

Aluminum Phosphide Poisoning in Egypt

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ABSTRACT

Aluminum phosphide is one of the significant causes of poisoning in Egypt because of its free availability in the market and its low price. It causes multiple organ failure, especially in the cardiovascular system causing high morbidity and mortality. Diagnosis of aluminum phosphide poisoning cases depends on the positive history of exposure and clinical manifestations that range from gastrointestinal to cardiac manifestations particularly arrhythmias and shock without accompanied or previous history of cardiac disease. Laboratory investigations can assess the condition of the patient and prognosis only. Leucopenia and low serum level of cortisol indicate the severity of toxicity besides high levels of SGOT or SGPT and metabolic acidosis. Chest x-ray, electrocardiogram, and electrolytes assay may also be used as assessment tools in these cases. Moreover, the level of plasma renin reflects the dose of aluminum phosphide predicting prognosis. The efficacy of the medical intervention in cases of aluminum phosphide intoxication is still representing a challenge to physicians. So, there is an increase in morbidity and mortality rates of aluminum phosphide intoxication cases. Management of aluminum phosphide poisoning cases is mainly based on early medical intervention and life-saving measures that provide a clear airway and adequate breathing besides stabilization of circulation until the elimination of phosphine gas. In addition, some clinical trials can be used to improve the outcome of these intoxicated cases such as some antioxidants besides supportive measures.

Keywords: Aluminum Phosphide; Poisoning; Egypt

Introduction

There are many types of pesticides that are used to protect grains from rodents and pests in developing countries. Some of these pesticides have become a challenge because of their widespread use and their high toxicity over the last years. Aluminum phosphide is one of these pesticides that are considered one of the major causes of poisoning leading to a high percentage of morbidity and mortality in these countries especially Egypt [1]. Aluminum phosphide is used extensively in rural areas of Egypt as a cheap fumigant for stored cereal grains. So, a lot of aluminum phosphide poisoning cases were reported leading to death in the last years. The mechanism of aluminum phosphide toxicity

depends on the liberation of phosphine which is considered a lethal gas via atmospheric moisture or hydrochloric acid in the stomach. Phosphine gas toxicity is caused by the generation of free radicals leading to oxidative stress and cellular injury via the lipid peroxidation process [2]. Aluminum phosphide poisoning usually affects the heart and vascular tissues causing some related manifestations such as hypotension, shock, and arrhythmias besides associated acidosis, hepatotoxicity, disseminated intravascular coagulation, and renal failure. However, the increased mortality rate in cases of aluminum phosphide poisoning is due to severe arrhythmias or profound shock [3]. Recently, some studies that were conducted on cases of aluminum phosphide poisoning

reported that the mortality rate exceeds 68% [4]. Furthermore, other studies refereed that the high number of aluminum phosphide poisoning cases is attributed to free availability in the market and the low price of this compound in Egypt, which is known as a rice tablet with easy accessibility in the home. On another hand, these studies informed that its high mortality rate is due to the absence of an effective antidote until now. Moreover, these studies showed that the most common mode of aluminum phosphide toxicity is self-poisoning wherein it is considered an agent of choice for suicidal cases besides accidental cases [5]. Therefore, the aim of this review is to investigate this problem in Egypt based on the previously published literature about it in the last years showing the clinical manifestations of these cases and assessing medical intervention and its reflection on the outcome and the mortality rate.

What is Aluminum Phosphide?

