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A Study of Clinical Profile of Claimed Zinc Phosphide Poisoning Patients at Rural Tertiary Care Center

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HIGHLIGHTS

1. Analyzed clinical profiles of poisoning cases.
2. Focused on zinc phosphide exposure incidents.
3. Rural patients presented unique health challenges.
4. Highlighted symptoms and treatment outcomes observed.
5. Aimed to improve rural health care responses.

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ABSTRACT

The study focuses on the clinical profile of patients suffering from zinc phosphide poisoning, admitted to a rural tertiary care center. Zinc phosphide, commonly used in rodenticides, poses a significant risk of fatality when ingested, particularly in cases of intentional poisoning. The research evaluates clinical presentations, treatments, and outcomes of 102 patients admitted between October 2022 and August 2024. The majority of the patients were young adults aged 21-30 years, with males constituting 63.73% of the cases. The findings highlighted that patients presented with elevated systolic blood pressure in 75.49% of cases, while diastolic readings were lower in most. Laboratory analysis revealed that survivors and non-survivors differed significantly in terms of parameters like PTINR, total bilirubin, SGOT and SGPT, all indicating liver damage as a critical determinant of fatality. Most patients (93.14%) had a single attempt at poisoning, and early medical intervention was crucial in reducing mortality rates. However, the absence of a definitive antidote for zinc phosphide remains a challenge, with heart and liver failure being the leading causes of death. The study concludes that strict regulation of zinc phosphide usage and increased public awareness are necessary to prevent such poisonings, especially in rural settings where it is easily accessible. Additionally, the research calls for ongoing efforts to develop effective treatments for this high mortality poisoning.

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INTRODUCTION

Zinc phosphide (Zn_3P_2) is commonly used as an active ingredient in rodenticide baits, sold under various brand names such as Agrophos, A Commando, Sudarshan, Ratoff, Ratol, and Robart. It is typically found in the form of dark grey crystalline compounds or pellets with a strong, unpleasant odor reminiscent of rotten fish. While its primary function is to control rodents like squirrels, mice, rats, and field mice, it is sadly often misused for suicide, leading to a significant increase in mortality rates [1].

Exposure to zinc phosphide poisoning can occur accidentally or intentionally, especially in suicide attempts. Once ingested, it reacts in the stomach and intestines, releasing phosphine gas, which then enters the bloodstream and spreads to vital organs such as the liver and lungs. There is currently no known antidote for zinc phosphide poisoning, with mortality rates ranging from 37% to 100%. Organophosphate poisonings, including zinc phosphide, are a major cause of morbidity and mortality, particularly in economically disadvantaged populations, especially in developing countries [3,4,5].

Zinc phosphide has been in use as a rodenticide in industrial, agricultural, and urban settings since the 1940s. Regulations to control its use have been implemented since 1985, making its use illegal in some countries. However, in places like Mexico, there are no restrictions on its production, sale, or use. This unrestricted availability makes it easily accessible, even though there is no direct evidence linking its availability to increased suicide rates [6,7].

Zinc phosphide's toxicity arises when it hydrolyzes in the presence of water or acid, releasing phosphine gas. Given its high fatality risk, stringent safety measures must be followed during its production, storage, and use. Research suggests that a safe ingestion threshold for humans is up to 50 mg/kg, with a toxic dose ranging from 4 to 5 grams. The most common route of exposure is through ingestion, where phosphine is released upon contact with stomach acid. Other routes, such as dermal or ocular exposure, generally cause only local irritation and are less clinically significant. Inhalation of phosphine gas is rare but possible, though it typically does not result in serious health effects if appropriate precautions are taken [8,9].

Phosphine gas interferes with mitochondrial function by inhibiting cytochrome c oxidase, particularly during complex IV of the respiratory chain. This leads to disruption of oxidative phosphorylation, causing cellular damage, systemic anoxia, free radical generation, and eventually cell death. Heart failure is the leading cause of death in zinc phosphide poisoning cases [10,11].

Various treatment options are discussed in the medical literature, including gastric lavage with substances like coconut oil, bicarbonate, or potassium permanganate, and the administration of activated charcoal to reduce the absorption of the toxin. Supportive measures, such as vasopressors and intravenous fluids for hemodynamic stabilization, are also critical. Emerging therapies, such as intravenous lipid emulsion (ILE) and hyperinsulinemia-euglycemia therapy (HIET), are explored, as well as antioxidants like magnesium sulfate and N-acetylcysteine (NAC). However, none of these treatments are definitive, and their effectiveness remains limited [12,13].

