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Research Article

A STUDY ON CLINICAL PROFILE AND OUTCOME OF RODENTICIDE POISONING IN SOUTH INDIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Objectives: The objectives of the study were to study the sociodemographic profile, clinical features, and clinical outcome of patients admitted with rat killer poison in a tertiary care hospital in South India.

Methods: A cross-sectional study was conducted among those who have been admitted with rodenticide poisoning in a tertiary care center in South India. Prior Institutional Ethical committee Permission and written informed consent were obtained. Data on sociodemographic profile were elicited. The clinical course of all those who were enrolled in the study was closely followed and monitored. All the necessary blood parameters were done on every alternate day after the admission blood investigations. The data were entered into Microsoft excel and were analyzed using PSPP software. The difference in mean blood parameters between survivors and non survivors was compared.

Results: The consumption of rodenticide poisoning was higher among females (59%). Majority (58%) were married. Vomiting was present in nearly two-third of the study population and abdominal pain in 21%. Dose ingested and time of reporting to hospital were high among non-survivors. Mean bilirubin, serum glutamic-oxaloacetic transaminase, serum glutamic pyruvic transaminase, and International normalized ratio were higher among non-survivors compared to survivors at all the days measured.

Conclusions: Monitoring of liver parameters plays a key role in assessing the prognosis of the patient and also in treating them.

Keywords: Rodenticide poisoning, Liver parameters, Clinical course and prognosis.

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INTRODUCTION

Deliberate self-harm (DSH) is an universal problem that increases in prevalence as time progresses. It has been in existence since ancient times till today and people have deliberately tried and succeeded in many attempts to end their own lives. Deliberate self-harm is common among people of all socioeconomic classes [1]. Many methods of DSH are being used across the world, and poisoning is the second most common cause of suicide. Rodenticide consumption is one of the most common methods used in India. According to national crime records bureau, poisoning accounts for 25.8% suicides in 2019 and 26.7% suicide deaths in 2018 [2]. Yellow phosphorus is a highly toxic substance, more toxic than red phosphorous, and is used in rodenticide products, match, and firework industries. Both underdeveloped and developing countries have reported intoxication with yellow phosphorus. The intoxication usually occurs after an accidental oral ingestion in developing nations, at the same time ingestion with suicidal tendency is also not rare [3].

India is a land majorly consisting of villages with people whose primary occupation is agriculture and farming. Rodents are one among the multiple pests which cause damage to the crops and stored grains. Uncontrolled rodent invasion will cause huge economic losses to the farmers. Hence, control of rodents is necessary mandating wide marketing and usage of rodenticides in India. Easy availability of yellow phosphorus is one of the deciding factors in its usage as a poisoning agent. This compound is classified as a highly lethal rodenticide when it is ingested more than1 mg/kg. It is a protoplasmic poison which acts by inhibition of enzymes and protein synthesis [3,4]. Zinc phosphide, which is also used as rodenticide, contains inorganic phosphorous which is hepatotoxic and can be lethal in small doses. After consumption the phosphide in the rodenticide gets converted into phosphine gas in the gut. Phosphine gas has considerable toxicity in humans acting by many pathways like inhibition of oxidative respiration by inhibiting cytochrome C oxidase. The signs of systemic toxicity, mainly gastrointestinal and cardiovascular effects usually appear within a short interval after ingestion. The other systems such as respiratory, hepatobiliary, and hematologic are also affected with metabolic and electrolyte abnormalities [5].

Phosphine poisoning has the following complications like include fluid loss, hypotension, circulatory failure, reduced cardiac contractility leading to acute renal failure cardiac arrhythmia, pulmonary edema, and congestive heart failure [3-5]

Acute liver failure is one of the most dangerous side effects of rat killer poisoning. Signs and symptoms of liver failure along with corresponding biomarkers may become abnormal even after 3–4 days of consumption, so meticulous clinical examination for signs of liver failure and repeated liver function tests should be done [4,5]

Cases of poisoning with yellow phosphorus can remain asymptomatic initially, minimal recovery can be seen after 2 or 3 days, and then, features of acute hepatic failure may occur [3].

