Original article

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Acute cyanide intoxication due to apricot seed ingestion

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ABSTRACT

Introduction: Cyanide poisoning, whether it be accidental or intentional, remains a significant danger to adults and children, especially in societies where agriculture is a primary source of income. We examined the clinical follow-up, complications, and results of cyanide poisoning cases that occurred after eating the pits and seeds of plants containing cyanide glycosides, such as apricot kernels and almonds.

***Methods*:** Between 01/01/2017 and 01/08/2022, 14 children aged 1-18 years who were followed up with a prediagnosis of cyanide poisoning in our Paediatric Intensive Care Unit (PICU) were retrospectively analysed.

***Results*:** Eight of the patients followed with a preliminary diagnosis of cyanide poisoning were female and six were male. The most common admission month was July (42.8%) coinciding with the agricultural season. The most common symptoms at presentation were weakness and fatigue (n = 7). In the PICU, 4 patients presented lip cyanosis; 3, altered level of consciousness. Vomiting, seizure, headache, dizziness and palpitatons were less frequent. Four patients were treated with hydroxocobalamin (Cyanokit®) as an antidote due to acidosis in their blood gases. All patients treated for cyanide poisoning were discharged.

***Conclusions*:** Cyanide poisoning should be considered in paediatric patients with suspicious findings, sudden loss of consciousness, increased anion gap acidosis and lactic acidosis. The history of eating the seeds of plants such as apricot and almonds should be investigated.

Keywords: *cyanides, toxicity; apricot seeds; ingestion; pediatrics.*

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INTRODUCTION

Cyanide is a rapidly acting substance that is traditionally known as a poison. The seeds and kernels of certain fruits, like almonds, apricots, and peaches, contain a cyanogenic glycoside called amygdalin.[1] Apricot kernels are more toxic due to their higher cyanide content and the easier release of hydrogen cyanide. After the consumption of fresh apricot kernels, amygdalin is converted into hydrogen cyanide through various enzymatic reactions in the body, which can lead to fatal poisoning especially in children.[2]

Cyanide inhibits the final step of oxidative phosphorylation, which is the reduction of molecular oxygen to water. Despite normal oxygen delivery to tissues cellular hypoxia occurs. In addition severe metabolic acidosis results from the inadequate anaerobic reduction of pyruvate and the conversion of adenosine diphosphate to adenosine triphosphate.[3] In cases of cyanide poisoning clinical symptoms can vary depending on the blood cyanide levels. Clinical manifestations may include increased salivation and lacrimation, headache, dizziness, tinnitus, vomiting, confusion, dyspnea, tachycardia, mydriasis, loss of consciousness, coma and can even cause death.[1,3,4]

The treatment for cyanide poisoning cases varies depending on the dose ingested and the patient's signs and symptoms. In mild cases, oxygen therapy and supportive measures may be sufficient. More severe cases may require the administration of antidotes and advanced medical intervention.[1,4,5] In antidote therapy there are two commonly used options: the "cyanide antidote kit" and hydroxocobalamin (Cyanokit®**).** The cyanide antidote kit contains amyl nitrite, sodium nitrite and sodium thiosulfate. The main disadvantages of the cyanide antidote kit are the side effects of nitrites, such as hypotension and methemoglobinemia and the delayed onset of action of sodium thiosulfate. In recent years, high-dose hydroxocobalamin has been used as a cyanide antidote due to its rapid action and ability to separate cyanide from the enzyme cytochrome oxidase thus restoring mitochondrial function. It also has a low side effects profile.[6]

This study aimed to describe the clinical observations, complications and outcomes of cyanide poisoning cases resulting from the consumption of fresh apricot kernels.

METHODS

It was a retrospective, cross-sectional study carried out between 01/01/2017 and 01/08/2022 in the Pediatric Intensive Care Unit of Diyarbakir Gazi Yasargil Training and Research Hospital. Fourteen pediatric patients who presented with a preliminary diagnosis of cyanide poisoning were included in the study. Age, gender, characteristics and patient's prehospital symptoms were analysed from their prehospital and hospital records. Patients were classified according to whether hydroxocobalamin use was indicated or not. This study was approved by the institutional review board (30.09.2022-187).

