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Breaking the dry ice: A case of accidental carbon dioxide poisoning due to dry ice inhalation

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Abstract

Background: Solid dry ice undergoes sublimation to gaseous carbondioxide (CO_2) at room temperature. Symptoms of exposure include headache, dizziness, unconsciousness, seizures, even coma and death based on concentrations of CO_2 inhaled. We present a case of accidental poisoning due to dry ice inhalation.

Case: 35-year-old Caucasian male with a history of depression and tobacco use was brought into the emergency department after he was found unconscious in the walk-in freezer at the fast-food center he was working at. On contacting his coworkers, we were told that the walk-in freezer was out of order, and they had packed it with dry ice. On examination, the patient was tachypneic, tachycardic and was saturating at 89% on room air. Physical examination was normal. Blood work showed acute hypoxic respiratory failure with metabolic acidosis with lactic acid 13.1 mmol/l. Carboxyhemoglobin level was elevated at 5.3% (normal level and smokers 3 to 5%). The patient significantly improved with supplemental oxygen and fluid boluses and was discharged in the next 24 hours.

Conclusion: Exposure to dry ice in confined spaces and warm temperatures can lead to carbon dioxide poisoning. Accurate and detailed history taking helps recognize this potentially fatal medical emergency.

Keywords: dry ice poisoning; carbon dioxide poisoning; accidental poisoning; inhalation toxicity.

Abbreviations: CO_2: Carbon Dioxide; ED: Emergency Department; EMS: Emergency Medical Services; HR: Heart Rate; RR: Respiratory Rate; AST: Aspartate Transaminase; ALT: Alanine Transaminase; ABG: Arterial Blood Gas; PO_2: Partial Pressure Of Oxygen; PCO2: Partial Pressure Of Carbon Dioxide; HCO_3: Bicarbonate; PPM: Parts Per Million; FSIS: Food Safety And Inspection Service; OSHA: Occupational Safety And Health Administration.

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Introduction

Carbon dioxide is an acidic, colorless, and heavy gas. Current carbon dioxide levels in the atmosphere is 409.8 parts per million [1]. Carbon dioxide (CO_2) inhalation acts as both an asphyxiant and a toxin. Dry ice is a solid form of CO_2 which is commonly used as a cheap and easily available coolant. It has numerous applications in commercial, industrial, and scientific avenues such as fog machines, flash freezing, blast cleaning and laboratories. Direct contact with dry ice causes frostbite injury. Solid dry ice also undergoes sublimation to gaseous carbon dioxide at room temperature and may cause hypercapnia, especially in confined locations. Symptoms of CO_2 inhalation include headache, dizziness, unconsciousness, seizures, even coma and death based on concentrations and duration of CO2 exposure. We present a case of accidental poisoning due to CO_2 inhalation from dry ice.

Case report

Our patient is a 35-year-old Caucasian male with a significant past medical history of depression and tobacco use. He was brought into the Emergency Department (ED) on a warm summer night after he was found unconscious in a walk-in freezer at the fast-food center he was working at by his coworkers. he regained consciousness while being brought to the ED by the Emergency Medical Services (EMS). He had mentioned that had been working in the freezer for 20-30 minutes when he developed a headache, felt dizzy, fatigued, went into a "dream-like state" and lost consciousness. We contacted his co-workers who informed us that the walk-in freezer had been out of order and they had packed it with dry ice.

On presentation, he was tachycardic (HR 128/ min), tachypneic (RR 24/ min) and was saturating at 89% on room air. He was started on 6 liters of oxygen by nasal cannula. On physical examination, he was in visible respiratory distress. Lungs were clear to the auscultation and the cardiovascular system exam was unremarkable. Laboratory tests were significant for low bicarbonate (17 meq/L), high lactic acid (13.1mmol/l), mildly elevated liver enzymes AST (82 U/l), ALT (73 U/l). Carboxyhemoglobin level was elevated at 5.3% (level in smokers 3–5% range). Arterial blood gases (ABG) on presentation short acute respiratory failure with metabolic acidosis and compensatory respiratory alkalosis (ph 7.38, PO_2 54, PCO_2 33.8, HCO_3 20.2, lactate 13.1). He received fluid boluses and was transitioned to a non-rebreather mask at 15L oxygen per minute. Repeat ABG in 2 hours showed pH 7.43, PO_2 53, PCO_2 36.7, HCO_3 24.1, lactate 1.1. He improved significantly in the next 24 hours and was able to be weaned off the oxygen. At discharge, he was saturating 96% on room air.

	Normal	ABG at presentation	ABG in 2 hours
pH	7.35-7.45	7.38	7.43
pO_2	75-110 mmHg	54	53
pCO_2	35-45 mmHg	33.8	36.7
HCO_3	22-26 mmol/l	20.2	24.1
Lactate	0.5-2.2 mmol/l	13.1	1.1

Discussion

Carbon dioxide acts as an asphyxiant by displacing oxygen in the blood, and as a toxin. Carbon dioxide exposure permissible by Occupational Safety and Health Administration (OSHA) is 5000 BPM in an eight-hour workday [2,3]. As defined by Food Safety and Inspection Service (FSIS), CO_2 levels around a bin of dry ice can be as high as 11,000 to 13,000 ppm [4]. Warmer temperatures increase CO_2 production from dry ice and confined spaces increase toxicity. Typically, people have mild respiratory symptoms, increased heart rate, tachypnea until 10,000-30,000 PPM of CO_2. Beyond 40,000 PPM exposure becomes immediately dangerous to life or health [4].

Since CO_2 is heavier than air, it settles in low-lying areas and confined spaces and may lead to confined space hypoxic syndrome. According to a study by OSHA in 2015, 90 deaths were attributed to confined space hypoxic syndrome in the United States which is described as accidents in oxygen-deficient atmospheres such as pits, mines, underground storage bins, etc [5].

On literature review, we found multiple cases of fatal carbon dioxide poisoning due to dry ice [6-8]. While some of these cases were accidental, some were due to occupational exposure, like during transport and walk-in freezers at ice cream parlors. OSHA has clear safety guidelines regarding the use and transport of dry ice.

Conclusion

It is important to reiterate the guidelines relating to dry ice use, and should be displayed in all laboratories, workplaces, and factories. Employees should be trained regularly on safe use and transport to avoid fatal accidents. For physicians, an accurate and detailed history taking can help recognize a potentially fatal medical emergency and ensure early intervention. Removal of the toxic environment, oxygen delivery and supportive management are mainstays of treatment.

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