Original Article

Toxidromes and Their Public Health Impacts: A Cross-Sectional Analysis From a South Indian Tertiary Care Hospital

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Abstract

Objective: This study aimed to assess the prevalence, clinical features, and public health impact of various toxidromes, focusing on their demographic associations and healthcare implications in a tertiary care hospital setting.

Methods: A hospital-based cross-sectional study was conducted over a period of one year (January 2021 - December 2021), involving patients who presented with signs of toxic exposure or poisoning. A total of 120 cases were analyzed using detailed questionnaires and clinical examinations.

Results: The study identified that organophosphate poisoning was the most common toxidrome, accounting for 35% of the cases. Toxidromes were more prevalent in individuals aged 20-40, with a higher incidence in males. A significant correlation was found between socioeconomic factors, such as low income and education level, and the incidence of poisoning.

Conclusion: The study underscores the significant public health burden of toxidromes, particularly in low-income areas. Early detection, public awareness campaigns, and preventive measures such as poisoning education are essential to reducing the burden of toxicological diseases.

Key-words: Toxidromes, Public Health, Organophosphate Poisoning, Substance Abuse

Introduction

Toxidromes, or syndromes resulting from toxic exposure to various chemicals, drugs, or environmental hazards, pose a significant public health concern globally. These conditions vary widely in clinical presentation and severity, depending on the type of toxic agent involved.[1] According to the World Health Organization (WHO) data from 2021, exposure to toxic substances led to 2 million deaths and 53 million disability-adjusted life-years (DALYs) lost in 2019, underscoring the need for a

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better understanding of the patterns and outcomes of acute poisoning to improve planning, prevention, and management strategies.[2] Organophosphate (OPC) poisoning, sedative-hypnotic overdose, and opioid intoxication are among the most commonly encountered toxidromes in clinical practice.[3] The increasing rates of substance abuse, pesticide use, and environmental hazards have made the recognition and management of toxidromes critical for clinicians.[4]

In India, the burden of poisoning cases is disproportionately high, contributing to a substantial public health crisis.[5] Given the rise in accidental, intentional, and industrial exposure, understanding the clinical and epidemiological profiles of these conditions is crucial. While numerous studies have investigated the incidence and management of individual toxidromes, there remains a paucity of data addressing the comprehensive impact of these conditions on public health, particularly in developing regions.[6]

Therefore, the aim of this study was to fill this gap by examining the prevalence, risk factors, and healthcare impacts of various toxidromes in a tertiary hospital setting in Tamilnadu.

Material and Methods

Study Design and Setting

This hospital-based cross-sectional study was conducted at a tertiary care center over the course of one year from January 2021 to December 2021. A total of 500 patients were screened to detect patients with clinical signs indicative of poisoning or toxic exposure. Inclusion criteria included patients of any age or sex, who showed symptoms of poisoning due to environmental, industrial, or accidental exposure to toxic agents. Exclusion criteria included individuals with a history of chronic illness not related to toxic exposure.

Sample Selection

Patients who were admitted to the emergency department or referred from other hospitals with suspected toxidromes were screened. The demographic data, medical history, and symptom onset were documented. Diagnostic criteria for each toxidrome, such as cholinergic effects for organophosphates and central nervous system depression for sedative-hypnotics, were utilized.

Sample Size Calculation

The sample size for this study was calculated using the formula for estimating proportions. Assuming a prevalence of toxidromes of 50% (p = 0.5) for the primary toxidrome (as there are no previousstudies in our target patient population), a confidence level of 95%, and a margin of error of 5% (d = 0.05), and using the formula: $N = Z^2_{1-al^2} * p * (1 - p) / d^2$, the required sample size was determined to be approximately 384 participants.[7] To account for potential dropouts and incomplete data, the sample size was increased by 20%, resulting in a final sample size of 500 patients.