The primary outcome was to describe the clinical characteristics of cyanide poisoning. Secondary outcomes included the relationship between initial laboratory measurements and clinical indications for hydroxocobalamin.

Ethical considerations

Diyarbakır Gazi Yaşargil Training and Research Hospital, Non-Invasive Clinical Research Ethics Committee, Date: 30.09.2022, Decision no:187

Statistical analysis

Analyses were performed using SPSS 24. Among continuous variables, those with parametric distribution were expressed as mean standard deviation (SD) and those with nonparametric distribution were expressed as median (IQR). Categorical variables were expressed as absolute values and percentages. Student's t-test was used to compare normally distributed variables; the Mann-Whitney U test for nonparametric variables and the x^2 test for categorical variables. Pearson or Spearman were used for correlation tests.

RESULTS

Our study included fourteen patients admitted to the PICU for cyanide poisoning between 01/01/2017 and 01/08/2022. The median age was 37 months and eight patients were female. The Glasgow Coma Scale (GCS) was 15 for patients who did not receive the antidote. Among the four patients who received the antidote, one had a GCS of 12 and another had a GCS of 10. All cases had a history of eating apricot seeds. Patient's initial symptoms and clinical findings were shown in *Table 1*. Stomach lavage followed by activated charcoal was performed on twelve patients on admission. The main abnormal result of laboratory investigations was metabolic (lactic) acidosis in five patients. No patient with

metabolic acidosis received sodium bicarbonate. The treatment given to four patients included high doses of hydroxocobalamin because two of them had seizures, one had intractable tachycardia and one had altered level of consciousness. Blue skin and lips were observed in 4 cases, altered level of consciousness in 3 cases and nausea/vomiting in 2. The other symptoms identified are presented in *Table 2*. Demographic data at admission, Glasgow Coma Scale (GCS) scores, Paediatric Risk of Mortality (PRISM) III values and intensive care length of stay are presented in *Table 2*. The most common complaints were weakness and fatigue in 7 patients (50%).

The analysis of the monthly distribution of cases showed that cyanide poisoning was most frequently observed in July with 6 cases (*Table 3*)

Four critically ill patients with acidosis received as antidote hydroxocobalamin. Comparing the laboratory parameters of patients who received the antidote and those who did not, a negative correlation was observed between GCS, pH, sodium bicarbonate, base excess and lactate values. Furthemore, a significant correlation was found between GCS, PRISM III score, capillary refill time, pH, sodium bicarbonate, base excess, and lactate ($p < 0.05$) (*Table 4*). There was no side effect of antidote treatment and supportive therapy. All patients recovered and were discharged.

During the follow-up there were no complications or mortality.

Table 1 Demographic data and patient characteristics of cyanide poisoning (n = 14)

	Median (minimum-maximum)
Age (months)	37 (27-179)
Body weight (kg)	17.5 (12-54)
Gender (Girl/Boy) n (%)	8/6 (57.2-42.8)
Time to hospital admission after intake (min)	195 (150-300)
Gastric lavage (n)	12
Antidote given (n)	4
GCS at admission	15 (10-15)
PRISM score at admission	9.5 (9-23)
Length of stay (hours)	61 (24-96)
PICU, length of stay (hours)	47 (18-62)

GCS: Glasgow Coma Scale, PRISM: Pediatric risk of mortality; PICU: Pediatric Intensive Care Unit.

Table 2. Clinical features of cyanide poisoning

	n	%
Fatigue, weakness	7	50
Lips cyanosis	4	28.5
Altered level of consciousness	3	21.4
Vomiting	2	14.2
Seizure	2	14.2
Headache	1	7.1
Dizziness	1	7.1
Palpitation	1	7.1

Table 3. Distribution of exposure by months

Month	n	%
May	1	7.1
June	4	28.5
July	6	42.8
August	3	21.4

Table 4. Comparison of data of patients who received and did not receive hydroxocobalamin

