

Aluminium phosphide poisoning: A case series at two hospitals in the Manzini Region, Eswatini

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Abstract

The absence of an antidote to Aluminium Phosphide (AIP) poisoning has been the subject of many studies. Very few, if any, of these studies have described AIP poisoning cases in Africa. This study reported on AIP poisoning and its management at Mankayane Government Hospital (MGH) and Raleigh Fitkin Memorial Hospital (RFMH), both in the Manzini region of Eswatini. This was a retrospective case series at MGH and RFMH for AIP poisoning victims for the period April 1st 2016 to March 31st 2017. Forty-two case records met the inclusion criteria comprising 26 (62%) females and 16 (38%) males and the number of deaths reported was 17 (41%). The most common presentation was hypotension (n=10, 24%). Twenty-two (52%) patients received gastric lavage. Activated charcoal was administered the most in the emergency departments of the respective hospitals. There is a need to develop standard treatment protocols for the treatment of ALP in both hospitals. Eswatini issues permit for regulating the sale of AIP and efforts should be put in place to enforce the use of this tool.

Introduction

Aluminium Phosphide (ALP) is a fumigant used for protecting grain against infestation from most forms of pests that attack stored grains.¹ It works by releasing phosphine gas on contact with moisture.¹ On ingestion or absorption into the circulatory system, the phosphine gas (PH₃) released leads to multiple organ failure in humans.^{2,3}

Ingestion of the poison can be confirmed with the silver nitrate test or a combination of history, garlic odour in the breath, vomitus or gastric washings and clinical presentation.^{4,5} The most common manifestations of AIP are; cardiac dysfunction, metabolic acidosis and severe hypotension.² The common cause of deaths

within the first 24 hours are cardiac dysrhythmias.⁴

The exact mechanism for AIP poisoning is not fully understood. It is thought that it inhibits Cytochrome C Oxidase, however, that has only been shown *in-vitro* and is thought not to have such a significant effect in humans.⁶ Others have suggested that formation of highly reactive hydroxyl radicals also leads to the fatal cellular respiratory failure.⁵ Unfortunately, there is no known antidote to aluminium phosphide poisoning, however, several authors have suggested supportive measures for treating patients with mixed outcomes.⁷⁻¹¹

Most reported cases in the literature are from India, Jordan, Morocco and Iran,^{6,9} with reported mortality rates well above 50%.⁴ However, not much information has been published on AIP poisoning in Africa. In Eswatini AIP is commonly known as "Weevil Tablet" and incidents of its misuse are so common that entering the phrase "Weevil Tablet" on the online search engine "Google", will yield top results on news articles about poisonings with AIP in Eswatini. Lawmakers have been aware of this public health issue, and a law on the control of AIP tablets was proposed as far back as 2009.¹² Currently, there is no known law enforcing the sale or use of AIP in Eswatini. Nevertheless, the ministry of agriculture of Eswatini, through the director's office, issues a permit to individuals intending to purchase and use AIP for grain storage purposes. Despite these efforts, AIP is still abused and inappropriately stored.¹³ This paper aims to highlight the existence of AIP poisoning, describe the general presentations and management of the poison victims at two hospitals in the Manzini region of Eswatini.

Materials and Methods

Study design

This study was a retrospective case series carried out at Mankayane Government Hospital (MGH) and Raleigh Fitkin Memorial Hospital (RFMH), in the Manzini region, from the 1st of April 2016 to the 31st of March 2017. The sample of the study was all ALP poison victims who presented during this period at the two hospitals. This study received ethical approval from the Eswatini National Health Research Review Board.

Data collection

Data were collected from the medical record departments of MGH and RFMH hospital. Patient files from the 1st of April 2016 to the 31st of March 2017 at both hos-

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pitals were identified as AIP poisonings based on a combination of the following; history, garlic odour in the breath, vomitus or gastric washings and clinical presentation.⁵

Patient demographics, nature of the AIP taken, the time between exposure and presentation to hospital, the intention of poisoning, laboratory investigations, blood pressure and first aid interventions were collected for analysis.

Statistical analysis

This was an observational study, all data collected were presented descriptively and analysed using Microsoft Excel to sum-

marise patient characteristics: mean, range, mode and graphical representations.

Results

Between the periods of 1 April 2016 to 31 March 2017, 42 files met the inclusion criteria with a population of 26 (62%) females and 16 (38%) males (Table 1). The average age of the sample was 28.3 years with a mode of 24 years, range of 17-74 years and the majority, 33 (79%), were aged below 35 years. Most cases were suicide attempts, just as most patients ingested the tablet form of the poison and the total deaths reported were 17 (41%). However, it seems most patients who vomited survived compared to the other patients (Table 1).