Aluminum phosphide is known in the Egyptian market under several trade names such as Cellphos or Alphos 600 mg which can release 0.2 g of phosphine gas while Phostoxin and Quickphos are dark brown or greyish tablets 3 g that can release 1 g of phosphine gas. It is known in Egypt as pest pills or wheat pills besides rice tablets [6]. Aluminum phosphide poisoning usually induces multiple organ failure, especially in the cardiovascular system. Clinically, diagnosis of aluminum phosphide poisoning cases depends on the positive history of exposure and clinical manifestations particularly arrhythmias and shock without accompanied or a previous history of cardiac disease. So, management of these cases is mainly based on life-saving measures that provide a clear airway and adequate breathing besides stabilization of circulation until the elimination of phosphine gas [7]. However, most of the studies concluded that aluminum phosphide poisoning cases are presented as a broad spectrum of non-specific clinical manifestations that range from gastrointestinal manifestations such as vomiting, abdominal pain, and diarrhea to cardiac manifestations such as tachycardia, hypotension, palpitation, and shock. In addition, there are many associated complications that may develop such as hemorrhage, disseminated intravascular coagulation, renal failure, pulmonary oedema, and arrhythmias [8]. In the related context, it is known that laboratory investigations have not any role in the diagnosis of aluminum phosphide poisoning cases until now. It is achieved to assess the condition of the patient and prognosis. However, there are some laboratory indicators that should be considered during the management of these cases such as leucopenia and reduction of the serum level of cortisol which show the severity of toxicity besides elevated levels of SGOT or SGPT and metabolic acidosis. Moreover, the level of plasma renin reflects the dose of aluminum phosphide in direct proportion and predicts prognosis (mortality). Chest x-ray, electrocardiogram, and electrolytes assay may also be used as other assessment tools in these cases [9]. The efficacy of the medical intervention in cases of aluminum phosphide intoxication

is still representing a challenge to physicians. So, there is an increase in morbidity and mortality rates of aluminum phosphide intoxication cases. Therefore, there are some clinical trials to use some antioxidants besides supportive measures and early medical intervention to improve the outcome of these intoxicated cases [10].

Aluminum Phosphide Intoxication Cases in Egypt

Much research was conducted about aluminum phosphide intoxication cases in different areas of Egypt over the last few years. These studies reported the rate of these cases and the possible risk factors showing available methods of diagnosis and treatment, and their bad outcome. A study was carried out by several patients in the Emergency Hospital of Mansoura University about the used evaluating parameters that can predict the outcome of acute aluminum phosphide intoxication. This study used scoring systems such as Acute Physiology and Chronic Health Evaluation II score and Simplified Acute Physiology II score besides electrocardiogram. It concluded that some laboratory parameters are reliable indices for the outcome prognosis of acute aluminum phosphide intoxicated patients. These parameters are cortisol level, renin activity, leucocyte count, and pH [11]. On the other hand, some studies were conducted in other Egyptian governorates such as Fayoum. The first study was conducted at Fayoum General Hospital during the period from 2015 to 2017 about the outcome of toxicity and mortality predictors of aluminum phosphide poisoning. This study showed that the mortality rate was 92% while poor prognostic criteria for the outcome of aluminum phosphide poisoning were cardiogenic shock, arrhythmias, and metabolic acidosis. Moreover, the mode of poisoning was statistically significant with the outcome of poisoning wherein there was also a significant difference between the mode of poisoning, cardiogenic shock, and delay time of poisoning with the outcome of toxicity [12]. Another study was carried out about fatal aluminum phosphide poisoning in the same governorate during the period from 2012 to 2019. This study showed that there was an increase in the number of deaths in recent years because of aluminum phosphide poisoning wherein the number of deaths was 36.5% and all deaths were suicidal attempts [13]. Toxicology Unit of Tanta Emergency University Hospital, Egypt conducted a study from 2009 to 2013 on acute phosphide poisoning-related deaths to show magnitude, pattern, trend, and possible risk factors. Results of this study concluded that intentional aluminum phosphide poisoning was the first cause of death in poisonings in Tanta Toxicology Control Unit during this period. Furthermore, most cases received improper first aid either at home or in primary health care units while the most of death cases occurred during the first 6 hours from admission wherein many cases did not require mechanical ventilation [14].

However, the available data about the mortality prediction among aluminum phosphide poisoning cases is still limited. So, a study was performed at Tanta University Poison Control Center, Egypt to assess the role of clinical and laboratory findings besides ECG findings for predicting mortality in these patients. The results of this study showed a significant difference between survivors and non-survivors for vital signs, abnormalities of electrocardiogram, serum creatine level, white blood cell count, the levels of K, pH, HCO₃, and the mode of poisoning. Moreover, this study reported that the mortality rate was high and recommended the use of blood pH level and ECG to predict mortality early in these cases [15]. In addition, another study was carried out from 2012 to the end of 2016 in Tanta Poison Control Unit, Egypt to evaluate the predictive factors of mortality from acute aluminum phosphide poisoning. This study reported that there is a significant association between increased toxic dose, abnormal electrocardiogram findings, metabolic acidosis, and prehospitalization period with the risk of mortality. Moreover, there are prognostic factors associated with a poor outcome such as altered consciousness, hypokalemia, hypernatremia, hyperglycemia, elevated liver enzymes, renal function tests, and the need for mechanical ventilation [16]. In comparison with other studies in different countries, a study conducted in India showed that clinical parameters (tachycardia and hypoxia) and biochemical parameters (raised creatinine level and low magnesium level) have been associated with bad outcomes in aluminum phosphide intoxicated patients [17]. On the other hand, another study revealed that Glasgow coma score, systolic blood pressure, urinary output, and serum HCO₃ were significant for predicting mortality. This study identified high-risk patients and predicted the risk of mortality using a four-variables and risk-prediction nomogram. Moreover, the results of the study showed that the APACHE II score can significantly distinguish between non-survivors and survived patients [18].