	Not received hydroxocobalamin n: 10	Hydroxocobalamin administration n: 4		
	Median (min/max)	Median (min/max)	Spearman correlation	*p*
PICU length of stay (hours)	33 (18/60)	54 (46/62)	0.49	0.07
Length of stay (hours)	50 (24/84)	73 (57/96)	0.45	0.11
GCS	15 (13/15)	12 (10/12)	-0.92	<0.05
PRISM III score	9 (9/11)	19.50 (18/23)	0.84	<0.05
Capillary refill time (sec)	2 (1/2)	3.50 (2/4)	0.72	0.004
pH	7.37 (7.31/7.42)	7.28 (7.24/7.31)	-0.77	0.001
HCO_3	20.21 (18.9/23.1)	16.87 (16.23/18.30)	-0.79	0.001
Anion gap	-3.44 (-5.42/-2.31)	-8.62 (-11.4/-4.3)	-0.71	0.005
Lactate	2.03 (1.17/5.08)	6.17 (3.39/9.39)	-0.77	0.005

PICU: Pediatric Intensive Care Unit; GCS: Glasgow Coma Scale; PRISM III: Pediatric risk of mortality III.

DISCUSSION

Acute cyanide poisoning can affect children when they consume plants and foods containing cyanide. The seeds of fruits such as apricots, peaches and almonds as well as large, flat beans and the cassava plant are considered cyanide-containing foods. Among these foods, apricot seeds are the more toxic due to their high cyanide content and their ease of releasing hydrogen cyanide. When apricot seeds are swallowed whole, cyanide is not released significantly. However, when crushing and breaking them between the teeth, a considerable amount of cyanide is released as a consequence of the action of the lysosomal enzyme emulsin.[2] Common signs and symptoms include headache, confusion, nausea, bradycardia, hypotension, drowsiness, loss of consciousness, and cardiovascular collapse. Cyanide poisoning requires rapid treatment with oxygen therapy and intravenous hydroxocobalamin.[5,6]

While cyanide poisoning in adults is more commonly associated with incidents like fires, in children it often occurs due to the consumption of cyanogenic foods. These include bamboo shoots, flaxseeds, and the seeds of stone fruits such as apricot and peach as well as the seeds of peas and beans like lima beans and the shells of soybeans.[1,7-9] In our study, all children were poisoned as a result of consuming apricot seeds. The location of our hospital in the country's agricultural production center explains both the oral intake of apricot seeds and the fact that 73.1% of the patients presented during the harvesting season in June and July. In oral intake, the chewing of seeds releases a greater quantity of cyanide which can result in severe clinical symptoms in children. Apricot seeds, with both their high cyanide concentration and their easy release of hydrogen cyanide are more toxic than other seeds. The most common symptoms observed in our patient group include weakness, fatigue, bluish discoloration of the lips, altered level of consciousness and vomiting. Nonspecific symptoms such as weakness and fatigue, were observed in approximately half of the patients. About cyanide poisoning, this presents a significant challenge. A review of the literature revealed that dizziness and nausea were reported in a similar proportion to our study.[3,9] The clinical symptoms resulting from ingestion are linked to cellular oxygen deprivation caused by the disruption of mitochondrial oxidative phosphorylation. Cyanide attaches to the ferric ion in cytochrome a3, impeding the function of mitochondrial cytochrome-c oxidase. This results in a disturbance in mitochondrial oxidative metabolism, culminating in cellular oxygen deprivation and lactic acidosis.[10] Therefore, the organ systems most commonly affected are those most metabolically active and sensitive to hypoxia, including the heart and brain.[11] Clinical signs begin shortly after ingestion. Early manifestations of cyanide toxicity include neurological and respiratory symptoms to compensate for tissue hypoxia. The early symptoms include confusion, headache, vertigo, dizziness, nausea, vomiting, palpitations, hyperventilation or shortness of breath. Then acute cyanide poisoning leads to neurological, respiratory, and cardiovascular depression due to the inability to compensate for tissue hypoxia. Eventually, seizures,

bradycardia, hypotension, coma, respiratory and cardiac arrest may occur. But even after the acute phase, cyanide exposure can result in permanent neurological disabilities ranging from various extrapyramidal syndromes to post-anoxic vegetative states.[12-15] When comparing the groups of patients who received the antidote and those who did not, it was observed that the patients who received the antidote had a significantly lower GCS ($p = 0.05$). Capillary refill time, an indicator of perfusion, was significantly prolonged ($p = 0.004$). These results reflect the clinical impact of cyanide toxicity. As oxidative phosphorylation is blocked, increased glycolysis results in lactic acidosis, the severity of which correlates with the level of poisoning.[3,16]