Data Collection and Analysis

Clinical examinations were conducted following standard toxicology protocols. Demographic and clinical data were entered into Microsoft Excel for preliminary analysis, followed by statistical analysis using SPSS version 25. Descriptive statistics were applied to summarize the sample characteristics.

Results

Demographic Distribution

A total of 500 patients were screened in this study, of whom 120 patients were found to present with clinical signs indicative of poisoning or toxic exposure. The mean age of the patients was 30.5 years, with the majority of patients (55%) being less than 30 years in age (**Figure 1**). The study population consisted predominantly of males, who represented 60% of the total participants. The geographic distribution of patients revealed that the majority were from rural areas (71.7%), whereas 34 patients were from urban areas, representing 28.3% of the cases. In terms of socioeconomic status, 70% of the cases came from economically disadvantaged and undereducated backgrounds, with low-income individuals showing a higher susceptibility to toxic exposures as shown in **Figures 2** and **3**.[8] Notably, agriculture-related jobs were noted to be the most common occupation in this cohort, highlighting the occupation-related risks associated with pesticide exposure (**Figure 4**).

Most Common Toxidromes Amongst Patients

All patients in the study intentionally ingested substances orally, with 120 patients (100.0%)

reporting this route of ingestion. The most prevalent toxidromes were organophosphate poisoning, rat killer paste, and ant killer powder toxicity. The distribution of ingested compounds among patients revealed that the OPC cypermethrin was the most frequently ingested compound, affecting 28 patients (23.3%). This was followed by rat killer paste, which was ingested by 18 patients (15.0%), and chlorpyrifos, affecting 10 patients (8.3%). Bromodialone and paraquat were each ingested by 9 patients (7.5%), while kerosene was also reported in 9 patients (7.5%). Dimethoate and oleander were ingested by 6 patients each (5.0%), while monochrotophos was ingested by 5 patients (4.2%).Glyphosate 41%, phenol, paracetamol 500 mg, and herbicides were ingested by 2 patients each (1.7%). A wide range of other compounds, including atenolol 50 mg, abrusprecatorius, alprazolam, amlodipine 5 mg, carbamazepine 200 mg, clonazepam, diazepam 5 mg, isopropyl alcohol, karthikaikilangu (glory lily), lorazepam 2 mg, metformin 500 mg, plant oil, profenofos 40%, rat killer powder, thyroxine (8 tablets), and zinc phosphide 80%, were each ingested by only 1 patient (0.8%). In addition, unknown substances were involved in 2 cases (1.7%) as shown in **Figure 5.**

Co-morbidities Amongst Patients

The distribution of comorbidities among the patients showed that the majority (93 patients, 77.5%) had no reported comorbidities. Among those with comorbidities, Type 2 Diabetes Mellitus (T2DM) was the most common, affecting 9 patients (7.5%), followed by systemic hypertension (SHTN) in 7 patients (5.8%). Psychiatric disorders were present in 3 patients (2.5%). Bronchial asthma (BA) and coronary artery disease (CAD) were each reported in 2 patients (1.7%). Other comorbidities, including chronic kidney disease (CKD), hypothyroidism, obesity, past tuberculosis (PTB-old), seizure disorder and old cerebrovascular accident (CVA)were reported in 1 patient each, representing 0.8%of the total cases (**Table 1**). Additionally, 45 patients (37.5%) reported alcohol use. In comparison, 75 patients (62.5%) reported no alcohol abuse.

The distribution of psychiatric diagnoses among the patients showed that impulsive disorder was the most common, affecting 42 patients (35.0%). Adjustment disorder was also prevalent, with 39 patients (32.5%) diagnosed. Major depressive disorder was reported in 5 patients (4.2%). Less common diagnoses included psychosis and schizophrenia, each affecting 1 patient (0.8%). Bipolar disorder was also in frequent, affecting 1 patient (0.8%). Not ably, psychiatric evaluations were not performed for 31 patients (25.8%) due to death prior to assessment (**Figure 6**).

