State of Alaska Epidemiology **Bulletin**

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Carbon Monoxide: Stay Aware - Stay Alive!!

Carbon monoxide (CO) is a colorless, odorless gas which combines with hemoglobin, interfering with oxygen transport and removal of carbon dioxide. Exogenous CO is produced by the incomplete combustion of organic fuels. Because many potential sources of large amounts of CO exist in modern society, and humans have a high susceptibility to CO exposure (hemoglobin has a CO affinity 210 times greater than for oxygen[1]), both fatal and non-fatal cases of CO poisoning occur yearly. Two cases which occurred in Alaska illustrate the dangers of CO exposure.

Case 1
A 46-year-old man was found unconscious aboard a 30-foot recreational boat in a small boat harbor. He was observed to have "cherry-red" skin. CPR was attempted, but the victim did not respond. An autopsy revealed his cause of death to be carbon monoxide poisoning. Investigators believe the most probable source of CO was a portable generator he used inside the tightly sealed vessel cabin. A possible second source was a water heater which vented onto the canvas-covered rear deck. CO levels of greater than 500 ppm from the generator and 40 ppm from the heater exhaust were obtained. The victim's blood carboxyhemoglobin (COHgb) level at autopsy was 51.1%.

Case 2
A family of five left a lodge for their cabin on an outboard motorboat with a fixed canvas canopy. The family crossed a lake at slow speed due to their heavily loaded boat. Forty-five minutes into the trip a member of the family became ill with symptoms of loss of control of one arm, weak legs, headache, and dizziness. The family was concerned that the victim could be suffering a heart attack, and called for help on the boat radio. A neighbor met them in another boat, and the victim and two other family members returned to the lodge in this vessel. These family members began suffering symptoms of weakness, severe shortness of breath with minimal exertion, headache, and shakiness. A family member drove to another lodge to call the hospital, and continued driving (20 miles) to meet the state trooper and ambulance. A medical evaluation of these three family members revealed the following: all victims were suffering from headache, nausea, and weakness. Their blood COHgb levels ranged from 24 to 29%.

The father and son had remained on the original boat to continue to their cabin and unload supplies. However, based on the medical findings of the rest of the family, these individuals were also examined. The son had a COHgb level of 23% -- 3 hours after exposure. The father's COHgb level was 4% -- he had steered the boat with his head outside the canvas canopy. All family members made successful recov- eries after medical treatment with 100 percent oxygen for 4 hours.

Recommendations:
Treatment includes removal of the victim from the CO environment, and immediate administration of 100% oxygen. Since the serum elimination half-life of COHgb when breathing ambient air (about 20% oxygen) is 4-6 hours (compared to about 1.5 hours at 100% oxygen)[1], strict bed rest should be maintained to reduce oxygen requirements. Hyperbaric oxygen is recommended for comatose patients with COHgb levels > 40%, patients with seizures or arrhythmias with COHgb levels > 25%, and patients with delayed onset of sequelae[1].

Individuals exposed to environments which are poorly ventilated or contain by-products of incomplete combustion are at increased risk for CO poisoning. Such hazards may exist in residences, recreational boats and airplanes, or industrial, agricultural, and commercial worksites. Exposure to other vehicles (cars, trucks, construction equipment, etc.) is also a potential risk. Internal combustion engine-driven machines (e.g., pumps, generators) with faulty exhaust systems, malfunctioning or improperly vented hot water heaters, stoves, furnaces fueled by natural gas, and portable propane or kerosene heaters used at construction sites are also potentially hazardous. Studies by the Section of Epidemiology have previously identified significant CO hazards associated with commercial fishing (1983), general aviation (1985), space heaters (1985), and hot water heaters (1987).

Any inadequately ventilated space with the potential for gas accumulation and partial combustion of fuel should be avoided. Measures should be taken to reduce excess production of CO. Above all, if exposure to such potentially hazardous areas is required, then adequate exhaust ventilation at the source of internal combustion must be continuously maintained. Some situations may also require continuous or periodic CO monitoring using gas detectors with alarms.

WARNING: Ensure that combustion exhaust ports are unobstructed, and adequate ventilation exists on any CO-generating equipment or machinery in use.

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References

1. Harrison's Principles of Internal Medicine, Twelfth Edition, J.D. Wilson et al, McGraw Hill, Inc., 1991.

(Submitted by: Kathleen Johnson and Gary Bledsoe, Section of Epidemiology.)