Original Article

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Phosphide Poisoning in Children in Tertiary Care Hospital of South India: A Retrospective Study

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Abstract

Background: Phosphide poisoning is among the most lethal poisons with high reported mortality. Incidence varies in different parts of the world and parts of the country. There few reports in pediatric age group.

Materials and Methods: A 33 patients below 18 years of age admitted to tertiary child care hospital in south India from January 1, 2013 to June 30, 2015 were retrospectively analyzed.

Results: The 33 were found to have acute phosphide poisoning and accounted for 9.93% of all poisonings and 0.5% of all admissions to a pediatric emergency. It was the fifth most common cause of acute poisoning in children. Males were only 10 out of 33 phosphide poisoning. 54.5% of all phosphide poisoning was observed in more than 14 years of age, followed by 10-14 years and 5-9 years age group with 21% in each group. The peak in poisoning was observed in winter and spring. Children were treated with gastric lavage with 1:1000 dilution potassium permanganate followed by sodium bicarbonate, activated charcoal, magnesium sulfate, inotropic support, and atropine whenever bradycardia and decreased plasma pseudocholinesterase. One case left against medical advice, but he had improved clinically and laboratory wise at the time of leaving. Only one death occurred out of 33 patients (3.3% mortality).

Conclusion: Phosphide is the fifth most common cause of poisoning in <18 years of age. Multipronged approach will certainly reduce mortality. The plasma pseudocholinesterase is to be measured, and low levels of the enzyme are the indication for using atropine and pralidoxime. Randomized control trials are necessary to substantiate our observation.

Key words: Atropine, Pseudocholinesterase, Organophosphorus, Zinc phosphide

INTRODUCTION

The phosphides, aluminum phosphide (AlP) in particular, which are used as rodenticides and insecticides are becoming an agent of choice for suicides. During the last 10 years, AlP has gained notoriety as an effective suicidal agent and has resulted in thousands of deaths in last two decades.[1,2] AlP, solid fumigant, was declared as an ideal fumigant pesticide in 1973 for its effectiveness, easy to use and low cost properties. Phosphine gas (PH3) is liberated from phosphide diffuses uniformly throughout the stored grains, leaving non-toxic residues in the form of phosphite and hypophosphite of aluminum without affecting the food value of grains.[3] Self-poisoning with paraquat and AlP ingestion have reported fatality in excess of 70%, although earlier studies report higher mortality (70-100%).[4-6] Mortality is higher when more than two tablets are consumed, and none survive with three or more tablets ingestion.[6] AlP has also emerged as one of the most common poisonings in children, with a mortality ranging from 30 to 100%.[7-9] Studies suggest that phosphides and organophosfates (OP) are commonly implicated in fatal poisonings in the northern and southern part of India, respectively.[10,11]

In one study of 2039 autopsies, 208 cases (10.02%) of death due to poisoning and AlP leads the lists of most killer poisons and accounts for 35.1% of deaths.[3] However, only one study has been done in north India on phosphide poisoning outcome among children aged 12 years and younger.[12]

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In the view of it's public health concern, non-availability of specific antidote and low survival rate and no similar study in geographically different south India, this study was undertaken to study acute phosphide poisoning and mortality in tertiary child care hospital from south India.

MATERIALS AND METHODS

This is a retrospective study of all the children aged below 18 years admitted with a diagnosis of acute poisonings, Vanivilas Women and Children's Hospital, tertiary health care center under Bangalore Medical College and Research Institute, Bengaluru. Data was collected for the period from January 1, 2013 to June 30, 2015 from the medico-legal registry, inpatient records, and daily duty reports. Forensic reports of gastric aspirates and post-mortem findings were not analyzed. Specially designed data collection performa was used for getting information on demographic profile, name, quantity nature of poison, route of exposure, information regarding first aid received else, signs and symptoms, investigations done, treatment given, complications, treatment outcomes, and events of mortality and the reasons for the mortality.

