Cyanide Inhalational Death After Mixing Organic Herbicides.

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Citation

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Abstract

Hydrogen cyanide (HC) is one of the most dangerous toxic agents that exist. Death can occur seconds after its inhalation. HC causes hypoxemia, especially in the central nervous, cardiovascular and pulmonary systems. Obtaining a lactate level is very important when there is a suspicion of HC toxicity. Levels of 10 mmol/L or more is a sensitive and specific indicator of HC toxicity with high correlation with the HC blood level. Hydroxycobalamin is an effective antidote requiring rapid administration. We present a fatal case of HC inhalation after mixing several organic herbicides despite hydroxycobalamin administration.

INTRODUCTION

Hydrogen cyanide (HC) is a substance, which is quickly absorbed through the respiratory tract, although it can also be absorbed through skin and ingestion. (1) It can exist as a gas, such as hydrocyanic acid, which is a volatile, colourless liquid (2), with a characteristic smell of bitter almonds. However, olfactory detection is a genetic condition absent in 20-40% of the population. (1)

HC has high affinity for molecules that contain cobalt, sulfanes, and the trivalent form of iron. A small amount of HC is excreted through the respiratory tract without being metabolised. There is a risk of exposure and secondary HC toxicity to caregivers. (3) Decontamination of the patient is important. Removing clothing and cleansing the skin with water and detergent are recommended.

HC binds strongly to cytochrome oxidase halting oxidative phosphorylation and ATP production in mitochondria. (3) Cellular asphyxia produces anaerobic metabolism increasing lactic acid levels. Clinical symptoms are usually immediate after HC inhalation.(4) The most common symptoms are headache, nausea, dizziness, vertigo, agitation, anxiety, dyspnea, tachypnea, palpitations, apnea, hypotension (low blood pressure), shock, arrhythmia, convulsions and coma.(5) Convulsions may be controlled with the administration of benzodiazepines.

The treatment for HC toxicity is based on supportive care and quick antidote administration. Treatment with intravenous fluids to replace volume, vasopressor agents for hypotension and sodium bicarbonate for metabolic acidosis may be required for resuscitation. The administration of 100% oxygen with a reservoir mask is indicated. (6)

CASE REPORT

The patient was a 38 year-old male farmer with no significant past medical history. He mixed several liquid herbicides while working in a shed: Harness GTZ® [acetochlor ($C1_4H_{20}ClNO_2$), terbuthylazine ($C_9H_{16}ClN_5$)] and Primma Mix 60® [2-methyl-4-chlorophenoxyacetic acid or MCPA].

He inhaled the fumes and immediately felt dizzy, lost consciousness and had respiratory arrest. The emergency medical team found him unresponsive, cyanotic and in respiratory arrest. ECG monitor showed sinus tachycardia of 130 bpm. Endotracheal intubation was performed along with 1400 mL normal saline infusion over 20 minutes.

On arrival to the Emergency Department (ED) his oxygen blood saturation was 83%, although the ventilador on 100% oxygen, and he presented severe arterial hypotension (50 mmHg of systolic blood pressure. On physical examination he had bilateral miotic pupils, conjunctival congestion and cutaneous erythema. He was decontaminated with a sodium chloride solution and soap, while controlling his body temperature. Simultaneously, saline irrigation of both eyes was carried out.

Laboratory results were glucose 209 mg/dL, blood urea nitrogen 37 mg/dL, creatinine 1.4 mg/dL, potassium 4.2

mEq/L, troponin I 0.15 ng/mL, leukocytes 18,300 x 10^9/L (59.1% of neutrophils), blood lactate 11.4 mmol/L and carboxyhemoglobin 1.2%. The arterial blood gas values were: pH 6.95, pO2 53 mmHg, pCO2 42 mmHg, bicarbonate 18.8 mmol/L. The urine drug screen was negative. ECG showed a sinus rhythm at 130 bpm, with no signs of acute ischemia. CT brain was normal.

Blood, urine and nasogastric aspirate were sent for toxicological analysis. The Reference Toxicological Center informed us that the herbicides separately, would not cause the patient's symptoms.