Gastric lavage was done in 22 (52%) of patients, and 11 (50%) died (Table 1). It is important to note that 10 out of the 11 patients who received gastric lavage and died comprised 5 (50%) with a systolic reading of less than 90mmHg whereas, 12 out of the 13 (92%) who survived without receiving lavage had systolic blood pressure greater than 90mmHg with the exception of 1. Only, 37 patients had their blood pressure recorded and patients with a systolic reading of less than 90mmHg were 10 (27%) and 7 (70%) of these patients died. Bradycardia was reported in 6 (17%) with deaths reported in 5 (83%) of the bradycardic patients. The most common presentation on arrival to the hospital was hypotension (n=10, 24%) (Figure 1). Activated charcoal was administered the most times in patients at the emergency departments of both hospitals (Figure 2).

The arrival time of 32 (76.2%) of the patients was noted, and 20 (62.5%) arrived within 3 hours of poison ingestion. The average arrival time of patients who died was 2 hours and 10mins (range 1 hour to 5 hours while the average arrival time for the survivors was 3 hours 50mins (range 58 minutes to 12 hours). There was no notable previous medical history in 28 (66.7%) of the patients (Table 2).

Discussion

Most AIP cases reported during the study period were in young people aged 35 and below who actively contribute to the economy of Eswatini. Most cases were either suicide or suicide attempts which could be an indicator of deep social or psychological challenges in this age group. Further analysis did not show any discernible pattern regarding the previous history of the patients other than being HIV⁺

(either on ART or not), pregnant or have recently delivered. Considering the high prevalence of HIV in Eswatini and that this is the prime childbearing age range for women in Eswatini, these trends may be purely coincidental.¹⁴ In addition, as these trends were not actively sought after, these figures could be higher than what was observed. Restlessness, lethargy, epigastric pain and vomiting which are consistent with

findings in other studies were common in these patients.^{2,4}

There was a wide selection of drugs which was used in patients across the two hospitals which was suggestive of a lack of standard protocol in managing AIP poisoning. In other published literature there are commonly used drugs around which debate has been centred.^{2,8,15} This study did not encounter most of these drugs notably;

Table 1. The relationship between patient characteristics on presentation to hospital, nature of poison, intervention, previous medical history and patient outcome.

Variable	Survived, n (%)	Outcome Unknown, n (%)	Died, n (%)
Gender			
Male	10 (24)	1 (2)	5 (12)
Female	14 (33)	0 (0)	12 (29)
Patient vomited			
Yes	14 (33)	1 (2)	5 (12)
No	10 (24)	-	7 (17)
Not documented	-	-	5 (12)
Nature of substance			
Tablet	19 (45)	1 (2)	16 (38)
Powder	4 (10)	-	1 (2.5)
Unknown	1 (2.5)	-	-
Intention of poisoning			
Suicide	23 (55)	1 (2)	15 (36)
Alleged homicide attempt	1 (2)	-	-
Unknown	-	-	2 (5)
Intervention			
Gastric lavage	11 (50)	-	11 (50)
No gastric lavage	13 (65)	1 (5)	6 (30)
Pre-hospital care			
A/C and R/L given by EPR	1 (2.4)	-	-
A/C given by EPR	1 (2.4)	-	-
Given 8 tablets of A/C at the local clinic	1 (2.4)	-	-
Given cooking oil at home	1 (2.4)	-	-
None	9 (21.4)	-	3 (7.1)
Took milk & cooking oil at home, vomited	1 (2.4)	-	-
Unknown	9 (21.4)	1 (2.4)	14 (33.3)
Given A/C and IV NS at the local clinic before referral	1 (2.4)	-	-

A/C: Activated charcoal; R/L: Ringer's Lactate; EPR: Emergency Preparedness and Response; NS: Normal Saline; IV: Intravenous.

Table 2. Showing the previous history of the patients and the number of patients with the corresponding history.

Previous medical history	n (%)	Survived	Died	Unknown
Sixth attempt to commit suicide	1 (2.38)	1	-	-
Dagga use	1 (2.38)	1	-	-
Incomplete miscarriage	1 (2.38)	1	-	-
None noted	28 (66.67)	12	15	1
Post C/S (6 days prior)	1 (2.38)	1	-	-
Pregnant	5 (11.9)	3	2	-
HIV ⁺	1 (2.38)	1	-	-
HIV ⁺ on ART	2 (4.76)	2	-	-
HIV ⁺ on ART, epileptic, alcohol abuse, depression	1 (2.38)	1	-	-
HIV ⁺ pre-ART	1 (2.38)	1	-	-

C/S: Caesarean Section; HIV⁺: Human Immunodeficiency Virus positive; ART: Antiretroviral Therapy.

magnesium sulphate, sodium bicarbonate and potassium permanganate. A possible explanation for their absence is that in the studies that report their use, they are administered for the management of metabolic acidosis and or cardiac arrhythmias. This study, in contrast, revealed that those parameters are not monitored which is concerning as they are important prognostic indicators beside hypotension.⁴ However, the lack of monitoring could be due to unavailability of ECG and blood gas analysis capacity at both hospitals.

