CASE REPORT

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Open Air Carbon Monoxide Poisoning

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ABSTRACT: An unusual manner of carbon monoxide poisoning claimed the lives of two adults in two separate incidents. In the first case, a young man was four wheeling in a swampy area when his jeep became stuck in the mud as he continued to floor the accelerator. Carbon monoxide fumes entered the vehicle through the rusted floorboards, killing the driver. In the second case, two teens were skinny dipping behind a motor boat when they became affected by the boat exhaust. One of the youths was overcome and submerged into the lake. Both incidents were initially attributed to incorrect causes—a car accident and a drowning—because of the false notion that carbon monoxide is not a hazard in a ventilated area. The carboxyhemoglobin levels in these victims were 78 and 62% respectively. It was only through laboratory testing that carbon monoxide poisoning was identified as the cause of their demise. Physicians as well as the public need to be aware of the potential for this life threatening hazard to occur so that there can be proper emergency treatment and the prevention of fatalities.

KEYWORDS: forensic science, forensic pathology, poisoning, carbon monoxide, open air

Carbon monoxide (CO) is a deadly odorless, tasteless, nonirritating, and invisible gas. It accumulates rapidly in the blood due to the increased affinity of red blood cells for this mixture over oxygen. The result is headache, nausea, vomiting, dizziness, lethargy, and confusion. As the blood level of carboxyhemoglobin rises, the brain and heart are deprived of much needed oxygen. Infants, the elderly, and others with chronic cardiac or pulmonary disease are at highest risk to experience adverse affects. People engaged in rigorous physical activity are also more susceptible as the increased respiratory effort increases CO absorption. The lack of specificity of the symptoms may make the clinical diagnosis difficult if there is no obvious source of the gas. CO is produced as the by-product of incomplete combustion and is ubiquitous in our technologically advanced society. The sources are endless including motor vehicles, gas operated equipment, wood stoves, furnaces, butane, propane, kerosene heaters, charcoal barbecues and fireplaces. Here I report two unusual sources of CO exposure in an outdoor air environment resulting in the deaths of two young individuals.

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Materials and Methods

Two cases of open air carbon monoxide poisoning were identified between 1991 and 1996. The victim and vehicle characteristics were analyzed as well as the circumstances of the deaths including how the decedents were found, their activity prior to death, witness accounts, review of 911 tapes and police investigations. Complete forensic autopsies including full toxicologic testing were performed in each case. In addition, the ambient air and the motor boat in the second case were tested for CO using both an Interscan Cotector with a gage range of 1 to 100 parts per million (ppm) and a Gastech personal detector with a digital output. Various compartments of the boat were measured for CO while the boat was idling and motoring.

Results

Case I

The decedent was a 27-year-old white male found slumped over in the driver's seat of his jeep (Fig. 1). The jeep was angled with the rear portion slightly downward in a swampy forest. The wheels were entrenched with mud and the right rear tire was flat. The windows of the driver's and front passenger's sides were completely open. The investigating officer noticed the decedent was unbelted and identified tire marks on the adjacent slope. The decedent had last been seen on July evening prior to his demise when he was going out four wheeling. Initial police investigation revealed the decedent to be a victim of a motor vehicle accident.

External examination of the body revealed pink colored lividity consistent with the position in which he was found. Rigor mortis

FIG. 1—*Case 1, decedent slumped in driver's seat of jeep with front windows open and wheels entrenched in mud.*

was fixed completely. The internal examination revealed no evidence of blunt trauma including fractures, contusions, or hemorrhage. No fractures were identified by X-ray examination. There were no natural disease processes to explain death. Toxicology studies for drugs were negative and the blood ethanol measured 215 mg/dL (more than twice the legal limit for driving − 100 mg/dL). Laboratory study for carboxyhemoglobin revealed a blood concentration of 78%.

Case II

The decedent was a 16-year-old white female who was skinny dipping with a young man off the stern of a recreational open bow motor boat (1981 Crestliner 17 foot long pleasure craft) (Fig. 2). The engine was an inboard/outboard style. They had traveled approximately 450 yards to the center of a freshwater lake for a midnight swim. Three members of the party stayed in the boat at the bow. The young man asked for the engine to be turned on to warm the water behind the boat where they wanted to swim. After swimming for approximately ten minutes the man felt tired and cold and got back in the boat. As he looked back at his swimming companion he noticed that she put her head in the water and then disappeared. He thought she was taking an underwater dive but became alarmed when she didn't resurface and he called 911. The recorded conversation reveals he was breathing at 40 breaths a minute and after a few minutes stated he had to get off the phone "to go breathe." An under water search ensued with the victim found five days later at a 50 foot depth with a water temperature of 48 degree Fahrenheit.

