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CASE REPORT

Carbon monoxide: An old poison with a new way of poisoning

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We present two events of carbon monoxide (CO) poisoning, which spread out through ventilation pipes to kill or injure neighbors. This is a previously undocumented poisoning process. In the first event, three people died and eight others suffered CO poisoning from a gas-powered water heater in an apartment building. Similar to the first event, three people expired and three others were injured by CO poisoning in the second event. We subsequently determined the cause of these tragedies were due to obstructions at the openings of ventilation pipes. CO is one of the most common causes of poisoning worldwide and these cases often result in tragedy. Early recognition of CO poisoning resulting from obstructed ventilation pipes will facilitate proper management and prevent possible lethal disasters. Additionally, all clinicians and other paramedical personnel ought to raise the suspicion of chemical-related casualties when encountering clusters of patients from a single locale.

Introduction

Carbon monoxide (CO) poisoning is not uncommon, but accidental events of CO poisoning due to exposure through ventilation pipes has not been documented previously. CO is an invisible, odorless, and tasteless gas that causes more accidental and intentional deaths than any other form of poisoning worldwide. In the United States, CO poisoning is the most common type of accidental poisoning, accounting for thousands of emergency department visits and some 800

Abbreviations: CO, Carbon monoxide; HBO_2, Hyperbaric oxygen; COHb, carboxyhemoglobin.

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deaths annually. The consequences of CO poisoning result in enormous costs to our society and the families of affected victims.

CO binds to hemoglobin 210 times more strongly than oxygen. It impairs the transport and delivery of oxygen to tissues and often results in persistent neuropathologic sequelae and deaths.[1,2] Moreover, this silent poison has the potential to kill many people if missed at the first scene. This report is interesting not only because of the rarity of its unique poisoning mechanism, but also because of the lethality resulting from delayed recognition.

Case reports

Case 1

In this event, three people died and eight others suffered CO poisoning from a gas-powered water heater in an apartment building in Taiwan. The fire bureau reported a reading of 1800 parts per million (ppm) CO on the fifth and sixth floors. All people from the households in the same building were evacuated. This accident started when a 29-year-old woman who lived on the sixth floor turned on the gas-powered water heater to take a shower at around 10:00 PM. After firefighters and rescuers entered her apartment at 8:00 PM the following day, the water heater was still on. She was found to be in a state of cardiopulmonary arrest and was transported to a nearby hospital. Earlier, at noon, two residents who lived on the ninth floor were experiencing fatigue, dizziness, and headache symptoms and went to seek medical assistance. Three residents living on the seventh floor experienced symptoms of nausea, vomiting, and dizziness at 3:00 PM. Two residents living on the third and fourth floors of the building also complained of these symptoms later. They were all rescued by fire department personnel.

A 31-year-old woman living on the fifth floor was found lying unconscious on the ground of her apartment at 7:00 PM. Her daughter and mother-in-law were brought to another hospital in a state of cardiopulmonary arrest, and she was brought to our hospital in a comatose status. Emergent endotracheal tubing with mechanical ventilation was given. A high level of carboxyhemoglobin (COHb) 52.9% with hypokalemia and metabolic acidosis were noticed. The patient underwent emergent hyperbaric oxygen (HBO_2) therapy for 3 hours and subsequently regained consciousness. After admission, she received three additional cycles of HBO_2 therapy. Fortunately, her condition improved rapidly and she was discharged 3 days later.

Case 2

In this event, three people expired and three others were injured by CO poisoning from a gas-powered water heater in an apartment building. The fire bureau founda young couple who lived on the 13th floor of the building. After firefighters broke into their apartment, the water heater was still on. They were both found to be unconscious and were brought to a nearby hospital in a state of cardiopulmonary arrest. Eventually both victims were diagnosed with CO poisoning.

In the meantime, another group of firefighters discovered a 61-year-old man who had also fallen unconscious in the apartment on the 15th floor of the building. He was sent to a nearby hospital and diagnosed to have suffered CO poisoning as well. Fortunately, he returned to consciousness after HBO2 therapy. A 39-year-old woman was also discovered to be in a state of cardio-respiratory arrest in the apartment on the 14th floor of the building with her son, a 12-year-old child who was found to be unconscious. They were transported to the hospital. The woman expired but her son returned to consciousness after HBO_2 therapy. A 25-year-old woman who lived on 18th floor also experienced symptoms of nausea and vomiting at this time. The firefighters inspected the apartment building and found that six ventilation outlets on the roof of the building had been covered with sheet metal plates. Slats were originally attached to the vent outlets, but after some of the slats were broken during a typhoon, the outlets were then blocked by steel plates. After CO was generated from the incomplete oxidation of a gas water heater in one of the apartments, CO was unable to escape through the blocked ventilation system. In conclusion, the blockage of the ventilation outlets was determined to be the major factor in this accident.

Discussion

These two accidental events are indeed notable. Several victims either died or were injured after exposure to high levels of CO. We determined that CO spread out through the ventilation pipes to reach the neighboring floors. We also observed that the survivors benefited from HBO_2 therapy. Randomized controlled trials have definitively shown HBO_2 as the only efficacious therapy for acute CO poisoning if delayed neurological sequelae are to be minimized; therefore, it is often recommended for patients with acute CO poisoning.[1,3]

In the first event, the CO originated from the gas-powered water heater on the sixth floor of the apartment building. The water heater was installed in the balcony, completely enclosed by windows. These windows were closed because the air conditioner was running. Moreover, the top of the ventilation pipes was found to be obstructed on the ninth floor of the building. CO remained within the ventilation pipes because they were blocked. The concentrations of CO become higher and higher, leading to the accident (Fig. 1).

The second event is similar to the first one. The gas-powered water heater on the 13th floor was also installed in a balcony completely enclosed by windows; additionally, the six ventilation outlets on the roof of the building had been remodeled with sheet metal plates. CO spread through the obstructed ventilation pipes and affected the residents of the 14th, 15th, and 18th floors.

In the first event, neither of the emergency physicians suspected that the two residents living on the ninth floor who sought medical assistance at noon were victims of CO poisoning. None of the firefighters raised the suspicion of CO poisoning due to CO coming through the ventilation pipes when they rescued three residents who lived on the seventh floor at 3:00 PM. Because no facilities that can