Management of Aluminum Phosphide Intoxicated Cases in Egypt

In the related context, a study was conducted in an emergency unit of Assiut university hospital, Egypt. This study was carried out in the first six months period of 2016 to show the extent of the efficacy of supportive measures in the treatment of aluminum phosphide poisoning cases as a trial to decrease mortality. All patients with severe aluminum phosphide poisoning received effective oxygenation, ventilation, and continuous invasive hemodynamic monitoring with early resuscitation via fluid infusion and vasoactive agents' administration till phosphine was excreted. In the same context, N-acetyl cysteine (NAC) administration was used as an antioxidant wherein it can reduce myocardial oxidative injury and increases survival time. The results of this study referred that the supportive measures were vital in the treatment of these

cases besides the efficacy of N-acetyl cysteine as a protective agent in these patients [19]. This agrees with another study that was conducted by Agrawal et al. [20]. This study suggested that supportive measures have an important role in the treatment of aluminum phosphide poisoning cases in the absence of a specific antidote. According to the above mentioned about the role of antioxidants in the treatment of toxicity, Elshama et al. [21] confirmed that many chemicals' intoxication is based on the oxidative stress process that leads to reactive oxygen species generation and antioxidant defense mechanism depletion in the body. So, the use of antioxidant agents can treat toxicities in the various body systems. In this context, Fatma et al, [22] used L-carnitine as an antioxidant in the treatment of severe acute aluminum phosphide toxicity wherein early intravenous infusion of L-carnitine besides other supportive measures treatment was effective and safe as an adjuvant treatment in these cases. Noteworthy, antioxidants can deactivate free radicals minimizing cellular damage and the risk of free radical related-health problems based on the prevention of lipid peroxidation process [23]. On the other hand, much of the toxicological experimental research was conducted to find a new treatment for aluminum phosphide poisoning cases. Ezz et al. [24] investigated the efficacy of coconut oil, copper, and oral iron as possible oral antidotes in the treatment of aluminum phosphide intoxication cases. This study recommended that copper may be used as an oral antidote in the treatment of aluminum phosphide poison because of its amelioration effect and its importance for cytochrome oxidase function besides oral coconut oil that is to be added to the treatment plan. This contrast with the results study of Vaidyanathan et al. [25] that do not show any advantage for coconut oil in the treatment of aluminum phosphide intoxication cases over the usual supportive measures. In the same context, another study was carried out to investigate a new combination therapy using N-acetyl cysteine, vitamin C, trimetazidine, and hyperinsulinemia-euglycemia to treat acute aluminum phosphide poisoning. This study showed that this new regimen therapy can ameliorate toxicity of aluminum phosphide with marked improvement in hemodynamic and survival parameters approving strong antioxidant effects of this new combination along with correction of associated hyperglycemia and hemodynamic changes [26].

Conclusion

Widespread use of aluminum phosphide caused a high rate of poisoning cases in Egypt over the last few years. The most common mode of aluminum phosphide toxicity is self-poisoning besides accidental leading to high morbidity and mortality rate. Cases of aluminum phosphide poisoning are presented as a broad spectrum of non-specific clinical manifestations that range from gastrointestinal to cardiac manifestations. Laboratory investigations do have not any role in the diagnosis of aluminum

phosphide poisoning, but they can assess the condition of the patient and predict prognosis. Treatment of aluminum phosphide intoxication depends on supportive measures with using some clinical trials such as antioxidants to improve the outcome.

Declaration of Conflicting Interests

The author declares that there is no conflict of interest.

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