Antidotes, Complications and Outcomes

Among these patients, 29(24.2%) received at ropineasanantidote. Flumazenil was administered to 4 patients (3.3%), and vitamin K was given to 8 patients (6.7%). N-acetylcysteine (NAC) was administered to 2 patients (1.7%). One patient (0.8%) received calcium gluconate. The majority, 84 patients (70.0%), received only supportive therapy without specific antidotes (**Figures 7** and **8**).

The distribution of complications among patients showed that 55 (45.8%) experienced no complications. Among those with complications, cholinergic crisis was the most common, affecting 23 patients (19.2%). Toxic hepatitis was reported in 19 patients (15.8%), and respiratory failure occurred in 15 patients (12.5%). Pulmonary fibrosis and acute kidney injury (AKI) were each observed in 8 patients (6.7%). Coagulopathy affected 6 patients (5.0%). Less frequent complications included multiple organ dysfunction syndrome (MODS) in 10 patients (8.3%), cardiogenic shock in 4 patients (3.3%), hepatic encephalopathy, intermediate syndrome, chemical pneumonitis, and toxic myocarditis, each affecting 3 patients (2.5%). Bradyarrhythmia was noted in 2 patients (1.7%), while aspiration and shock were reported in1 patient each (0.8%) as shown in **Table 2**.

Table 1: Distribution of Co-Morbidities Among Patients

Co-Morbidity	No of patients	Percentage
Bronchial Asthma	2	1.7%
Coronary Artery disease	2	1.7%
Chronic Kidney Disease	1	0.8%
Hypothyroidism	1	0.8%
Obesity	1	0.8%

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Psychiatric Disorder	3	2.5%
Pulmonary Tuberculosis	1	0.8%
Rural residence	1	0.8%
Seizure Disorder	1	0.8%
Systemic Hypertension	7	5.8%
Type 2DM	9	7.5%
Old Cerebrovascular Incident	1	0.8%
No co-morbidities	93	77.5%

Table 2: Complications Among Patients.

Complications	No of patients	Percentage
Cardiogenic Shock	4	3.33%
Coagulopathy	6	5.00%
Hepatic Encephalopathy	3	2.50%
Toxic Hepatitis	19	15.83%
Intermediate Syndrome	3	2.50%
Pulmonary Fibrosis	8	6.67%
Acute Kidney Injury	8	6.67%
Aspiration	1	0.83%
Bradyarrythmia	2	1.67%
Chemical Pneumonitis	3	2.50%
Cholinergic Crisis	23	19.17%
Multi-Organ Dysfunction Syndrome	10	8.33%
Respiratory Failure	15	12.50%
Shock	1	0.83%
Toxic Myocarditis	3	2.50%
None	55	45.83%