Specific antidote has not been discovered and hence supportive care is the mainstay of treatment. The death rate remains high in spite of the efforts made to establish an efficient treatment modalities, mainly for aluminum phosphide poisoning. Although both the phosphides of zinc and aluminum in the human body liberate the phosphine gas, few clinical features and the mortality rates vary between the two metal

phosphides [4]. There is only limited literature about this topic in south India. This study has been planned to be conducted to understand the sociodemographic profile, clinical features and clinical outcome of patients admitted with rat killer poison in a tertiary care hospital in South India.

METHODS

This cross-sectional study was conducted on 100 consecutive patients by convenient sampling technique who was admitted for accidental/deliberate ingestion of rodenticide between October 2018 and October 2019 in the department of gastroenterology of a tertiary care medical college, South India after institutional ethical committee clearance. The patients' attenders were informed about the nature of the study, the need for it and written informed consent was obtained for the same. Inclusion criteria included all the patients whose attenders were willing to participate in the study irrespective of the comorbid status. Those attenders who were hesitant/not willing were not included in the study. The data elicited included demographic data such as age, gender, marital status, along with information regarding the time of ingestion, nature, and amount of the compound ingested. Other details included clinical features and outcome of the patient. Serum creatinine, bilirubin, serum glutamic-oxaloacetic transaminase (SGOT), serum glutamic pyruvic transaminase (SGPT), International normalized ratio (INR), and total protein were measured apart from routine blood parameters on the day of admission and then on day 3 and day 7. The clinical progress of the patients was also monitored daily and the changes were recorded till the patient gets discharged or till the expiry of the patient.

Statistical analysis

The data collected were collected on a real time basis during the course of the treatment. It was entered in Microsoft excel, double checked and was analyzed using IBM SPSS software version 26. The basic demographic and clinical variables were expressed in frequencies and percentages. The continuous variables were expressed as mean±standard deviation. The study participants were divided as two groups based on the outcome of the treatment (survived and expired). The collected parameters were compared between both the groups. The association between categorical variables and the outcome was measured using Chi-square/Fischer exact test. The difference in blood parameters between the survivors and non survivors was measured using Mann–Whitney U test. $p < 0.05$ was considered statistically significant.

RESULTS

This observational study was done on 100 patients who were admitted with history of ingestion of rat killer poison in a tertiary care hospital in south India. Around 41% of the study population were males and the remaining 59% were females. Only 7% of the study population were illiterates. Nearly 58% of them were married. Around 67% consumed <5 g of the toxic product, 20% consumed 5–10 g of the substance while the rest 13% had consumed more than 10 g. Thirty-seven percent of the study population expired. Nearly 58% of them were brought to the hospital within 6 h of ingestion of poison (Table 1).

Vomiting was present in 61.46% of the study population and abdominal pain was present in 21% of the population. Around 6% had no symptoms. Another 6.2% had Malena. Jaundice was found in <3% of study population and Gum bleed in less than 2% of the study population (Fig. 1).

The mean of blood parameters measured was compared between survivors and non survivors. There was no significant difference between means with respect to age. There is a significant difference in the amount of drug ingested between the survivors (1.82±3.5 g) and non survivors (9.16±3.94 g). Similarly, the mean time of reporting to hospital among survivors was 3.76 h while the mean time for reporting to hospital among non survivors was 16 h. Blood parameters signifying liver injury (bilirubin, SGOT, SGPT, INR, and total protein) were measured on day 1, day 3 and day 7. There was a significant difference in all the mean values between survivors and non survivors in all measurements except for serum protein and INR levels on day 1. There was also an exponential increase in value of blood parameters in non survivors as the number of days post ingestion increased (Table 2). When the mean blood parameters value signifying liver injury was compared between day 1, day 3, and day 7, there was a statistically significant difference in mean values.

