

Unintentional Acute Cyanide Poisoning of an Infant

Maria S Kazantzi^{1*}, Menelaos Svirkos¹, Eleni Bassanou², Charikleia Barbaressou¹ and Panagiotis Kalampalikis¹

¹*Pediatric Intensive Care Unit, "Aghia Sofia" Children's Hospital of Athens, Athens, Greece*

²*Poison Information Center, Panagiotis and Aglaia Kyriakou Childrens Hospital, Athens, Greece*

***Corresponding Author:** Maria S Kazantzi, Pediatric Intensive Care Unit, "Aghia Sophia" Children's Hospital of Athens, University of Athens, Athens, Greece.

Received: December 12, 2019; **Published:** January 04, 2020

Abstract

Background: Cyanide ingestion is particularly dangerous because of the early onset of severe symptoms, lack of suspicion and delay in diagnosis. Cyanide poisoning of infants is rare.

Case Report: An 11-month old girl presented in the emergency department in coma, hypothermic, bradycardic and gasping for air, after the ingestion of an unknown substance, later identified as a cyanide containing jewel cleaning solution. Her laboratory tests revealed profound lactic acidosis. She was treated with the cyanide antidote kit with a rapid improvement of her clinical and laboratory state. Excessive methemoglobinemia was noted with no further adverse events. Her final outcome was excellent.

Discussion: Although unintentional ingestion of household substances is often in young children, cyanide poisoning is rare since the sale of consumer products containing soluble cyanide salts is prohibited. Patients rapidly progress to a stuporous state and tissue hypoxia in the absence of cyanosis may be a diagnostic clue, as well as the presence of severe lactic acidosis with a high anion gap. Sodium thiosulfate alone or with sodium nitrite or amyl nitrite is traditionally used as an antidote, but it results in methemoglobinemia, potentially dangerous.

Conclusion: Diagnosis of cyanide poisoning requires a high level of suspicion. Infants may be particularly vulnerable to cyanide ingestion and to the treatment induced methemoglobinemia.

Keywords: *Cyanide Poisoning; Infant; Unintentional Ingestion*

Background

Cases of childhood exposure to cyanide are rare despite multiple potential sources, including inhalation of fire smoke, ingestion of toxic household and workplace substances, and ingestion of cyanogenic foods [1]. Cyanide ingestion is particularly dangerous because of the early onset of severe symptoms and lack of suspicion and, therefore, delay in diagnosis [2]. Manifestations, treatment and risk of antidotes are not well described in children, because all available information comes from only few published case reports.

This case report describes the unintentional poisoning of an infant after ingestion of an unknown amount of a cyanide-containing jewelry-cleaner solution and points out some important issues in managing exposure to this toxin.

Case Report

A previously healthy 11-month old girl was transported to the emergency department (ED) by her parents because of a sudden alteration of her skin color and her level of consciousness, following the ingestion of an unknown powder stored in a vase in a cupboard containing household products. The baby was left alone for a few minutes in the kitchen, suddenly started crying and was found by the

mother next to an open vase containing a powder. Soon after that she became pale and lethargic. Until the arrival at the ED, approximately 30 minutes after the ingestion, her state has dramatically deteriorated. She was unresponsive (Glasgow Coma Scale: 3), pupils sluggishly reactive bilaterally, gasping for breath, blood pressure indeterminate and no peripheral pulse palpable, heart rate 60 beats/min and temperature 35.4°C. No specific odor was noted and the oropharynx was unremarkable. All clothes were removed, she was intubated and ventilated with 100% oxygen, activated charcoal was administered via nasogastric tube approximately 40 minutes post ingestion, she was resuscitated with crystalloid fluids and transferred to the Pediatric Intensive Care Unit (PICU).

At her admission in the PICU she was still in coma, mechanically ventilated with equal breath sounds bilaterally and oxygen saturation on room air 100%. She was hemodynamically stabilized after the initial crystalloid fluids (30 ml/kg of normal saline solution), with a blood pressure of 90/50 mmHg and pulse rate 135 beats/min.

