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Clinical Symptoms and Para-Clinical Findings among the Deceased Patients Due to Aluminum Phosphide Poisoning in Ardabil, Iran, From 2009 To 2017

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ABSTRACT

Introduction:
Aluminum phosphide or rice tablet is one of the most common pesticides and insecticides used in agriculture to protect crops, cereals, and rice. Recently, this substance has been increasingly used as a method for committing suicide among people in society. This study aimed to evaluate the clinical symptoms and para-clinical findings of deceased patients due to Aluminum phosphide poisoning in Ardabil province, Iran.

Materials and Methods:
This descriptive cross-sectional study was conducted on 97 hospitalized patients who died due to Aluminum phosphide poisoning in Ardabil province, Iran, from 2009 to 2017. The data were collected using a checklist and then analyzed in SPSS software (version 19) through descriptive and analytical statistics

Results:
The mean age of all patients was 34.3±15.8 years, and the majority of the cases (77.3%) were female. The most important symptoms were nausea and vomiting in males (92%) and females (100%). Moreover, the patients had a mean recovery time of 5.89 h. Of all the deceased patients, 22 and 75 cases took two and one tablets, respectively. Furthermore, 92.7% of the patients had taken the rice tablets orally. The amount of Glasgow Coma Scale (P=0.001), systolic blood pressure (P=0.001), PH (P=0.001), heart rate (P=0.001), respiratory rate (P=0.001), bicarbonate (P=0.001) and white blood cell (P=0.009) in died patients in more than 24 hour significantly difference with died patients in less than 24 hour. The females obtained a significantly lower systolic blood pressure (P=0.01) and lower pH (p=0.045), but the higher partial pressure of oxygen (P=0.01), compared to males.

Conclusion:
The results of this study showed that the frequency of deaths due to rice pill poisoning was much higher in males than females; moreover, this value was higher in middle-aged groups, compared to other age groups.

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Introduction

Aluminum phosphide (ALP) tablets, known as "rice tablets", are one of the most common pesticides and insecticides used in agriculture to protect crops, grains, and rice during storage and transportation in developing countries (1). This substance which is known in Iran as the "Rice pill" is extremely toxic and was introduced in 1973 as an appropriate pesticide (2).

The ALP poisoning is common in Asian countries, especially India, Jordan, Morocco, and Iran.In addition to its accidental use, it has often been used as a suicide factor (3). The number of deaths due totheALPpoisoning in Iran is increasing daily (4). In Iran, most cases of phosphine ($PH_{3)}$ poisoning are committed with the intention of committing suicide by taking ALP tablets (5,6). Furthermore, most cases of poisoning occur in the young age group (7,6). Cardiovascular insufficiency, hypotension, severe acidosis, and acute renal insufficiency are the most common complications of ALP poisoning leading to death (8).

The side-effects of ALP poisoning varied from nausea and vomiting to multi-organ insufficiencyand death which was commonly occurred during the first 24 to48 h after poisoning(9-10).Despite much progress in the field of toxicology, ALP poisoning still accounts for a high mortality rate, and investigations in this regard could be essential in the future (11). Due to the few numbers of studies conducted in this field in Iran and Ardabil, this study aimed to describe the clinical symptoms and para-clinical findings of the deceased patients due to ALP poisoning in Ardabil province, Iran, from 2009 to 2017.

Materials and Methods

This descriptive cross-sectional study was performed on 97 hospitalized patients who died due to poisoning with ALP during 2009-2017 in hospitals, Ardabil, Iran. Clinical symptoms and paraclinical findings in all studied patients were collected upon admission and during hospitalization. Subsequently, they entered in the pre-established checklists. Following that, the electrocardiogram (ECG) results were registered for all patients, and the data were analyzed in SPSS software (version 19) through a statistical t-test to compare the mean of quantitative data and the chi-square test to assess the relationships among qualitative data. A p-value less than 0.05 was considered statistically significant. The study protocol was approved by the Ethics Committee of Ardabil University of Medical Sciences, Ardabil,Iran(IR.ARUMS.REC.1398.123).

Results

According to the results, the majority of the patients (n=75; 77.3%) were male. The frequency of ALP poisoning was significantly higher in males, compared to females regarding the male-female ratio of 3.4. The mean age of all patients was obtained at 34.3±15.8 years, and the mean age of the males (35.6±16.2 years) was significantly higher, compared to females (30.1±13.9 years).