There was a statistically significant association between survivors and non survivors with age group, dose ingested and time at which they reached hospital. Around 84% of the study participants between 11 and 20 years expired and 62.5% above 50 years expired. The death rate was high among <20 years and above 50 years. Death rate was very less in age group 41–50 years. When the dose ingested was more than 5 g, mortality was more (81.8%). Mortality increased as the time to reach hospital increased (Table 3).

DISCUSSION

Deliberate self-harm using rodenticide is a major health problem worldwide and causes great impact on the social aspects of the family

Table 1: Basic characteristics of the study population

Parameter	Frequency	Percentage
Age (years)		
<10	5	5
11–20	18	18
21–30	35	35
31–40	23	23
41–50	11	11
>50	8	8
Gender		
Male	41	41
Female	59	59
Literacy		
Literate	93	93
Illiterate	07	07
Marital status		
Married	58	58
Unmarried	42	42
Dose ingested (g)		
<5	67	67
5–10	20	20
>15	13	13
Time taken to reach hospital (h)		
<6	58	58
6–12	20	20
12–24	14	14
>24	8	8
Outcome		
Survived	63	63
Expired	37	37

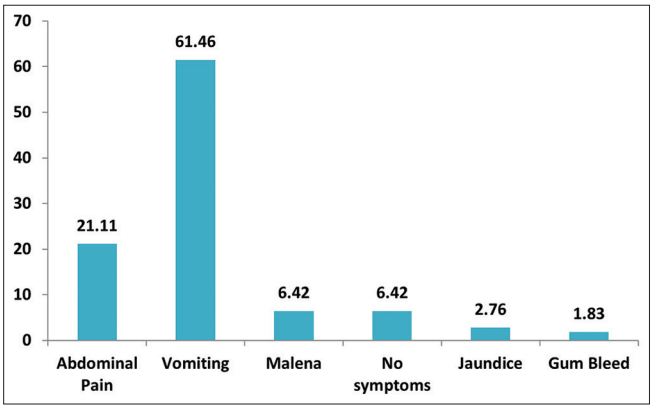

Fig. 1: Distribution of study population according to symptoms

Table 2: Comparison of mean values of clinical parameters

Variable	Group	Mean	SD	Mean difference	Mann-Whitney U value	p value
Age	Survived	31.52	10.98	4.145	784.5	0.006
	Expired	37	27.38			
Amount Ingested (g)	Survived	1.817	3.55	7.34	186	<0.001
	Expired	9.162	3.94			
Time of reporting after ingestion	Survived	3.72	7.10	13.10	238.5	<0.001
	Expired	16.85	13.95			
Creatinine	Survived	0.978	0.36	0.93	183.5	<0.001
	Expired	1.908	0.55			
Bilirubin day 1	Survived	0.973	0.331	4.864	594	<0.001
	Expired	1.459	0.75			
Bilirubin day 3	Survived	2.144	0.91	2.05	195.5	<0.001
	Expired	4.203	1.15			
Bilirubin day 7	Survived	1.93	1.09	6.68	33	<0.001
	Expired	8.61	2.18			
SGOT day 1	Survived	59.37	50.16	105.58	459	<0.001
	Expired	164.95	217.05			
SGOT day 3	Survived	244.43	100.82	349.27	167	<0.001
	Expired	539.7	220.19			
SGOT day 7	Survived	153.75	70.11	1114.06	0.000	<0.001
	Expired	1267.81	376.23			
SGPT day 1	Survived	54.6	46.71	91.37	496	<0.001
	Expired	145.97	184.31			
SGPT day 3	Survived	217.79	92.53	349.27	159.5	<0.001
	Expired	526.81	175.79			
SGPT day 7	Survived	125.3	59.20	965.72	0.000	<0.001
	Expired	1091.05	314.15			
INR day 1	Survived	1	0.08	0.0297	980	0.114
	Expired	0.97	0.09			
INR day 3	Survived	1.28	0.33	0.695	172.5	<0.001
	Expired	1.97	0.29			
INR day 7	Survived	1.05	0.28	1.24	105.5	<0.001
	Expired	2.29	0.55			
Total protein day 1	Survived	6	0.33	0.00	1096	0.610
	Expired	6	0.43			
Total protein day 3	Survived	5.913	0.30	0.45	431.5	<0.001
	Expired	5.454	0.41			
Total protein day 7	Survived	6.13	0.26	0.72	77	<0.001
	Expired	5.41	0.27			