RESULTS

Three hundred and thirty two children were admitted and treated for acute poisoning in a pediatric emergency. The poisoning contributed for 5.3% of total admissions (332 of 6199 admissions) during the period of January 2013-June 2015. 33 children of 332 children were due to phosphide ingestion. The phosphides accounted for 9.93% of all poisonings and 0.5% of all admissions to a pediatric emergency. It was the fifth most common cause of acute poisoning in children. First four were in the order; kerosene, snake bites and scorpion stings, OP compounds, and drugs (Figure 1). AlP accounted for 15 and zinc phosphide for 18 of phosphide poisoning. Males were only 10 (30%) out of 33 phosphide poisoning (Figure 2). This is in contrast to all major groups of poisoning except kerosene where males dominated the female. Incidence of phosphide poisoning increased with age. 54.5% of all phosphide poisoning was observed in more than 14 years of age, followed by 10-14 years and 5-9 years age group with 21% in each group. Only one case was observed in <1 year of age and 1-4 years age group each (Figure 3).

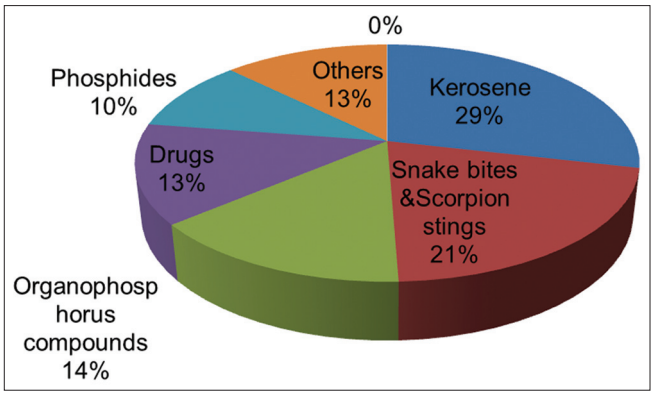

Figure 1: Distribution of various types of acute poisoning in children

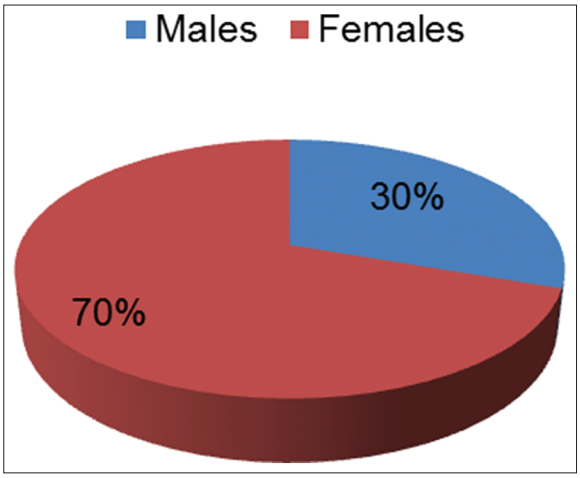

Figure 2: Gender distribution in acute phosphide poisoning

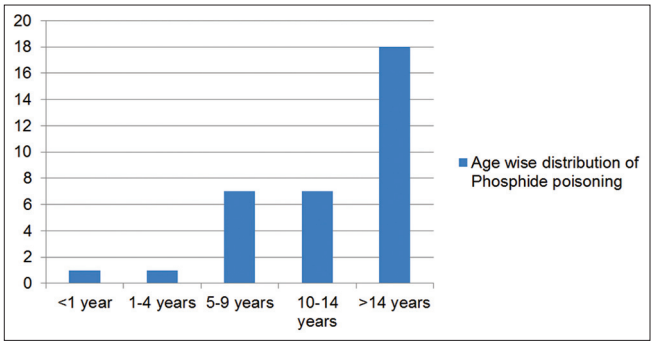

Figure 3: Agewise distribution of phosphide poisoning

Seasonal Variation

Maximum number of phosphide poisoning cases was observed during winter season followed by spring season (Figure 4). This is in contrast to the incidence of all-cause admissions due to poisonings. A number of admissions due to all causes were maximum during summer (31%) followed by the rainy season. There was no correlation in different months of the year, but peaking observed was correlated with seasonal variation when 2 years valves were merged to calculate occurrence (Figure 5).