Furthermore, the mean total time elapsed from the use of the rice pill to the onset of treatment was estimated at 5.98±5.57 h. Moreover, the mean lengths of time elapsed from the pill consumption to the onset of treatment were estimated at 6.7±3.5 and 4.9±4.6h for those who died within the first 24 h and after 24 h, respectively. According to the patients' statements or their companions, 90 (92.7%) cases took the rice pills orally, and 94% of the patients consumed it without solving in water. In terms of the number of pills consumed, 75 (77.3%) and 22 (22.7%) patients had taken one and two pills, respectively. Furthermore, the length of hospitalization for patients was between 12 and 24 h (38.1%). Out of all patients, 41% of the cases had a loss of consciousness upon admission. The mean values of the Glasgow Coma Scale score (GCS) were 14±1 and 4.7±3.9 at the time of death and the first day of hospitalization in all patients, respectively. Additionally, the systolic blood pressure at the time of death was estimated at 69.6±23 in all patients (Table 1).

In terms of ECG, 30 (31%) and 67 (69%) cases had normal and abnormal ECG results, respectively. Of all patients with abnormal ECG, 33 (49.3%), 22 (32.8%), 7

(10.4%), and 5 (7.5%) individuals suffered from sinus tachycardia, arrhythmias, sinus bradycardia, and ECG cardiac block. There was a significant difference between the survivors in fewer and more than 24 h in terms of the number of consumed rice pills (P=0.018), heart rate (P=0.001), respiratory rate (P=0.001), systolic blood pressure (P=0.001), pH (P=0.001), bicarbonate (P=0.001), GCS score (P=0.001), and white blood cell count (P=0.009) (Table 2).

Table 1: Descriptive statistics of para-clinical indices in patients at the time of death

Variables	Mean±SD
White blood cells	11121±5079
Hematocrit	41.5±22.3
Fasting blood sugar	117.1±49.7
Sodium	140.3±4.5
Potassium	4.9±1.5
Creatinine	1.3±0.8
Hemoglobin	13±2.1
Urinary excretion in 24 h	22800±1680
Systolic blood pressure (SBP)	69.6±23

Table 2: Comparison of the changes in clinical findings with hospital stay duration among the studied patients

Time of hospital stay Indices	more than 24 h	less than 24 h	P-value
Amount of used rice pill	1.1	1.8	0.018
Heart rate	86	96	0.001
Respiratory rate	18	23	0.001
Systolic blood pressure	104	80	0.001
PH	7.4	7.2	0.001
Bicarbonate (mEq/L)	21	14	0.001
White blood cells	9826	11800	0.009
Glasgow Coma Scale	14	11	0.001

Regarding the time of mortality, 26 (26.8%) and 37 (38.1%) cases died in the first 12 h and during 12 to 24 h, respectively. Moreover, within 24 to 48 h and after 48 h following hospitalization, 19 (19.5%) and 15 (15.6%) cases died, respectively. Nausea and vomiting were observed in 94% of all patients. Moreover, 92% of males and all females had nausea and vomiting, respectively. In terms of pupil conditions, the patients were divided into three categories of meiosis, mydriasis, and normal. In male patients, 4 (5.3%) and 71 (94.7%) patients were meiosis and normal, respectively. In addition, 3 (13.6), 2 (9%), and 17 (77.4%) cases in females were meiosis, mydriasis, and normal, respectively.

Upon admission, five (5.2%) cases complained of thirst. The mean blood pressure in males was 10.7±3.4 mmHg, which was significantly lower than that in females (7.7+4.1 mmHg). Moreover, the patients who took one rice pill had significantly higher blood pressure and heart rate, compared to those who took two rice pills (Table 3).

Table 3: Vital signs in patients by gender and number of used rice pills

Gender	Systolic blood pressure (mm Hg)	Herat rate (per min)	Respiratory rate(per min)	Fever (°C)
Male	10.7±3.4	78.3±19.1	19.1±4.4	36.7±1.1
Female	7.7±4.1	91.4±20.7	20.3±4.3	36.5±1.2
P-value	0.03	0.425	0.5	0.63
Number of used rice pills	Systolic blood pressure	Herat rate	BR	Fever
One	8.7±3.1	85.3±18.1	19.2±4.1	36.7±1.2
Two	7.1±4.1	98.4±19.7	20.1±4.3	36.6±1.2
P-value	0.01	0.01	0.5	0.63

In terms of the arterial blood gases (ABG) results, the mean pH value was obtained at 7.24±0.39 in males, which was significantly lower than that in females (7.05±0.61). Additionally, the mean of the partial pressure of oxygen in males (66.4±33.4) was significantly lower than that in females (75.2±31.5) (Table 4).