SGOT: Serum glutamic-oxaloacetic transaminase, SGPT: Serum glutamic pyruvic transaminase, INR: International normalized ratio

Table 3: Association between survivors and non survivors with age, dose and duration for attention

Parameter	Expired		Survived		Chi-square/Fischer exact value	Significance
	No	%	No	%		
Age group						
<10 years	2	40	3	60	26.715	<0.001
11–20 years	15	83.3	3	16.7		
21–30 years	9	25.7	26	74.3		
31–40 years	5	27.1	18	78.3		
41–50 years	1	9.1	10	90.9		
>50 years	5	62.5	3	37.5		
Dose ingested						
<5 g	10	14.9	57	85.7	42.44	<0.001
>5 g	27	81.81	6	18.19		
Time at which they reached hospital						
<6 h	4	6.9	54	93.1	54.285	<0.001
6–12 h	16	80	4	20		
12–24 h	10	71.4	4	28.6		
>24 h	7	87.5	1	12.5		

and society. This cross-sectional study was done to understand the effect of rat killer poisoning on the liver among south Indian population. There was a female predominance (59%) in our study and 39% of females and 34.1% of males did not survive after ingestion. In a similar study done by Radhika *et al.* [6] in Chennai, 62% of the participants were females. Suneetha *et al.* [7] in their study in Mysore in 2016 also found that 59% of the participants were females. Similar results were obtained in studies done by Banerjee *et al.* [8] in West Bengal, Marahatta *et al.* [9] from Nepal and Güloğlu, and Kara [10] from Turkey. Kumar *et al.* [11] from Andhra Pradesh and Maharani and Vijayakumari [12] from Tamil Nadu had a male preponderance. Attempt suicide is higher among females and complete suicide is common among males. Varied psychopathology and psychosocial stressors can contribute to Women's greater inclination to suicidal behavior and this is a gender-related

vulnerability. Child abuse, sexual abuse, and domestic violence are few stressors precipitating suicides among females [13].

The mean age of study population was 30 years. About 55% of the study population were in the age group of 11–30 in our study population. Similar results were obtained in studies done by Radhika *et al.*, [6] Suneetha *et al.*, [7] Noor and Srinath [14], Mishra *et al.*, [15] Balasubramani *et al.*, [16] and Maharani and Vijayakumari [12]. Unable to cope up with the stress on their career, not able to adapt to modern lifestyle practices, failure in love, family problems, nuclear family concept, failure in exams, etc., attribute to more suicides in the 11–30 years age group [6].

Around 87% consumed <10 g of the poison. Similar result was obtained by Radhika *et al.* [6].

About 58% of the participants were admitted in the tertiary care center within 6 h of the ingestion. About 70% of those who had rodenticide poison were brought to the emergency department within 6 h in the study done by Radhika *et al.* [6] in a study done by Banerjee *et al.* [8] on 4432 patients in west Bengal 23.4% of the study population reached hospital within 6 h. 90% of the study population were admitted within 6 h of ingestion in a study done by Balasubramani *et al.* [16].

Vomiting was the predominant symptom in more than two thirds of the study population. Abdominal pain was present in another one fifth of the study population. About 33% had vomiting and 36% had abdominal pain was reported by Suneetha *et al.* [7] Balasubramani *et al.* [16] in their study in 2019 in Bangalore, India observed that 32.7% had vomiting and 20.13% had abdominal pain. Although we could not find significant difference in the mean age between the survivors and non survivors, when compared with age category the mortality is high in younger and elder people.