Symptoms

Gastrointestinal symptoms were present in 22 (66%), central nervous system symptoms in 6 (18.1%), respiratory symptoms in 6 (18%), hypotension in 5 (15.1%), and asymptomatic in one. Overall, more than the system was involved in seven patients.

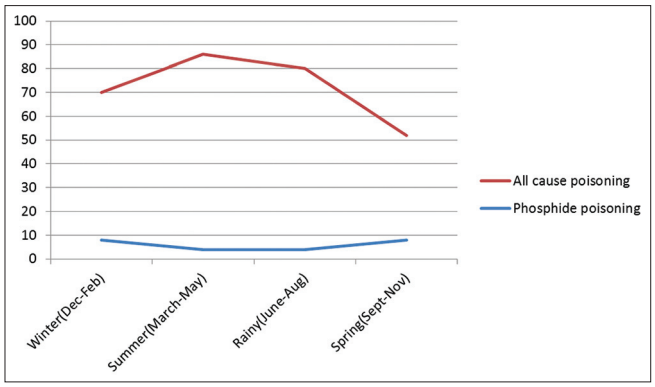

Figure 4: Season wise distribution of phosphide poisoning

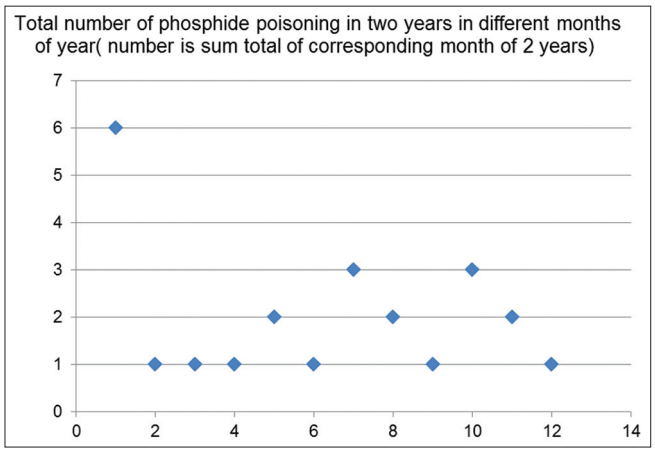

Figure 5: Scattered diagram showing frequency of occurrence in different months

Toxic Dose

Exact dose phosphide ingested was available only in four of our study patients. Rest were either unknown or nor given the information. Lowest consumed dose was 1 g, and highest was 5 g. One child who had consumed 3 g of AlP presented with drowsiness and hypotension. He did not respond to treatment and succumbed.

Treatment

The gastric lavage was carried out using normal saline, 1:1000 dilution potassium permanganate followed by sodium bicarbonate lavage, activated charcoal for gastrointestinal contamination. Intravenous fluids, inotropic support, vitamin K, vitamin C, and magnesium sulfate 100 mg/kg, 6th hourly was administered up to 4 days depending on the severity of symptoms. The children were monitored for vital parameters, renal function tests, and liver functions tests wherever required. One patient aged 15 years who stable with supportive treatment, normal total counts, and liver functions tests started gasping at about 24 h of ingestion with low volume pulses, prolonged capillary refill time, bradycardia (heart rate - 32/min), and saturation of 64%. Pupils were 3 mm bilaterally and reactive to light. There were a lot of bronchial secretions. Cardiopulmonary resuscitation was done, and the patient was mechanically ventilated along with inotropic support using dopamine at 10 μg/kg/min. The patient was administered with atropine 0.05 mg/kg bolus followed by infusion at 0.05 μg/kg/h to maintain in optimal atropinization. Injection pralidoxime was given at a dose of 30 mg/kg intravenously. The plasma pseudocholinesterase (PCHE) was found to be low with 3344 U/L (normal value is 5385-12920 U/L). Symptoms dramatically improved within 2 h. Atropine was continued until the elevation of pseudocholinesterase was observed and stopped.