A common drug used in the management of the patients was activated charcoal (AC). Any statistically significant trend associated with AC would have been an interesting find considering some evidence shows AC may not have the capacity to effectively arrest phosphine gas release in AIP poisoning,¹⁶ with other studies showing positive responses from AC.¹⁷ There are studies that have shown that concomitant use of atropine and Pralidoxime can reduce morbidity and mortality.¹⁸ RFM hospital was using Obidoxime, a drug in the same pharmacological class with Pralidoxime, with other medicines. Unfortunately, our design makes it is impossible to associate positive or negative outcome to the use of any particular drug in our study.

There was a positive pattern associated with gastric lavage in the current study considering more than half of the patients who received lavage and died presented with hypotension which is a known poor prognostic indicator in AIP poisoning.⁴ Furthermore, it is the investigator's opinion that the SSPS protocol (suction of gastric contents, oral sodium bicarbonate, lavage with potassium permanganate, oral sodium bicarbonate) that was used in another study had a weakness due to its inclusion of potassium permanganate which has been attributed to worsening of symptoms in AIP.^{8,16} It is therefore reasonable to expect a more favourable outcome if potassium permanganate is excluded or replaced with an appropriate oxidising agent and gastric lavage is administered within a reasonable time after poison ingestion. There are authors who are against gastric lavage citing the risk of increasing negative pressure in the stomach which in turn could provoke internal gas ignition.¹⁹

Overall, survivors in the current study either; had vomited post-ingestion, taken the powder form of the poison, ingested expired tablets, had received cooking oil as first aid, had ingested trace amounts of the poison or had received first aid intervention in the form AC and IV fluids. These qualities have been associated with good prognosis in several papers. An exception to this

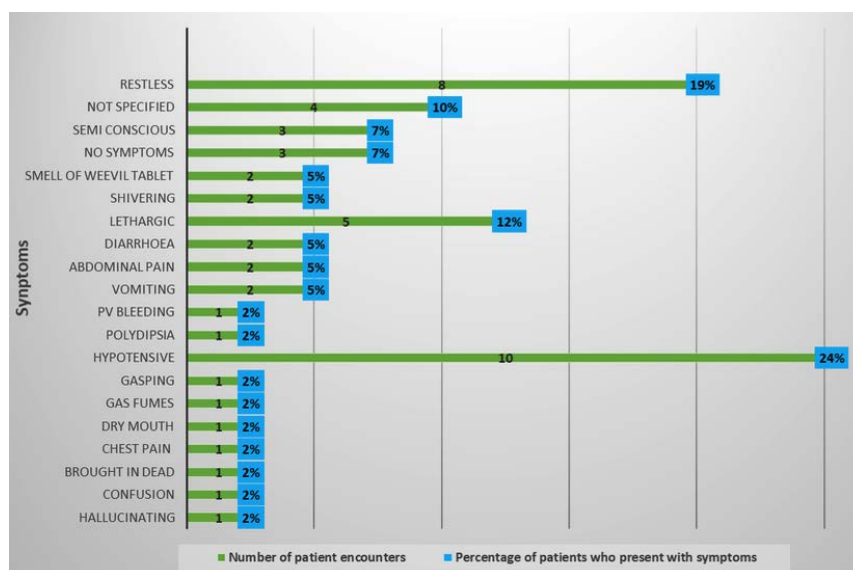


Figure 1. Frequency of symptoms reported/detected in patients on arrival at the emergency department.