Poisoning from zinc phosphide is a medical emergency that requires immediate intervention. Patients must seek urgent care as quickly as possible, regardless of the amount of poison ingested. In hospitals, physicians need to understand the specific poisoning risks in their regions to provide effective care. This is particularly true in rural areas, where cases of zinc phosphide poisoning are more common, as demonstrated in studies on clinical characteristics and outcomes in rural Maharashtra [14,15].

The aim of this study is to investigate the clinical presentations and treatment of patients hospitalized for alleged zinc phosphide poisoning. The objectives include evaluating the clinical features and outcomes of each hospitalized case, as well as identifying factors associated with the outcomes of patients affected by zinc phosphide poisoning.

MATERIAL AND METHODS

This longitudinal study was conducted in the general medicine ward and ICU of a tertiary care hospital. The study focused on patients admitted with zinc phosphide poisoning. All patients who presented with zinc phosphide poisoning during the study period were included as the study population. The research was conducted over a period from October 2022 to August 2024, with data collected from all cases of zinc phosphide poisoning admitted to the hospital during this time frame.

Study Population

The study included all patients treated for zinc phosphide poisoning between October 2022 and August 2024. Diagnosis was based on clinical data, including a history of rodenticide ingestion, details of the rodenticide brand or characteristics, and patients bringing the containers to the hospital. Inclusion criteria involved patients aged 18 years and older with a confirmed history of zinc phosphide ingestion.

-ts females, those with incomplete information, without consent, or who ingested mixed poisons were excluded. Data were collected on demographics, clinical presentation, treatment, and outcomes, including recovery and mortality.

Data Analysis

Data were analyzed using statistical tests to identify trends and correlations. Descriptive statistics were employed to summarize the demographic and clinical characteristics of the study population. Comparative analyses were conducted to determine significant differences in outcomes based on variables such as age, gender, severity of poisoning, and treatment protocols. Survival analysis was performed to evaluate factors influencing patient outcomes. Informed consent was obtained from patients or legal guardians, and the study adhered to ethical guidelines, with approval from the hospital's ethics committee and strict confidentiality maintained.

RESULTS

Among the 102 patients diagnosed with zinc phosphide poisoning, the age distribution revealed that 21.57% were between 11-20 years old, 40.20% were aged 21-30, and 20.59% were in the 31-40 age group. Additionally, 6.86% of patients were aged 41-50, 5.88% were between 51-60 years old, and 4.90% were aged 61-70. Regarding gender, males accounted for the majority, with 63.73% (65 patients), while females comprised 36.27% (37 patients). This data suggests that young adults, especially males, were disproportionately affected by zinc phosphide poisoning in this patient cohort.

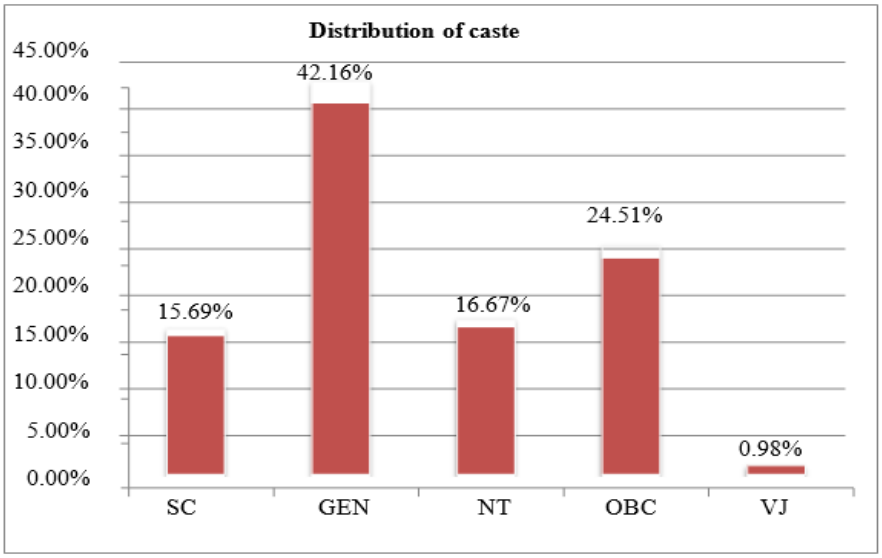
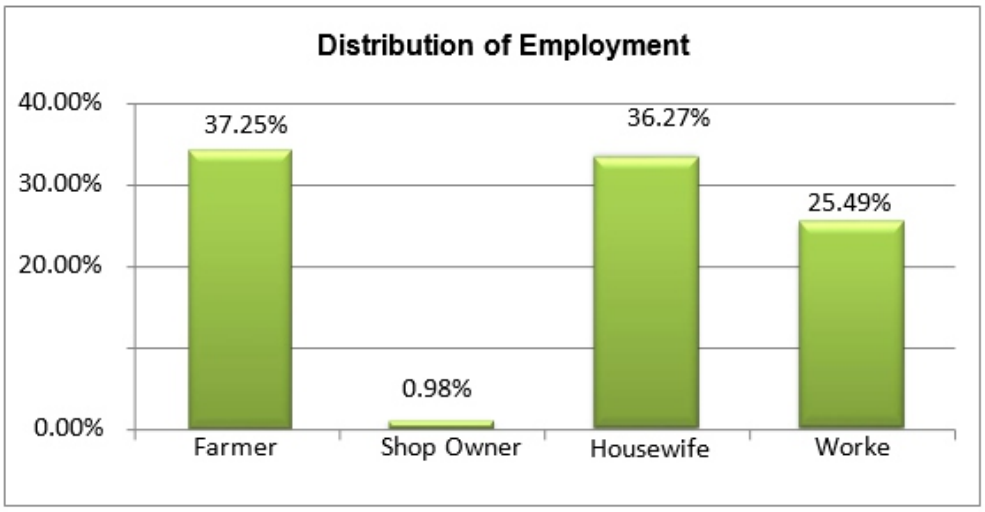