There is a significant difference in the amount of drug ingested (1.82 vs. 9.16 g) and time of reporting to hospital (3.76 h vs. 16 h). Blood parameters signifying liver injury (Bilrubin, SGOT, SGPT, INR, and total protein) were significantly higher in non survivors compared to survivors.

Yellow phosphorus is an inorganic substance and is a protoplasmic poison. It emits smoke and has a very strong garlicky odor. It usually get absorbed through mucus membrane and skin. The absorption by gastrointestinal epithelium and respiratory epithelium can also occur. After ingesting the compound orally, it gets absorbed and it circulates all throughout the tissues, particularly the liver, and the peak level is reached after 2–3 h. In human beings, the Phosphine gas is a lethal gas and it causes mortality by many proposed mechanisms like inhibition of cytochrome C oxidase and thereby halting oxidative respiration. Bile salts are important for absorption of phosphorus. Because of water content and low oxygen tension, phosphorus remains stable in gut for longer period. It can lead to multiorgan failure such as hepatic, renal, and cardiac failure.

The patient who consumes the white phosphorus usually undergoes three clinical stages.

i. During the first 24 h, the first stage occurs, in which patient presents with no symptoms or sometimes presents with clinical features like gastrointestinal irritation such as nausea, vomiting, diarrhea, and abdominal pain. Laboratory investigations were almost normal in this period. Sudden cardiac arrests were noted in number of cases, the reasons could be attributed to the large amounts of ingestion of fireworks, which can directly result in cardiovascular arrhythmia and circulatory collapse on the 1st day of admission. Vomiting and diarrhea occur as a result of fluid and electrolyte loss, this, in turn, may cause cardiac failure if left untreated. Electrolyte disturbances such as hypocalcemia and hyperkalemia may cause cardiac dysrhythmias which can further lead to sudden demise of the patient.
ii. During the next 24–72 h, the second stage begins (may last for several days) after ingestion. Similar to the first stage, which patient presents with no symptoms. But mild hike in hepatic enzymes and bilirubin levels are observed in this stage. Rarely toxic hepatitis may be seen.
iii. After 72 h, (mostly between 4 and 7 days) the third stage begins. This advanced stage progresses until the resolution of symptoms or death. In this last stage, various metabolic derangements occur causing deteriorating complications such as coagulopathy, embolism, cardiogenic shock, and arrhythmias. Few cases present with acute liver failure, acute renal failure, encephalopathy, and abnormal hepatic function tests. Neurological complications such as mental changes including confusion, delirium, hallucinations, varied psychosis, and Coma occurs. This stage is often due to the absorption of high doses of phosphorus and the symptoms due to the systemic effects [17-20].

We can conclude the conglomerate symptoms under the term multiorgan failure.

The management of yellow phosphorus aims at the removal of the poison and supportive therapy as we do not have specific antidote for it. Gastric lavage with potassium permanganate is recommended to convert the phosphorus to relatively harmless oxides. Careful monitoring of renal and hepatic functions is of vital importance and management of these failures were the need of the hour. In patients presenting with acute liver failure, liver transplantation was considered superior [17,18,21].

In our study, the liver parameters increased with time and were high on the 7th day also. Only after the third phase has resolved the liver enzymes started resolving to normal. Similar results were obtained in other studies [6,18,19,22-25].

CONCLUSIONS

Nearly all the patients with rodenticide poisoning had elevated liver enzymes. Too young or elderly age, delay in arriving to hospital, and dose of ingestion of the poison are few of the risk factors. Liver parameters play a vital role in monitoring the prognosis of the condition and are helpful in the management of the condition. Suicide preventive strategies such as counseling and mental health support as directed by national mental health program need to be taken care of to reduce the incidence of the same.

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AUTHORS' CONTRIBUTION

All authors contributed significantly to the article. Malarvizhi and Radhakrishnan designed the study and guided. Jeevithan performed the statistical analysis of the data, drafted, and finalized the manuscript. Prasanna collected the data and managed the literature searches. All authors read and approved the final manuscript.

CONFLICTS OF INTEREST

Nil.

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