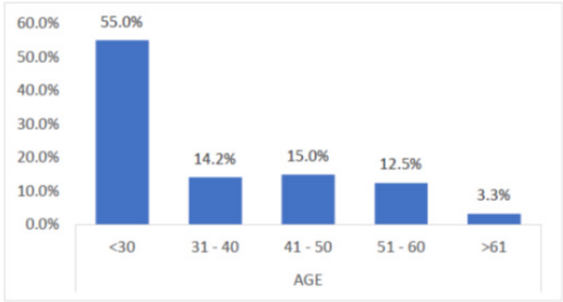

Figure 1: Age distribution of patients

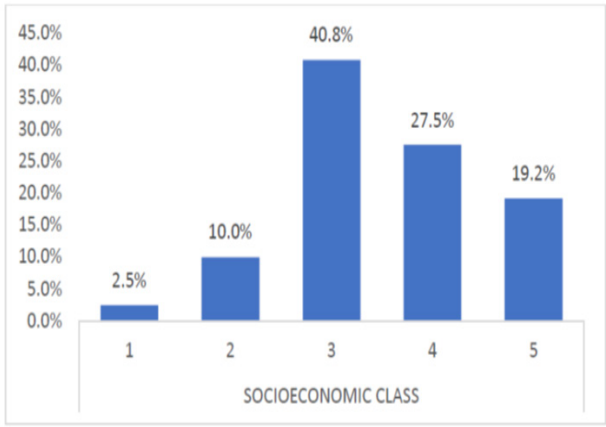

Figure 2: Socioeconomic Class Distribution of Patients

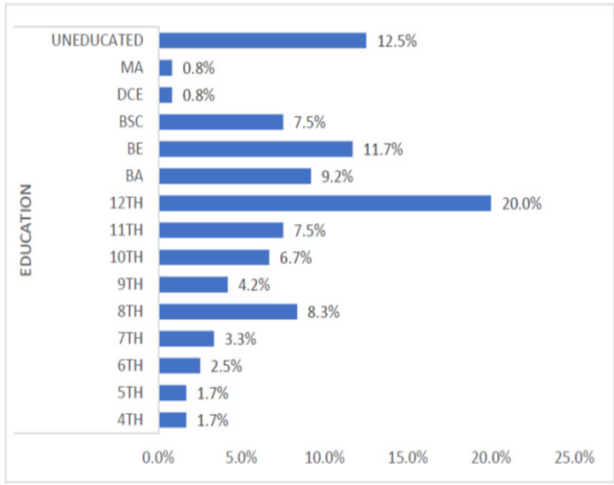

Figure 3: Educational Level of Patients

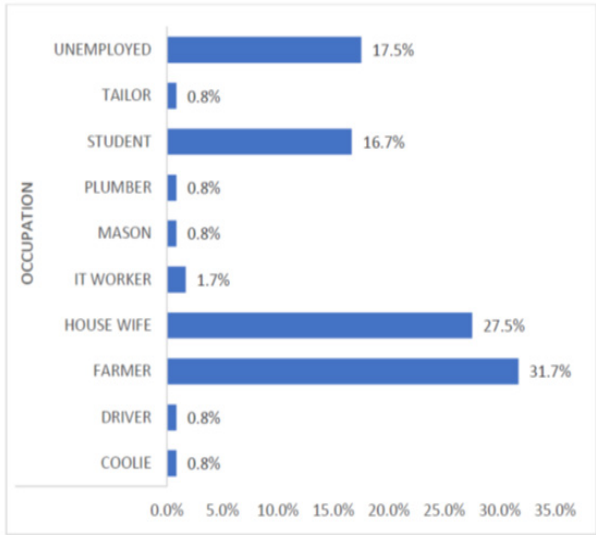

Figure 4: Occupational Distribution of Patients

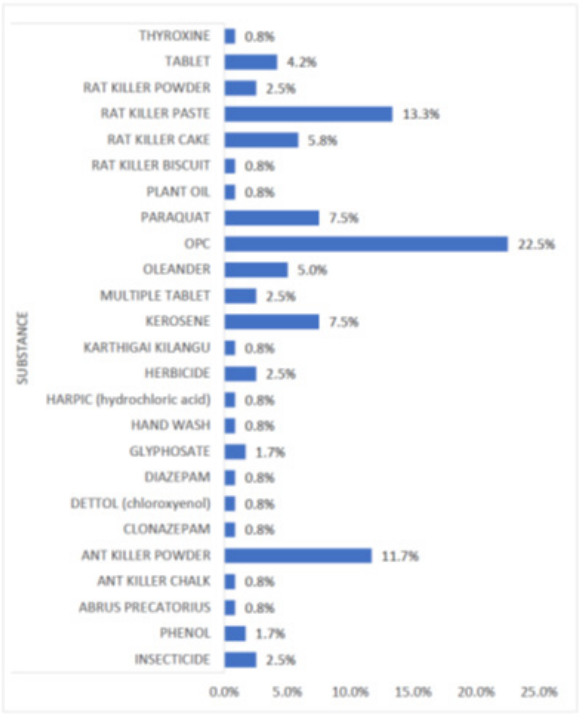

Figure 5: Distribution of Substances Ingested by Patients

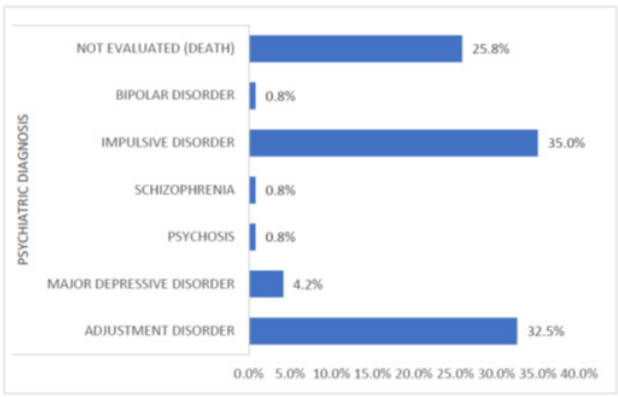

Figure 6: Psychiatric Diagnoses Among Patients

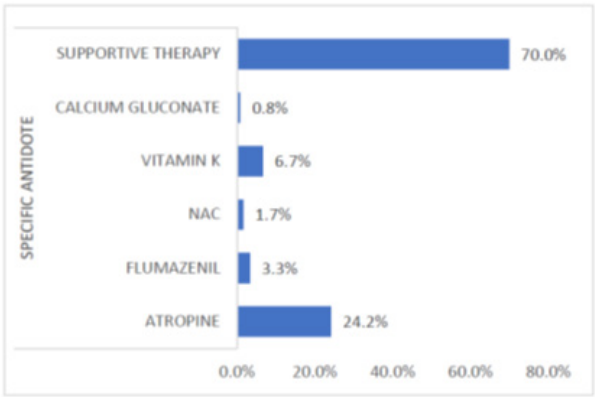

Figure 7: Administration of Antidotes

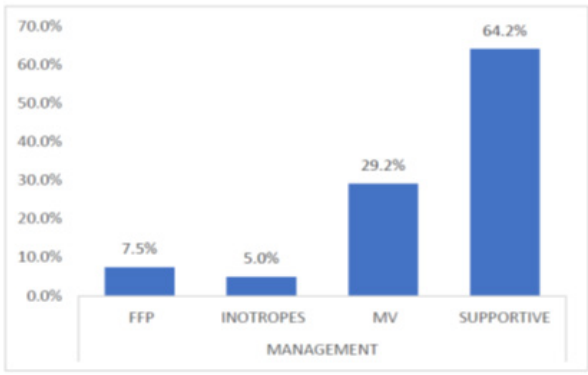

Figure 8: Management Strategies for Patients

Discussion

Our study revealed that poisoning is predominantly noted in younger patients, with more than half (55%) of the cases being individuals under the age of 30. This is consistent with prior research indicating that younger populations are particularly susceptible to acute toxic exposures, often driven by behavioral and lifestyle factors.[9] A previous study similarly found that the majority of poisoning cases occurred in individuals under 30 years of age, supporting the finding that younger adults are at a higher risk due to factors such as experimentation with substances or workplace exposures.[10] Similarly, gender analysis demonstrated that male patients accounted for 60% of the cases, a trend also noted in a previous study which reported a male predominance (50.7%), with a significant proportion of cases (47.8%) being in the 21-30 age group.[11] This aligns with the observation in our study that males are more likely to engage in risky behaviors, including alcohol consumption, pesticide exposure, and substance abuse.