Based on laboratory test results, in the group of patients who received hydroxocobalamin, there was a significant degree of acidosis and decreased bicarbonate levels ($p = 0.001$). Elevated lactate levels and increased base deficit were also observed ($p = 0.005$). These results indicate that the patients had increased anion gap metabolic acidosis. Acidosis is typical in cyanide metabolic poisoning with a high anion gap. Metabolic acidosis is observed in two-thirds of patients acutely poisoned through oral ingestion.[17] Cyanide levels can be measured in the blood, but serum cyanide levels may not necessarily correlate with clinical symptoms. The concentration of lactate increases proportionally with the amount of cyanide poisoning due to metabolic acidosis.[16] The diagnosis of cyanide poisoning should be strongly considered in cases where there is clinical suspicion and laboratory findings reveal an increased anion gap metabolic acidosis. We consider that the early administration of hydroxocobalamin was an important factor in achieving the discharge of all our patients without morbidity. All patients were admitted from the emergency department to the intensive care unit, and their PRISM III scores were assessed. PRISM III score is considered excellent in discriminating between survival and mortality. Moreover, it can be utilized to predict the length of stay among survivors.[18] In patients who received the antidote, PRISM III scores were found to be significantly higher ($p = 0.05$). In our study the indication for treatment with the antidote in patients with compatible clinical history with cyanide poisoning showed a positive correlation with plasma lactate concentration, capillary refill time, and PRISM III score; the correlation was negative with GCS, venous pH, and base excess. The use of specific criteria to diagnose cyanide poisoning would be helpful in reducing the unnecessary use of hydroxocobalamin.

In conclusion, cyanide poisoning should be considered in children presenting to the emergency department with sudden loss of consciousness, decreased GCS, and laboratory evidence of increased anion gap metabolic acidosis or lactic acidosis.

The release of cyanide and cyanogenic compounds (such as nitriles) from the burning of common fabrics (nylon, silk, wool) and many plastics (melamine, polyurethane, polyacrylonitrile) is the most common source of human exposure to cyanide. Children of agricultural families should be thoroughly questioned about the consumption of seeds and kernels of fruits such as apricots, peaches, cherries, bitter almonds, almonds, and apples.

Administering antidotes to affected patients often depends on clinical signs, as it's not practical to detect potentially harmful blood cyanide levels at the scene. Furthermore, even single blood analyses taken later may not reliably indicate peak levels due to difficulties in calculating cyanide kinetics in the blood.[19]

LIMITATIONS

The retrospective nature of the study poses limitations in extracting comprehensive clinical information for each case. Inconsistent documentation and varying clinical approaches complicate the analysis of all study variables. Although we addressed reasons for disagreements, there is still potential for misclassification of hydroxocobalamin indication in patients evaluated by a single expert. While it would have been ideal to have laboratory confirmation of cyanide exposure, obtaining this retrospectively was not feasible. Nevertheless, our study reflects real-world clinical practice as cyanide levels are currently unavailable for guiding clinical decisions. Lastly, to enhance patient care, there is a need for prospective implementation and study of a prehospital protocol for treating cyanide toxicity, which can validate or challenge our findings. ■