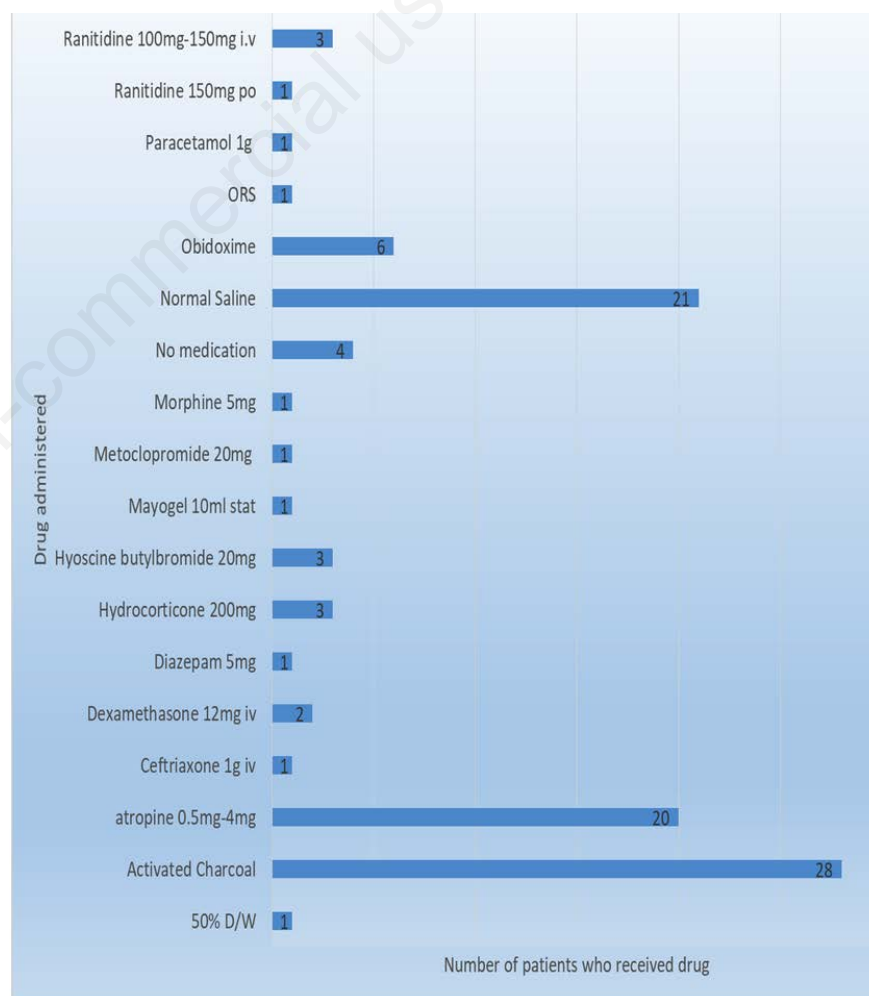


Figure 2, Drugs commonly used for management of patients (both emergency department and on admission).

generalisation in the current study was a patient who had taken the powder form of the poison, had a history of vomiting but still died. Further scrutiny of this case showed that the patient was hypotensive by the time they received medical attention and the time of ingestion was not stated. Out of these positive prognosis indicators, the one intervention that could easily be used by first responders is oral administration of cooking oil. Evidence to support its application lies in that vegetable oils and liquid paraffin have the ability to inhibit phosphine release *in-vitro* because of physiochemical properties of ALP and its non-miscibility with fat.¹⁵ Having said this, a significant portion of patients who died (n=14, 82%) had no information on whether they received first aid intervention or not and as a result it is impossible to attribute any positive outcome to any of the listed first aid interventions. Intravenous administration of Intralipid 20% is thought to be useful, basing the rationale of this practice on the 'lipid sink' theory.^{8,19} The Eswatini Standard Treatment guidelines published in 2012 does not include Intralipid 20% which means it is not readily available at either hospital. Its availability would make it possible to extend its use in ALP patients in Eswatini. Having said this, studies with appropriate designs are yet to be done to fully explore the practical implications of widely adopting these practices seeing as their evidence of use is based on limited case reports.

In the current study patients who make it earlier to the hospital tend to have poor outcomes compared to those who come later. A possible explanation for this is that patients who report early are those who show signs of distress immediately after exposure or possibly there was misdiagnosis as "weevil tablet poisoning" in the group that arrived later to the hospital. It is for the latter reason that the silver nitrate test on gastric aspirate or breath should be considered as standard practice for ALP diagnosis.⁴

Other studies have identified hypotension, cardiac arrhythmias, and metabolic acidosis in ALP poisoning as important poor prognostic indicators.^{3,6} It is concerning that none of the patients in this study had active monitoring of either biomarker. Nonetheless, detection of abnormalities in these parameters is not a guarantee of a positive outcome as high mortality rates have been observed in well-equipped medical facilities.³ From the files that were reviewed, the authors noted that on discharge the patients were not given review

dates to monitor their progress; interestingly there is evidence that some survivors have reported post-admission complications including oesophageal strictures, fistulae, and headaches.³

Being a case series, the study was not able to control for confounders which makes it impossible to ascertain causality and is limited to describing associations. The quality of the data evaluated from both centres was marred by gross instances of missing data. However, it was an appropriate design in this instance because prior to this study, there had been no paper describing the existence or management of ALP in Eswatini.

Conclusions

There is a need to rationalise the treatment of ALP at both hospitals. More drugs and techniques with good clinical data should be explored further with appropriate study design. We recommend enforcing the function of the purchasing permit before more options are explored.

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