Figure 1: Distribution of Caste of Patients Claimed Zinc Phosphide Poisoning

Among the 102 patients with zinc phosphide poisoning, 82.35% were Hindu (84 patients), while 17.65% were Muslim (18 patients). In terms of marital status, 78.43% of the patients were married (80 patients), and 21.57% were unmarried (22 patients).

Figure 2: Distribution of Employment of Patients Claimed Zinc Phosphide Poisoning



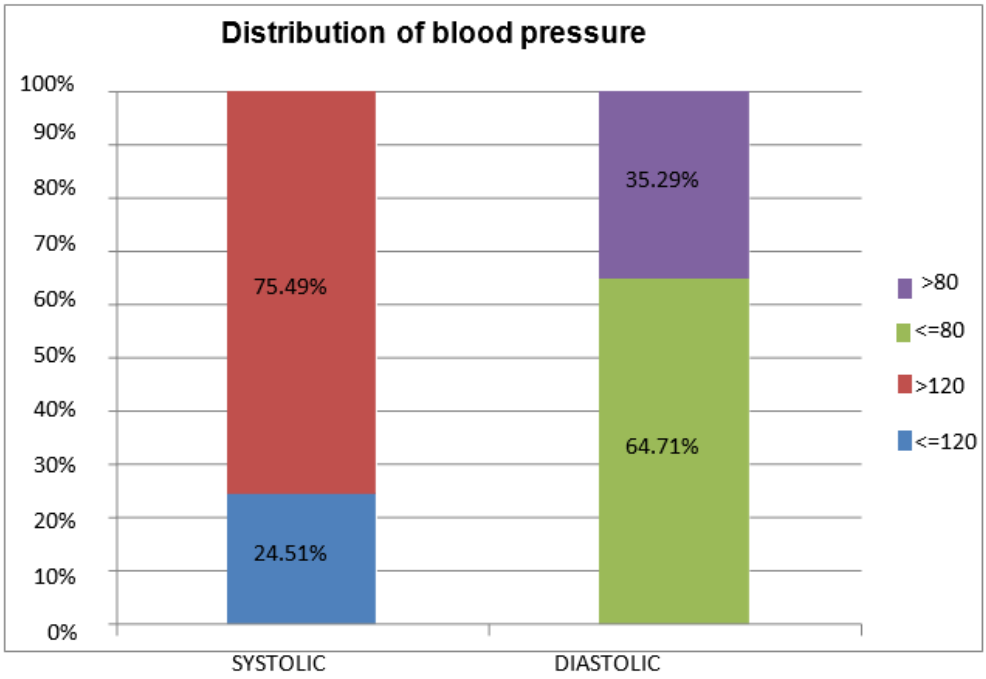


Figure 3: Distribution of Blood Pressure of Patients Claimed Zinc Phosphide Poisoning