The urban-rural divide is another important aspect highlighted in our results, with 71.7% of patients coming from rural areas. This finding emphasizes the disparities in healthcare access and environmental factors between urban and rural populations. Rural areas, in particular, are often at higher risk due to occupational hazards in agriculture or local industries, where exposure to chemicals such as pesticides is common. Our study's socioeconomic data show that a significant portion of patients belonged to middle to lower socioeconomic classes and had low educational attainment. These findings

are consistent with the idea that individuals from lower socioeconomic backgrounds face increased vulnerability to toxic exposure, often due to occupational hazards or limited access to preventive healthcare services. Poorer access to healthcare infrastructure and education in these populations likely exacerbates the risk of delayed diagnosis and treatment of poisoning cases.A similar study noted that among 278 patients, 36% were illiterate, indicating that low educational attainment could correlate with a higher risk of poisoning, as individuals may not fully comprehend the risks associated with certain substances or toxic exposures.[12]

Factors contributing to higher poisoning rates in this population include workplace stress, peer pressure, and limited access to adequate healthcare. People in lower socioeconomic strata are more likely to face challenges such as poor mental health, limited career opportunities, and exposure to toxic environments. Addressing these underlying social determinants of health could reduce the incidence of poisoning, particularly in vulnerable groups. Occupational risk factors were also significant in this study, with a high proportion of patients being farmers, followed by housewives and the unemployed. Farmers, in particular, face a higher risk of toxic exposure due to agricultural practices involving pesticides and herbicides. This aligns with findings from other studies, where farmers accounted for a substantial proportion of poisoning cases due to pesticide exposure.[13] This group also faces challenges related to the lack of proper safety measures in agriculture, further exacerbating the risk.

Substance abuse was another critical factor in our study. Alcohol consumption was present in 37.5% of the cases, highlighting its role in poisoning incidents, often in combination with other toxic substances. A previous study similarly reported that benzodiazepines, alcohol, and opioids were common toxic agents in their study, with poly-drug use being a frequent cause of poisoning.[9] Substance abuse not only increases the risk of intentional poisoning (e.g., suicides) but also contributes to accidental toxic exposures due to impaired judgment or recklessness.

Regarding the management of poisoning, our study found that treatment with atropine, a standard antidote for organophosphate poisoning, was the most commonly used measure while other antidotes like flumazenil and vitamin K were also used, but more sparingly. Our finding that the majority of patients only received supportive care and the mortality rate in our cohort was 26% emphasizes the need for better-equipped healthcare facilities capable of providing timely interventions such as antidotes, mechanical ventilation, and intensive care. This mortality rate also highlights the severe nature of toxic exposure and the limitations of current treatment protocols, especially in settings where resources may be scarce. Previous studies have reported similar mortality rates which are largely attributed to organophosphate poisoning.[14] The findings of our study call for a re-examination of treatment protocols, especially for patients with severe poisoning, to improve survival outcomes. Moreover, psychiatric evaluations conducted on patients revealed that impulsive disorder and adjustment disorder were very common diagnoses amongst our patients. This finding underscores the critical need for integrating mental health assessments into poisoning management, particularly given the high incidence of poisoning related to suicidal intent.

The primary limitation of this study lies in its cross-sectional design, which restricts the ability to draw causal inferences or evaluate long-term outcomes. Additionally, reliance on patient self-reports and medical records may introduce bias, particularly regarding substance use or the circumstances surrounding poisoning. Another limitation is the relatively small sample size for specific variables, such as rare toxins or complications, which may limit the generalizability of our findings.

Conclusion

This study underscores the significant public health burden posed by toxidromes, particularly in vulnerable populations. The findings call for urgent public health interventions targeting high-risk occupational groups, such as agricultural workers, and individuals with substance abuse problems. Educational campaigns that raise awareness about the risks of toxic exposures, along with better safety regulations and healthcare services, are crucial steps in mitigating the burden of toxidromes.

Further research is needed to explore the long-term effects of toxic exposure and to assess the effectiveness of preventive measures. Additionally, longitudinal studies examining the relationship between toxidromes, socioeconomic status, and chronic health outcomes are essential in shaping future public health policy.

Conflicts of interest: None.

Fundingsources: Self.

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Ethical clearance: Provided by the Institutional Ethics Committee, Thanjavur Medical College (dated 20/7/2022, certificate no 999/2002).

Informed Consent: All patients in this study were enrolled after their full and informed consent which was provided by them after a study information sheet was read by/read to them.

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