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REFERENCES

1. Geller RJ, Barthold C, Saiers JA, Hall AH. Pediatric Cyanide Poisoning: Causes, Manifestations, Management, and Unmet Needs. *Pediatrics*. 2006;118(5):2146-58.
2. Holzbecher MD, Moss MA, Ellenberger HA. The cyanide content of laetrile preparations, apricot, peach and apple seeds. *J Toxicol Clin Toxicol.* 1984;22(4):341-7.
3. Reade MC, Davies SR, Morley PT, Dennett J, Jacobs IC, Council AR. Review article: management of cyanide poisoning. *Emerg Med Australas*. 2012;24(3):225-38.
4. Beckerman N, Leikin SM, Aitchinson R, Yen M, Wills BK. Laboratory interferences with the newer cyanide antidote: hydroxocobalamin. *Semin Diagn Pathol*. 2009;26(1):49-52.
5. Hamel J. A review of acute cyanide poisoning with a treatment update. *Crit Care Nurse.* 2011;31(1):72-81; quiz 2.
6. Dang S, Tsui AK, Herndon R, Babiak C, Szkotak A, Füzéry AK, et al. Hydroxocobalamin interference in routine laboratory tests: Development of a protocol for identifying samples and reporting results from patients treated with Cyanokit™. *Clin Biochem*. 2021;91:31-8.
7. Cumpston KL, Rodriguez V, Nguyen T, MacLasco A, Zin C, Rose SR, et al. Evaluation of prehospital hydroxocobalamin use in the setting of smoke inhalation. *Am J Emerg Med*. 2021;50:365-8.
8. Mintegi S, Clerigue N, Tipo V, Ponticiello E, Lonati D, Burillo-Putze G, et al. Pediatric cyanide poisoning by fire smoke inhalation: a European expert consensus. Toxicology Surveillance System of the Intoxications Working Group of the Spanish Society of Paediatric Emergencies. *Pediatr Emerg Care*. 2013;29(11):1234-40.
9. Haden M, Wheatley N, Gray LA, Bradberry SM, Sandilands EA, Thanacoody RH, et al. Potential cyanide poisoning reported to the UK national poisons information service: 2008-2019. *Clin Toxicol (Phila).* 2022;60(9):1051-8.
10. Andersen LW, Mackenhauer J, Roberts JC, Berg KM, Cocchi MN, Donnino MW. Etiology and therapeutic approach to elevated lactate levels. *Mayo Clin Proc*. 2013;88(10):1127-40.
11. Way JL. Cyanide intoxication and its mechanism of antagonism. *Annu Rev Pharmacol Toxicol*. 1984;24:451-81.
12. Mushtaq F, Graham CA. Discharge from the accident and emergency department after smoke inhalation: influence of clinical factors and emergency investigations. *Eur J Emerg Med*. 2004;11(3):141-4.
13. Lawson-Smith P, Jansen EC, Hyldegaard O. Cyanide intoxication as part of smoke inhalation--a review on diagnosis and treatment from the emergency perspective. *Scand J Trauma Resusc Emerg Med*. 2011;19:14.
14. Rosenow F, Herholz K, Lanfermann H, Weuthen G, Ebner R, Kessler J, et al. Neurological sequelae of cyanide intoxication--the patterns of clinical, magnetic resonance imaging, and positron emission tomography findings. *Ann Neurol*. 1995;38(5):825-8.
15. Fortin JL, Desmettre T, Manzon C, Judic-Peureux V, Peugeot-Mortier C, Giocanti JP, et al. Cyanide poisoning and cardiac disorders: 161 cases. *J Emerg Med.* 2010;38(4):467-76.
16. Baud FJ, Borron SW, Mégarbane B, Trout H, Laposttolle F, Vicaut E, et al. Value of lactic acidosis in the assessment of the severity of acute cyanide poisoning. *Crit Care Med.* 2002;30(9):2044-50.
17. Yen D, Tsai J, Wang LM, Kao WF, Hu SC, Lee CH, et al. The clinical experience of acute cyanide poisoning. *Am J Emerg Med*. 1995;13(5):524-8.
18. Kaur A, Kaur G, Dhir SK, Rai S, Sethi A, Brar A, Singh P. Pediatric Risk of Mortality III Score - Predictor of Mortality and Hospital Stay in Pediatric Intensive Care Unit. *J Emerg Trauma Shock*. 2020;13(2):146-50.
19. Geldner G, Koch EM, Gottwald-Hostalek U, Baud F, Burillo G, Fauville JP, et al. Report on a study of fires with smoke gas development: determination of blood cyanide levels, clinical signs and laboratory values in victims. *Anaesthesist*. 2013;62(8):609-16.