Table 1: Distribution of Vitals of Patients Claimed Zinc Phosphide Poisoning

Vitals	Min-Max	Mean + SD
RR (per min)	14-20	16.48 + 1.80
Pulse Rate (BPM)	84-124	100.7 + 10.99
SPO2 (%)	96-99	97.33 + 1.03

In patients with zinc phosphide poisoning, the respiratory rate ranged from 14 to 20 breaths per minute, with a mean of 16.48 ± 1.80. The pulse rate varied between 84 and 124 beats per minute, averaginging 100.7 ± 10.99 BPM. SPO2 levels ranged from 96% to 99%, with a mean of 97.33% ± 1.03. All patients had a body temperature of 37°C and a Glasgow Coma Scale score of 15. Regarding the attempts of poisoning, 93.14% of patients had a single attempt, while 6.86% had two attempts.

Table 2: Time Interval Before Seeking Hospital Care of Patients Claimed Zinc Phosphide Poisoning

Time Interval Before Seeking Hospital Care (Hour)	Number (N=102)	Percentage (%)
< 1	36	35.29%
2	23	22.55%
3	19	18.63%
4	11	10.78%
6	13	12.75%

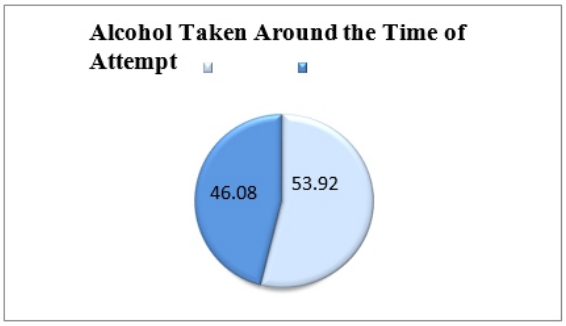


Figure 4: Alcohol Taken Around the Time of Attempt of Zinc Phosphide Poisoning

Table 3: Lab Parameters of Patients Claimed Zinc Phosphide Poisoning

Lab Parameters		Min-Max	Mean + SD	P-Value
PTINR (secs)	Death	2.9-3.1	3.00 + 0.14	2.2e-16
	Survival	1.1-1.8	1.37 + 0.20	
Sr. Cholinesterase (U/L)	Death	8524 - 8524	8524.00 + 0.000	0.3219
	Survival	4564 - 9879	7359.66 + 1645.924	

The laboratory parameters for patients with zinc phosphide poisoning revealed a significant difference in PTINR values between survivors and non-survivors. For survivors, the mean PTINR was 1.37 seconds, with a range of 1.1 to 1.8 seconds. In contrast, deceased patients had a mean PTINR of 3.00 seconds, with values ranging from 2.9 to 3.1 seconds. The p-value for PTINR was <0.05, indicating a significant difference between the two groups. Serum cholinesterase levels, however, did not show a significant difference, with deceased patients having a constant level of 8524 U/L, while survivors had a mean of 7359.66 U/L with a range from 4564 to 9879 U/L.

Table 4: Lab profile of Patients Claimed Zinc Phosphide Poisoning

Lab Profile		Min-Max	Mean + SD	P-Value
TLC	Death	8100 - 9600	8850.0 + 1060.66	0.4518
	Survival	4400 -11200	7855.6 + 1849.78	
HB (g/dl)	Death	12.4 - 13.6	13.00 + 0.84	0.6077
	Survival	10.2 -15.5	12.54 + 1.25	
PLT (mcL)	Death	146 – 412	279.00 + 188.09	0.6171
	Survival	124 – 548	325.78 + 129.90	
TB	Death	9 - 9.1	9.05 + 0.07	2.2e-16
	Survival	0.2 -1.5	0.94 + 0.37	
SGOT(/L)	Death	1349 - 1534	1441.50 + 130.81	2.2e-16
	Survival	22 – 53	36.22 + 6.98	
SGPT(/L)	Death	1085 -1165	1125.0 + 56.57	2.2e-16
	Survival	22 – 53	37.45 + 6.54	
UREA (mmol/L)	Death	23 – 28	25.50 + 3.53	0.2801
	Survival	16 – 48	32.71 + 9.34	
CREAT (mg/Dl)	Death	0.6 - 1.1	0.850 + 0.35	0.9088
	Survival	0.2 - 1.5	0.881 + 0.37	

Figure 5: Outcome of Patients Claimed Zinc Phosphide Poisoning

DISCUSSION

The objective of this research was to evaluate the clinical presentation, treatment, and outcomes of patients hospitalized for zinc phosphide poisoning at a local tertiary care center. The demographic analysis revealed that the majority of patients were young adults, with the age group of 21–30 years constituting 40.20% of the total cases. This was followed by patients in the 11–20 years age range (21.57%) and those aged 31–40 years (20.59%). A notable gender disparity was observed, with males accounting for 63.73% of the cases compared to 36.27% for females. This suggests a potential gender-related pattern in zinc phosphide poisoning incidents [16,17].