Mortality

The acute phosphide poisoning contributed for 1 out of 7 deaths due to all poisonings. Hence, the mortality rate of phosphide poisonings in our institute is 2.1%, a figure not different from the mortality due to all causes poisonings. One out of 33 acute phosphide poisoning admissions died (3% mortality). The 8-year-old male died of accidental consumption of AlP. He had consumed about 3 g of AlP. The presentation was vomiting, altered sensorium, and hypotension after 2 h of consumption. The patient had been received vitamin K, magnesium sulfate, sodium bicarbonate, intravenous fluids, inotropic, and mechanical ventilator support. Comorbid conditions: Depression, mood disorder, adjustment disorder, and deliberate self-harm were the predominant diagnoses in those who were older than 10 years.

DISCUSSION

Phosphide compounds are available as zinc phosphide (Zn_3P_2), AlP, magnesium phosphide (Mg_3P_2), and calcium phosphide (Ca_3P_2). Among these, AlP and Zn_3P_2 are encountered in our study. Zn_3P_2 was seen 18 and AlP in 15 out of 33 phosphide poisoning. Zn_3P_2 has been reported to have lower human mortality.[6] The acute phosphide poisoning is either by ingestion or inhalation.[13,14]

Burden

Very much insurgence of phosphides in the open market during cropping and storage seasons, although poisoning can occur in any season of the year, may explain increased incidence of acute poisoning during winter and spring. The phosphides are second only to OP compounds in our study and observation is inconsistent with in other studies.[10,11]

Toxic Dose

The exact dose of phosphide ingested was available only in four of our study patients with an average of 3.5 g. Rest were either unknown or nor given the information. Lowest consumed dose was 1 g, and highest was 5 g. One child who had consumed 3 g of AlP presented with drowsiness and hypotension and did not respond to treatment and died. The toxic dose reported in the literature is >1.5, 3 g, and 20 mg/kg for AlP, and 4-5 g for Zn_3P_2.[12,15-17] The higher dose in our study

could be fallacious and possibility of inappropriate history regarding the amount of phosphide ingested.

Gender Distribution

Females:males in our study was 7:3 in contrast to reported male:female ratio being 2.1:1 in one north Indian study. The incidence of poisoning was highest in the age group of 21-25 years in that particular study.[18] Male predominance (63%) was reported in a study done exclusively in children below 12 years of age.[12] Our study population was <18 years and geographically different, i.e. south India. Accessibility for females in grain storage process could be the reasons. Clinical Features

The gastrointestinal symptoms were present in 22 (66%), central nervous system symptoms in 6 (18.1%), respiratory symptoms in 6 (18%), hypotension in 5 (15.1%), and asymptomatic in one. Over all, more than one system were involved in seven children of the study group. The hypotension and metabolic acidosis were less than reported. Nausea was present in 79.4%, vomiting in 76.5%, abdominal pain in 31.4%, and metabolic acidosis in 41.1% in a study of 102 patients with AlP poisoning in the age of 28.5 ± 12.4 years.[19] In one more study done exclusively in children, hypotension was observed in 46.7%, respiratory system involvement in 26%, and central nervous system involvement in 12%.[12]

Mortality

One child who had consumed 3 g of AlP died. Mortality of 3.3% in our study is much lower than reported 46.67% where in 14 of 30 children with phosphide.[12] Lethal dose in our died child is inconsistent with observations made in which no survivors had consumed more tablets (2.2 ± 2.4).[19] Combination of treatment modalities used rather than individual treatment regimens described fact that less toxic zinc phosphide was observed in 18 of 33 cases, and possibly less amount of phosphide ingested could be reason for low mortality in our study.