Investigations

Initial arterial blood gas (ABG) test revealed severe metabolic acidosis (pH 6.88, pO₂ 243.1 mmHg, pCO₂ 20.5 mmHg, HCO₃⁻ 3.8 mmol/l) with high levels of lactic acid (exceeding 20 mmol/l) and methemoglobin in the normal range (1.2%). Venous blood gas analysis also revealed high pO₂ (pH 6.84, pO₂ 222 mmHg, pCO₂ 25.6 mmHg HCO₃⁻ 2.5 mmol/L) Other laboratory data were white blood cell count 31 x 10⁹/L, haemoglobin 100 g/L, platelets 315 x 10⁹/L, sodium 140 mmol/L, potassium 3.8 mmol/L, chloride 101 mmol/L, phosphate 3.42 mmol/L, blood urea 8.57 mmol/L, plasma creatinine 61.9 µmol/L, glucose 25.7 mmol/L, creatine kinase (CK) 251 U/l, aspartate aminotransferase (AST) 50 U/l, alanine aminotransferase (ALT) 11 U/l, creatine kinase myocardium isoenzyme (CK-MB) 15.18 µg/L and Troponin I 0.039 µg/L. The anion gap was 38 nmol/L and serum osmolality 310 mmol/kg H₂O. Urinalysis revealed glycosuria whereas the electrocardiogram (ECG) and chest radiograph were normal.

Given the profound metabolic acidosis and the high serum lactate level, we focused on attempts to identify the ingested substance. On further questioning, it was found out that the maternal uncle was jeweler and that some of the materials he used were stored in the child's home. The details that came up from the history as well as the clinical and laboratory findings pointed out the possibility of cyanide ingestion. The maternal uncle later confirmed the presence of this cyanide-containing solution at the site where the baby was found. Unfortunately, blood was not sent to determine the cyanide concentration.

Treatment

The patient was initially supported with intravenous fluids, mechanical ventilation with 100% oxygen and intravenous administration of sodium bicarbonate to correct the acidosis. With the strong suspicion of cyanide ingestion, the poison center was contacted at 2 hours after ingestion and the infant was treated with the nationally available antidote. Sodium nitrite 3% was administered at a dose of 6 mg/kg (0.2 ml/kg) of body weight (BW), followed by 250 mg/kg (1 ml/kg) of BW of sodium thiosulfate 25%. The ABG test taken before the antidote administration revealed pH 7.09 and HCO₃⁻ 8.7 mmol/l whereas after the administration the following values were noted at 30, 75 and 120 minutes, respectively: pH 7.24, 7.26 and 7.35 and HCO₃⁻ 15.0, 19.9 and 20.2 mmol/l.

Excessive methemoglobinemia (38.7%) was noted 75 minutes after the administration of the antidotes. At that time haemoglobin was 79 g/L and the infant was transfused with 10 ml/kg of BW packed red cells. The next measured value of methemoglobin was at 23.4%, with a further decrease at 12.4% five hours after the administration of sodium nitrite and sodium thiosulfate.

Outcome and follow up

With continued supportive care, the patient's acidosis resolved over the ensuing 8 hours and she was extubated 12 hours after her admission. Her neurological examination after the cessation of sedation was normal.

At the second day in the ICU there was a significant increase in CK levels (maximum value 17340 U/l) as well as CK-MB (95.65 µg/L) and Troponin I (2.25 µg/L). There was no change in her ECG and no pathological findings from the echocardiogram. The CK elevation was treated with intravenous fluids and started decreasing at 48 hours after admission.

Seventy two hours after admission, the patient was transferred to the pediatric ward without any ventilatory, renal or hemodynamic support and with no obvious neurological impairment.

Discussion

Unintentional ingestion of household substances containing poisons often involves young children [1,3,4]. Although the sale of consumer products containing soluble cyanide salts is widely prohibited, cases of ingestion have been reported concerning children [5-9]. Only in few cases the accident was caused by a workplace solution [10,11] and this is very rare in recent years, since the sale of consumer products containing soluble cyanide salts is prohibited and it can mostly be found in industrial products. Our case was attributed to a jewel cleaning solution, possessed by a family member for professional use and inappropriately stored in the house.