Table 4: Results of arterial blood gases in deceased patients by gender

Gender	Partial pressure of carbon dioxide	Bicarbonate	Partial pressure of carbon dioxide	PH	BE
Male	27.9±4.85	14.9±6.8	66.4±33.4	7.24±0.39	-10.1±8.5
Female	26.6±3.95	15.5±6.1	75.2±31.5	7.05±0.61	-9.7±8.1
P-value	0.3	0.45	0.01	0.045	0.3

Discussion

This study was conducted on 97 deceased patients due to ALP poisoning from 2009 to 2017. In this study, nausea and vomiting are the most common symptoms, which were observed in 91 (94%) patients. The results of this study were not consistent with the findings of the studies conducted by Khodabandeh et al. Singh etal and Montazer et al. who reported 84.6%, 96.4%, and 100%.Vomiting is the first sign of the effects of aluminum phosphide on the gastrointestinal tract and has been suggested as a contributing factor in the excretion of ALP and the reduction of phosphine gas release in some studies (1,2,7,9,11-12).In this study, 41% of the patients had a loss of consciousness upon admission due to brain cell hypoxia as the main cause, which results from the presence of free radicals in these cells and the low blood pressure. In the brain autopsy of these patients, significant hypertension was observed along with areas of exudate aggregation and minor bleeding (7). In the etiology of hypotension in these patients and the resulting shock, cardiogenic shock or shock due to peripheral circulatory failure or both can be raised. Increased permeability of the arteries was also affected by damage to their cell walls and heart cell poisoning (1,2,13,14). Bakhit et al. performed a study to evaluate the pathological changes in patients who had been referred to ureagenesis with rice pill poisoning. In total, 195 patients were examined considering the vital signs recorded for them upon admission, the transfer time of the patient to the medical center, and other symptoms. Eventually, out of 195 patients, 115 cases died in this study. The results of this study showed that the cause of death in these patients was metabolic acidosis and low blood pressure. The survivors were those who had severe vomiting as soon as they took the ALP. Studies have shown no significant relationship between mortality and the transfer time of the patient to the medical center (14).

The present study investigated the patients who died due to using rice pills; however, there is no data on the number (percentage) of the survived patients after rice pill consumption. On the other hand, it is hypothesized that the rate of survival is more among patients who vomit immediately after swallowing the pill.

Etemadi et al. conducted a study in Tehran from 2013 to 2016 entitled "Evaluation of the frequency of rice pill poisoning cases in Tehran". The majority (51%) of the patients were female, and all patients were in the age group of 10-40 years. In the aforementioned study, 96% of the cases used ALP intending to commit suicide, and 4% of the patients misused this substance. Of the 327 samples recorded, 307 cases died mostly due to low blood pressure and organ failure (15). In the present study, 100% of the cases used ALP for suicide. A study was performed by Solaj et al. to determine the prevalence of rice pill use in Albania. According to the results, more than 300 cases intended to commit suicide between 2007 and 2014. Moreover, the majority (56%) of the cases were female, and 19% of the patients suffered from

known psychiatric illness.After comparing the results of this study with those of previously conducted studies, it was found that the number of patient referrals with rice pill poisoning was two times more in the last five years (16). Unfortunately, this shows an increase in the studies conducted in Iran on ALP poisoning. It seems that more accurate studies can be used to estimate the patients' prognosis. There has been no known cause for acidosis in these patients; however, a part of it can be attributed to lactic acidosis caused by tissue hypoxia.In these patients, phosphine gas combines with oxygen to form phosphoric acid. Another cause of acidosis is a decrease in the number of breaths in some patients, which increases the arterial CO2 pressure and causes respiratory acidosis (3,12,17-19). According to the findings of the current study, the transfer time of the patient to the medical center is of significant importance. In other words, those patients who were transferred to the hospital in less than an hour were more likely to survive (9). Regarding the management of aluminum phosphide poisoning, the major steps include rapid transfer to a medical center, avoidance of rinsing the stomach with serum and paraffin utilization instead, rapid analysis of ABG, electrocardiography, antacid prescription, and laboratory tests to evaluate sodium, potassium, calcium, and magnesium. The results of this study revealed fundamental data about the status of ALP poisoning, which can pave the way for future research. The results of the ECG evaluation of the patients showed that 69.1% of the cases had abnormal ECG, of which 33 (49.3%) cases had sinus tachycardia, which was almost slightly higher, compared to the findings of a study conducted by Khodabandeh et al. in which this corresponding value was estimated at 43.2% (9).

In this study, 96% of the patients took the rice pill directly without dissolving it in water, and in a study carried out by Montazer et al. in Sari, Iran, all patients had taken the rice pills directly, which was almost consistent with the results of the present study. However, Montazer et al. in a study showed that the use of the pill could be directly related to the death of poisoned patients with ALP. It is worth mentioning that this result was not investigated in the present study (12).

Conclusion

The results of this study showed that the frequency of mortality due to rice pill poisoning was much higher in males, compared to females. Moreover, it was higher in middle-aged groups than the other age groups.

The findings also revealed that the increased heart rate, white blood cells, decreased GCS, systolic blood pressure, pH, and carbonate were associated with an increased rate of mortality in patients with ALP poisoning. It is suggested that further studies be conducted to investigate the psychological causes of rice pill use among suicidal individuals and their companions. It is also of utmost importance that aluminum phosphide tablets be provided to farmers and specialists following special regulations to avoid easy access to these tablets for the general population.

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