. and Azizuddin et al. [17, 22]. In complicated or medico-legal circumstances, more conclusive confirmation may be obtained using advanced techniques such as HPLC, GC-MS or LC-MS/MS.

The significantly higher mortality observed among patients with cholinergic toxidrome is clinically important and is most likely related to the predominance of organophosphate poisoning in this group. Organophosphate compounds can rapidly produce bronchorrhea, bronchospasm, neuromuscular weakness, seizures, and respiratory failure. Therefore, early bedside recognition of cholinergic toxidrome has direct therapeutic implications because atropine, oximes, airway support, and decontamination measures can be initiated without waiting for laboratory reports. In the present study, qualitative analytical testing added value by providing presumptive support to the bedside diagnosis, especially when history was unreliable, the poison container was unavailable, or mixed exposure was suspected.

From a forensic medicine point of view, the combination of bedside toxidromic assessment and analytical screening is of considerable value. Correct identification of suspected poison aids in treatment, helps in selection and preservation of relevant biological samples, enhances the quality of medico-

legal documentation and supports the final opinion in poisoning cases. Clinical findings, contextual history, sample preservation, poison container handling, toxidromic traits, therapeutic response and analytical data should thus be considered in concert and not in isolation.

Overall, the present study supports the practical value of bedside toxidromic assessment in emergency toxicology. In resource-limited settings, where advanced toxicological confirmation may not be immediately available, a structured toxidrome-based approach supported by presumptive qualitative screening can improve early clinical decision-making and strengthen medico-legal documentation.

Limitations

This study has certain limitations. It was conducted at a single tertiary care center with a relatively small sample size; hence, the findings may not be generalizable to all emergency settings. The analytical component was based on qualitative color tests, which are presumptive screening tests and cannot replace definitive instrumental confirmation. Mixed poisoning, prior treatment before hospital arrival, delayed presentation, and co-existing illness may have influenced the bedside toxidromic presentation. Patients who were referred to another center could not be followed up; therefore, their final clinical outcome could not be determined.

Conclusion

The present study showed that acute poisoning was more commonly observed among young adult males, with organophosphate compounds being the most frequent poisoning agents. Bedside toxidromic evaluation was a useful early clinical approach for identifying the probable category of poisoning, particularly when history was unclear, or laboratory support was not immediately available. Recognition of cholinergic toxidrome is especially important because it allows early initiation of antidote-based treatment in suspected organophosphate poisoning. Qualitative color tests provided presumptive laboratory support to the clinical diagnosis; however, they should not be considered definitive confirmatory tests. Definitive confirmation requires advanced validated analytical methods such as HPLC, GC-MS, LC-MS/MS, or other validated toxicological techniques where available. Integration of toxidromic assessment with appropriate toxicological testing can improve early clinical management and strengthen medico-legal documentation in acute poisoning cases.

Ethical Approval Statement

The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC). The proposal was approved vide IEC No. 103/24, dated 12.06.2024. Written informed consent was obtained from all participants or their legally authorized representatives, as applicable. No additional expenditure for research investigations was charged to the patients, and all included patients received standard treatment as per institutional protocol.

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Conflicts of Interest

The authors report there are no competing interests to declare.

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