Due to the lactate level and the patient's presentation, HC toxicity was suspected. Two intravenous doses of hydroxycobalamin (Cyanokit®), 5 g each 60 minutes apart were administered.

An internal jugular intravenous line was placed in order to measure the central venous pressure (CVP), which was 3 cmH_2O initially. 640 mEq of sodium bicarbonate was administered in order to correct the acidosis. After 1500 ml of sodium chloride infusion, a CVP of 10 cm H_2O was reached and the systolic blood pressure of 80 mmHg could be maintained. We began dopamine infusion.

Correction of the metabolic acidosis up to a pH of 7.31, and a bicarbonate of 23 mmol/L, BP stabilized to 120/70 mmHg, and heart rate of 105 bpm were achieved, but the patient had a Glasgow score of 3 and persistent bilateral miosis.

The patient was admitted to the Intensive Care Unit. Two days later, neurologic death was confirmed and his kidneys, heart and liver were donated. Later the blood HC level was confirmed to be 0.4 mg/dl.

DISCUSSION

The possible origins of HC can be found in high temperature fires in closed spaces with natural (wood, paper, wool, silk) or synthetic (polyurethane, carpets, resins, plastics, etc.) substances, in habitual foods found in our environment (cherries, peaches, bitter almonds, and bay leaves), in metal cleansing agents and in some herbicides.(1,4,10) In fires HC and CO intoxication usually coexist.(12) Hyperbaric oxygen therapy (HBO2) would only be indicated in case of a coexisting carbon monoxide (CO) intoxication (7), but it´s not effective in cyanide poisoning.

HBO2 should not be administered to hemodynamically unstable patients because resuscitation is difficult to perform while the patient is enclosed in the chamber.

We did not find any case reports of possible HC toxicity after mixing certain herbicides. In our case, the mixture of acetochlor, terbuthylazine, and 2-methyl-4-chlorophenoxyacetic acid (MCPA) leads to high concentrations of HC.

HC is one of the fastest and deadliest toxic substances that exist. A concentration greater than 300 ppm is usually lethal in a few minutes. Blood levels greater than 0.2 mg/dL are considered toxic and levels greater than 0.3 mg/dL are at risk of death.(3)

HC is an asphyxiating gas causing hypoxemia especially in the central nervous, cardiovascular and respiratory systems.(4) In this case the presence of coma, apnea, lactic acidosis, cardiovascular alterations and reddish color of the venous blood are highly suggestive of HC toxicity.

High blood lactic acid levels greater than 10 mmol/L is a very sensitive and specific indicator of HC toxicity and strongly correlates with HC blood levels of 0.2 mg/dL or more.(8,12) Early administration of the HC antidote is essential even if there is a slight suspicion before being admitted in hospital.(13)

There are three groups of HC antidotes: sulphur donors (sodium thiosulfate), methemoglobinemia inducing agents, and cobalt containing agents (dicobalt EDTA and hydroxycobalamin). (8) Before 1929 sodium thiosulfate was the only known specific cyanide antidote. It removes CN from the blood by the Rhodanese enzyme action, located in the liver, kidney and skeletal muscles´ mitocondria. It adds a sulphur atom to CN and forms thiocyanate, which is less toxic and is excreted through the kidneys. But sodium thiosulfate has a slow onset of action. Methemoglobin inducing agents are powerful but affect oxygen transport to the tissues because of the transformation of hemoglobin into methemoglobin.

Hydroxycobalamin and dicobalt EDTA act immediately (are fast-action antidotes). Hydroxycobalamin is considered the first-line antidote because it causes less severe side effects. Red of skin and urine is one of the most common side effects of hydroxycobalamin. Hydroxycobalamin can also produce high blood pressure and may interfere with colorimetric laboratory tests, including bilirubin, creatinine, magnesium, serum iron, oxyhemoglobin and methemoglobin (11).

CONCLUSION

Suspect HC toxicity if a patient presents with signs and

symptoms consistent with the illness and high lactate blood levels. Cyanide antidote administration such as hydroxycobalamin must be administered as soon as possible. Moribund patients should be considered as potential organ donors and the administration of an antidote is not a contraindication for organ donation. (14,15)

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