Clinical findings of acute cyanide poisoning are nonspecific and mainly attributed to tissues' oxygen deprivation [12-14]; therefore it is difficult to diagnose cyanide poisoning on the basis of clinical findings. Venous blood in the cyanide-poisoned patient has a high partial pressure of oxygen and appears bright red. Accordingly, tissue hypoxia in the absence of cyanosis may be a diagnostic clue [15,16] as was in our case. Sometimes a smell of bitter almonds is noted but this is an unreliable finding and the ability to detect this odor is often absent [13,17].

The presence of severe lactic acidosis with a high anion gap is the most reliable finding in cyanide intoxication in adults [18]. No such data are available for children. Although whether children and adults are differentially susceptible to cyanide poisoning has not been systematically studied [1,18], it was proposed that children are more vulnerable than adults because of their lower body mass and immature metabolic mechanisms [1,19-21]. In smoke-inhalation victims, where higher respiratory rates may also contribute to the level of intoxication, a slightly higher fatality rate was reported among patients younger than 14 years than older patients. Lower cyanide concentrations among the deceased children were also noted [16]. In the recent literature, there is no previous report of poisoning of an infant after cyanide ingestion, apart from an 11-month girl after administration of laetrile tablets [12]. Cyanide concentration in whole blood is elevated in acute poisoning but technical difficulties and long time required for results limit its clinical utility.

The treatment of cyanide poisoning involves removing the patient from the source, stripping all contaminated clothes, administration of activated charcoal and 100% oxygen, cardiorespiratory support and administration of the antidote [22,23]. Activated charcoal binds to cyanide poorly but it could have a favorable result when the amount ingested is expected to be high [24,25]. Hydroxocobalamin is the preferred antidote, because of its better risk/benefit ratio [23]. In Greece it is not licensed as a cyanide antidote and was not available for treatment of our case. If hydroxocobalamin is not available, sodium thiosulfate alone or with sodium nitrite or amyl nitrite may be used. The nitrite compounds produce methemoglobin, which competes with the cytochrome system for binding of the cyanide ion. Cyanomet-hemoglobin is formed and cytochrome oxidase is restored. The extent of methemoglobinemia required to achieve its therapeutic benefit is undetermined; it is therefore suggested to use the lowest amount of methemoglobinemia that reverses the cyanide-induced clinical findings [1,26]. Additional therapeutic benefit by the nitrites may be achieved through alterations in the nitric-oxide redox pathway [26]. Elimination of cyanide predisposes its conversion to thiocyanate by the mitochondrial enzyme rhodanase. Thiosulfate provides the sulfur groups rhodanase requires for this conversion and this is the basis of sodium nitrite and sodium thiosulfate combination [27].

Nitrite-induced methemoglobinemia can be proven toxic as it further deteriorates the significant oxygen-carrying deficit. Younger children and infants confront an additional hazard because of their higher proportion of fetal hemoglobin, which is more easily oxidized by nitrites to form methemoglobin [1]. Moreover, infants and young children have significantly reduced activity of methemoglobin reductase to convert methemoglobin back to normal hemoglobin [1]. It is generally advised that the level of methemoglobin should be kept below 35 - 40% [27] and childhood should possibly necessitate even lower levels to compensate for the above-mentioned factors of susceptibility. Methylene blue should likely reverse methemoglobinemia, but it was not administered to our patient because of the permissible methemoglobin level and its rapid decline with the aid of blood transfusion.

The blood cyanide concentration was not determined to our patient upon arrival and this is a limitation of this case report.

Conclusion

Acute exposure to cyanide is a rare cause of morbidity and mortality in children and data on infantile cases are missing. Clinical manifestations in this case were non-specific: because of unexplained lactic acidosis, the history of the event was reviewed in details, until we reached the diagnosis. Young age was a significant risk factor, because of increased susceptibility to cyanide poisoning as well as treatment induced methemoglobinemia. Early decontamination, supportive measures, administration of antidote and careful monitoring of methemoglobin levels contributed to a favorable outcome.