The study further found that while most patients with zinc phosphide poisoning survived, liver failure emerged as the primary cause of death among non-survivors. This highlights the crucial need for early identification and management of liver damage in these patients. Significant laboratory parameters, such as PTINR, total bilirubin (TB), serum glutamic oxaloacetic transaminase (SGOT), and serum glutamic pyruvic transaminase (SGPT), were identified as critical indicators for prognosis and therapeutic guidance. The laboratory data revealed that non-survivors had considerably higher levels of these parameters compared to survivors, emphasizing the severity of liver injury in cases of zinc phosphide poisoning [18,19].

In terms of occupational impact, farmers and housewives were the most affected groups, with farmers constituting 37.25% of the cases and housewives 36.27%. Workers accounted for 25.49% of the cases. This occupational distribution is consistent with findings from other studies, where farmers and housewives were also prominently affected by zinc phosphide poisoning. The high incidence among farmers could be attributed to the use of zinc phosphide as a rodenticide in agricultural settings.

Blood pressure measurements provided additional insights into the clinical profile of patients with zinc phosphide poisoning. The majority of patients (75.49%) had a systolic blood pressure higher than 120 mmHg, while 24.51% had systolic readings below this threshold. For diastolic blood pressure, 64.71% of patients had values less than 80 mmHg, and 35.29% had values above 80 mmHg. This distribution highlights the variations in blood pressure among patients and underscores the importance of monitoring these vital signs in the management of poisoning cases [20,21].

A significant observation from the study was the time interval before seeking hospital care. Most patients (35.29%) arrived at the hospital within one hour of ingestion, indicating a rapid response to the poisoning event. However, some patients took up to six hours to seek medical help. The study also noted that 53.92% of patients had consumed alcohol around the time of poisoning, which could potentially complicate the clinical picture and management [22].

The analysis of laboratory investigations showed marked differences between survivors and non-survivors in certain parameters. Elevated levels of SGPT, TB, SGOT, PTINR, and SGPT were found in non-survivors, suggesting that severe liver damage plays a significant role in mortality. In contrast, other measures such as blood urea, creatinine, serum cholinesterase, hemoglobin, platelet count, and total leukocyte count did not show significant differences between survivors and non-survivors [23].

Comparing these results with existing literature, it is evident that zinc phosphide poisoning predominantly affects young adults and is often linked to suicides, with a notable incidence among individuals with low educational levels or from lower socioeconomic backgrounds. The findings align with similar studies that have highlighted the high incidence of suicides related to zinc phosphide poisoning. In particular, res-

-earch indicates that zinc phosphide is a leading cause of poisoning deaths, particularly in rural areas where agricultural use of rodenticides is prevalent [24].

The study also reflects the broader context of toxic substance poisoning, where zinc phosphide ranks as a significant cause of morbidity and mortality. The high mortality rate associated with zinc phosphide poisoning underscores the need for improved preventive measures, early diagnosis, and effective management strategies. Additionally, the findings emphasize the importance of addressing underlying psychosocial factors that may contribute to the high incidence of self-poisoning and suicide related to zinc phosphide [25].

Overall, the research highlights critical aspects of zinc phosphide poisoning, including demographic trends, clinical features, treatment outcomes, and the impact of occupational and socioeconomic factors. The results underscore the need for targeted interventions and preventive measures to address this serious health issue effectively.

CONCLUSION

Zinc phosphide is a highly toxic poison, posing a significant threat in countries with easy access and widespread use in impoverished communities. In a study of 102 patients, males (63.73%) and those aged 21-30 (40.20%) were most affected. Most patients were Hindu (82.35%), married (78.43%), and involved in farming or housework. Elevated systolic blood pressure was observed in 75.49%. Early medical intervention was critical, with 93.14% attempting poisoning once. Alcohol consumption (53.92%) was a potential risk factor. Laboratory differences in PTINR, bilirubin, SGOT, and SGPT levels were linked to survival. Strict regulations and public awareness are crucial.

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