FIG. 2—*Case 2, motor boat which is a 17 ft open bow model without a cabin. The exhaust is located at the stern and vented only at the water level when idling.*

External examination of the body revealed a nude female teenager in pristine condition due to the water temperature. The lividity was pink and posterior. Full rigor mortis was present. No injuries were identified. The internal examination revealed no evidence of blunt trauma including fractures, contusions, or hemorrhage. The lungs were heavy with a combined weight of 1490 grams and filled with congestion and edema. The brain revealed a pink discoloration. Toxicology studies were negative for drugs and revealed a small amount of alcohol. Laboratory study done stat for carboxyhemoglobin revealed a concentration of 62% in the heart blood and 51% in the femoral blood. The specimens were tested twice and then submitted to a separate laboratory with confirmatory results. Methemoglobin was negligible.

Testing of the boat after idling for eight minutes revealed that CO was present in concentrations over 100 ppm in the air several inches above the water level at the stern. The largest accumulation of CO was at the stern just above the water surface as well as at the transom. When the boat was running with the accelerator depressed, the exhaust was vented through the under water prop as well as the water surface and therefore less accumulated at the water level than when the boat was idling and only exhausted fumes at the water surface level. There was no significant accumulation of CO at the driver's or passenger's seats. During the testing all three of the investigators developed headaches and could smell excessive exhaust fumes.

Discussion

The most common cause of unintentional poisonings in the United States is due to CO with an estimated 1000 fatalities annually excluding fire related deaths (1). The number of people that seek medical treatment due to CO exposure is much higher reaching 10 times that amount (2). Despite recent reductions in the fatality rate, CO poisoning remains a significant public health problem because victims do not recognize that the activities in which they are engaged are exposing them to this hazard (1,3–8).

Automobiles are the most frequent source of these poisonings with an increase of cases in the winter months (1,9). Though the vast majority occur in an enclosed environment, outdoor deaths associated with motor vehicles have been reported. Pick up trucks with canopies or tarpaulins can accumulate exhaust with resulting CO poisoning of rear passengers (4). Similarly boats with enclosed cabins can draw exhaust into the passenger compartment with resultant poisoning (5). Additional outdoor cases have been reported involving individuals lying beneath their running vehicles in an effort to end their lives (10).

An equally important source of CO is the home heater/furnace which is responsible for a majority of residential cases (11). A recent celebrated case underscores the need to perform annual checks on home heating equipment. Vitas Gerulaitis, a renowned tennis player, was killed by fumes from a faulty propane system (12). Other home sources of CO are gasoline powered equipment being used indoors. Though many operator manuals may advise using the equipment with adequate ventilation, this does not alleviate the inherent risk. This is demonstrated with the reports of several poisonings among farmers using pressure washers indoors despite open doors and exhaust fans in operation (6). Indoor CO exposure can also occur at demolition derbies, ice skating rinks, and sporting events. This can be a significant problem since a large number of people may be at risk. In one ice arena in Seattle 78 of 300 people were evacuated to emergency rooms after exposure to levels of 354 ppm CO (7).

In both of these current cases, CO exposure resulted from improper use of recreational vehicles. In each instance the motors were running while the vehicles remained stationary allowing toxic levels of CO to accumulate despite passive ventilation in an open air environment. In the first case the fumes were forced into the body of the vehicle due to blockage of the muffler by mud. This is the same mechanism that caused numerous outdoor poisonings during the blizzard in the northeast in the winter of 1996 when running automobile tailpipes were blocked by snow (8). In the second case the proximity of the individuals to the exhaust emitted at water level permitted their exposure.

The potential magnitude of this problem is underscored by the increasing popularity of motorized boating equipment, all terrain and four wheel drive vehicles, and snowmobiles. Users of these vehicles may be too preoccupied with the recreational enjoyment to realize the exhaust hazard. Passengers on motorized water vehicles may be particularly susceptible to CO injury as they might attribute their ill health to seasickness and could also become submerged if affected by the gas (9).

The unusual circumstances of these reported deaths led officials to ascribe the cause of death to recreational accidents and overlook the possibility of CO poisoning. Both victims displayed the presence of pink lividity prompting testing for carboxyhemoglobin. However this should not be the only criterion for laboratory screening. Lividity may be difficult to ascertain in darker skinned individuals and pale in other circumstances. Physicians and those involved in death investigation should routinely test for carboxyhemoglobin in victims when there is no obvious bodily trauma and there exists potential exposure to this deadly gas. This comprehensive approach will uncover cases of occult carbon monoxide poisoning and raise public awareness about this preventable mode of death.

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