Bibliography

1. Geller RJ, *et al.* "Pediatric cyanide poisoning: causes, manifestations, management, and unmet needs". *Pediatrics* 118.5 (2006): 2146-2158.
2. Beasley DMG and Glass WI. "Cyanide poisoning: pathophysiology and treatment recommendations". *Occupational Medicine* 48 (1998): 427-431.
3. Herranz M and Clerigue N. "Poisoning in children: methaemoglobinaemia [in Spanish]". *Anales del Sistema Sanitario de Navarra* 26.1 (2003): 209-213.
4. Michael JB and Sztanjnkrycer MD. "Deadly pediatric poisons: nine common agents that kill at low doses". *Emergency Medicine Clinics of North America* 22 (2004): 1019-1050.
5. Caravati EM and Litovitz TL. "Pediatric cyanide intoxication and death from an acetonitrile-containing cosmetic". *Journal of the American Medical Association* 260 (1988): 3470-3473.
6. Geller RJ, *et al.* "Cyanide toxicity from acetonitrile-containing false nail remover". *American Journal of Emergency Medicine* 9 (1991): 268-270.
7. Kurt TL, *et al.* "Cyanide poisoning from glue-on nail remover". *American Journal of Emergency Medicine* 9 (1991): 271-272.
8. Losek JD, *et al.* "Cyanide poisoning from a cosmetic nail remover". *Pediatrics* 88 (1991): 337-340.
9. Sauer H, *et al.* "Severe cyanide poisoning from an alternative medicine treatment with amygdalin and apricot kernels in a 4-year-old child". *Wiener Medizinische Wochenschrift* 165.9 (2015): 185-188.
10. Berlin CM. "The treatment of cyanide poisoning in children". *Pediatrics* 46 (1970): 793-796.
11. Krieg A and Saxena K. "Cyanide poisoning from metal cleaning solutions". *Annals of Emergency Medicine* 16 (1987): 582-584.
12. Ruangchanasetr S, *et al.* "Cyanide poisoning, 2 case reports and treatment review". *Journal of the Medical Association of Thailand* 82.1 (1999): S162-S171.
13. Megarbane B, *et al.* "Antidotal treatment of cyanide poisoning". *Journal of the Chinese Medical Association* 66 (2003): 193-203.
14. Dart RC and Bogdan GM. "Acute cyanide poisoning: causes, consequences, recognition and management". *Frontline First Responder* 2 (2004): 19-22.
15. Augustine JJ. "Smoke and fire: recognizing cyanide as a toxic agent". *Fire EMS* (2005): 18-23.
16. Baud F, *et al.* "Elevated blood cyanide concentrations in victims of smoke inhalation". *The New England Journal of Medicine* 325 (1991): 1761-1766.
17. Peddy SB, *et al.* "Acute cyanide poisoning". *Pediatric Critical Care Medicine* 7 (2006): 79-82.

18. Baud FJ., *et al.* "Value of lactic acidosis in the assessment of the severity of acute cyanide poisoning". *Critical Care Medicine* 30 (2002): 2044-2050.
19. Agency for Toxic Substances and Diseases Registry. Toxicological Profile for Cyanide. Atlanta, GA: US Department of Health and Human Services (2004).
20. Lynch EL and Thomas TL. "Pediatric considerations in chemical exposures: are we prepared?" *Pediatric Emergency Care* 20 (2004): 198-208.
21. Morris-Kukoski CL and Eglund AG. "Toxicity, deadly in a single dose" (2016).
22. American Academy of Clinical Toxicology, European Association of Poisons Centres and Clinical Toxicologists. Position statements: single-dose activated charcoal (2016).
23. Borron SW. "Recognition and treatment of acute cyanide poisoning". *Journal of Emergency Nursing* 32 (2006): S12-18.
24. Anderson AH. "Experimental studies on the pharmacology of activated charcoal. I. Adsorption power of charcoal in aqueous solutions". *Acta Pharmacologica Sinica* 2 (1946): 69-78.
25. Neuvonen PJ and Olkkola KT. "Oral activated charcoal in the treatment of intoxications. Role of single and repeated doses". *Medical Toxicology and Adverse Drug Experience* 3 (1988): 33-35.
26. Pearce LL., *et al.* "Reversal of cyanide inhibition of cytochrome c oxidase by the auxiliary substrate nitric oxide: an endogenous antidote to cyanide poisoning?" *Journal of Biological Chemistry* 278 (2003): 52139-52145.
27. Chin RG and Calderon Y. "Acute cyanide poisoning: a case report". *The Journal of Emergency Medicine* 18.4 (2000): 441-445.

Volume 9 Issue 2 February 2020

© All rights reserved by Maria S Kazantzi., *et al.*