Mechanism

PH3, active form of phosphide, is released when phosphide comes in contact with acid, and it is the culprit for clinical features phosphide poisoning.[7] There is conflicting evidence on the occurrence of magnesium disturbances and it's role.[13,14] The most of deaths, mostly due to cardiac complications, occur within 24 h of ingestion. Delayed deaths could occur when adult respiratory distress syndrome (ARDS) supervenes. Circulatory collapse, ARDS, myocardial dysfunction, metabolic acidosis, acute renal failure, disseminated intravascular coagulation, and hepatic necrosis are other reasons for mortality. Varying degree of congestion, edema and leukocyte infiltration suggesting cellular hypoxia in AlP poisoning, notably in lungs, kidneys and adrenals, have been documented.[20] Decreased PCHE in the absence of liver cell damage is another effect of PH3. These children mimic OP compounds in manifestations.[21] Low PCHE levels correlate with outcome in OP poisoning.[22,23] This relation of PCHE with mortality in phosphide poisoning needs to be evaluated by randomized control trials.

Treatment

The principle is same for all phosphides. The gastric lavage with potassium permanganate ($KMnO_4$) activated charcoal + sorbitol solution. $KMnO_4$ (1:1000 solution) oxidizes PH3 in the stomach to phosfate, and reduces the amount of PH3.[24] Other modalities are intra-aortic balloon pump, trimetazidine and magnesium sulfate, vitamin C + methylene blue, hyperbaric oxygen therapy, and supportive treatment.[25-28] Survival rate of 42% with extensive gastric lavage with coconut oil and sodium bicarbonate solution with simultaneous aspiration and supportive treatment has been reported.[29] Mg^{2+} - carrying nanoparticle and sodium bicarbonate combination, N-acetyl cysteine (NAC) improved survival time animal experiments.[30,31] Further studies showed improved out come with NAC and oral sweet almond oil.[32,33] The magnesium sulfate improves the outcome in humans by reducing life-threatening cardiac arrhythmias and decreasing apoptosis in neuronal tissue as a result of decreased calcium influxs.[12] Vitamin C, magnesium, and NAC, and glutathione act against oxidative stress. The hosphide poisoning with reduced PCHE responds very well to atropine and pralidoxime as evidenced from animal study and our observation.[21] Decreased PCHE could be the culprit for mimicking OP poisoning. The bradycardia has also been attributed to transient vagotonia that responds to atropine.[34] The phosphides shall be considered for differential diagnosis in OP poisoning. Recently, boric acid has been proposed as a non-toxic and efficient trapping agent and an antidote for PH3 poisoning by investigating the chemical reaction between them.[35]

Limitations of the Study

The limitation of our study includes the retrospective nature of data collection, and relatively small sample size, no availability of exact amount of phosphide ingestion. The zinc phosphide which is relatively less toxic than AlP may be another factor for low mortality in our study population. Multiple modalities of treatment were used in management and were not compared between one another.

CONCLUSIONS

The Proper antidote for acute phosphide poisoning is still unavailable although boric acid has been proposed as an antidote for PH3. The combination of treatment modalities would help reduce mortality rather than one modality. Treatment with atropine and pralidoxime when the

presentation is like OP poisoning supported by decreased PCHE, in addition to gastrointestinal decontamination, vitamin C, magnesium, NAC, and supportive therapy, may be an effective treatment. Measurement of PCHE in all case of phosphide poisoning is recommended. Further studies are required on effects atropine and pralidoxime in acute phosphide poisoning in humans.

LEARNING POINTS

1. Phosphide poisoning is the fifth most common cause of acute poisoning in children peaking during adolescence
2. Phosphide peaks during winter and spring
3. Phosphide can mimic organophosphorus poisoning
4. PCHE levels are to be measured in AlP poisoning
5. Combination of various treatment options reduces mortality
6. Treatment with atropine and pralidoxime shall be considered in every case of bradycardia, hypotension, increased secretions following AlP poisoning even in the absence of PCHE estimation.

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