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CENTER FOR DISEASE PREVENTION & EPIDEMIOLOGY • OREGON HEALTH DIVISION

CARBON MONOXIDE POISONING: A SILENT AND DEADLY THREAT

CARBON MONOXIDE (CO) is a byproduct of the incomplete combustion of carbon-based fuels (e.g. petroleum products, natural gas, wood). Unintentional CO poisoning occurs in many different settings, including residences, motor vehicles, workplaces and public settings such as sports arenas and ice skating rinks.[1-6] CO is a colorless, odorless, non-irritating gas that induces toxic effects by binding tightly to hemoglobin to form carboxy-hemoglobin (COHb), thereby reducing the oxygen-carrying capacity of blood. CO also binds with mitochondrial cytochrome oxidase, interfering with cellular respiration.[7]

FATALITIES

Nationally, an estimated 600 deaths occur annually due to unintentional CO poisonings in the United States.[8] From 1992 through 1995, at least 22 Oregonians died that way, according to a review of Vital Records data and medical examiner records. Most victims (86%) were male. They ranged in age from two to 74 years old. Thirteen (59%) of these deaths took place in or around the home. Of the remainder, seven occurred while camping; two were mining-related. Several examples follow:

Case 1. In July 1993, two adult males on a camping trip in eastern Oregon used a propane space heater for a short period of time to warm their van at night. In the morning, one man woke up and found his companion dead. The survivor was hospitalized with near-lethal levels of carbon monoxide in his blood.

Case 2. In June 1995, exposure to a malfunctioning propane refrigerator that was vented into the home caused a double fatality in a rural Oregon community. A 71-year-old woman collapsed as she got out of bed in the morning. She was found dead on the floor with characteristic cherry-red appearance to the extremities. Her husband had died in his sleep. Repair work had been done on the refrigerator the week prior to their deaths.

Case 3. Also, in June 1995, a Portland woman was found dead of carbon monoxide poisoning in the attached garage of her home. She did not have a radio in the house, and would reportedly open the door from the garage into the house and play music on the car radio. She would leave the car running so as not to wear down the battery.

Eleven of the twenty-two Oregon fatalities resulted from malfunctioning or inappropriately placed gas appliances and inadequate ventilation. Inhalation of motor vehicle exhaust while working on a car engine in an enclosed garage, or while sleeping in a vehicle with the motor running caused seven of the deaths. Four deaths stemmed from the use of charcoal briquets in enclosed spaces for heating.

NON-FATAL INCIDENTS

The Oregon Poison Center (OPC) logged 882 reports of non-fatal, unintentional CO poisoning during the same four-year period.[9] This is an underestimate of the true number of cases of non-fatal CO poisonings, because not all cases are reported there.* The early symptoms of CO poisoning are non-specific (e.g., headache, nausea, dizziness, weakness, drowsiness and confusion).[7] Therefore, individuals with mild symptoms may not seek treatment, and physicians may not link the nonspecific symptoms to CO poisoning. Symptoms are sometimes misdiagnosed as acute, self-limited illnesses such as food poisoning, "flu" or other upper respiratory tract infections.

EXPOSURE FACTORS

Four factors determine COHb levels and the degree of CO poisoning[2]:

- the concentration of CO in the air;
- the duration of exposure;
- the activity level of the persons exposed; and
- the time interval between exposure and clinical evaluation.

Indoor concentrations of CO vary widely depending on sources and occupant use patterns. Houses with a normally operating gas furnace may have CO concentrations of 1-2 parts per million (ppm), but a faulty furnace can produce levels >1,000 ppm. Simply running four burners on a gas stove can produce CO concentrations of 35-120 ppm after 20 minutes of operation.[10]

Normal COHb concentration is <2% among non-smokers. Among smokers, concentrations may range from 5%-9%. Exposure for 1-2 hours to CO levels of 80-140 parts per million (ppm) can result in COHb concentrations of 3%-6%. At these levels, decreased exercise tolerance can be expected in otherwise healthy individuals, and may precipitate angina and cardiac arrhythmias in at-risk individuals. Headache, nausea, and mental impairment tend to appear at COHb levels of 10%-20% usually associated with CO concentrations in the range of 105-205 ppm. At COHb levels of 30%-60%, more serious central nervous system responses, including coma and death, can occur.[11] Toxic levels may be substantially lower for fetuses, infants, pregnant women, and persons with underlying pulmonary or cardiovascular diseases.[8]

The Occupational Safety and Health Administration recommends an exposure limit of 35 ppm for CO as a time-weighted average, with a limit of 200 ppm that should not be exceeded at any time.[12] These legal standards, were developed for the protection of a generally healthy adult worker; and may not be applicable to more at-risk segments of the population. The National Ambient Air Quality Standard has set a one hour maximum standard of 35 ppm, and the maximum 8-hour standard is 9 ppm (neither are to be exceeded more than once per year).[11] While these standards are more protective of sensitive populations, they only apply to outdoor air concentrations.

* or anywhere else, for that matter.

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Primary sources of CO associated with non-fatal poisonings may differ significantly from sources of fatal cases.[1] Malfunctioning gas heating furnaces are important sources of CO poisonings in non-fatal residential cases, but are less likely to be associated with fatal cases. While specific sources for non-fatal cases are lacking for Oregon, 26% of Oregon homes are heated by natural gas or propane furnaces, and 55% rely on some form of carbon-based combustion fuel.[13] A new potential threat from CO comes in the form of unvented gas fireplaces. These are decorative gas fireplaces that are vented directly into the living space. Levels as high as 90 ppm were measured near one such fireplace.[10]

Because this potentially lethal gas is not readily detected, it remains a substantial health threat. The problem is made worse by the fact that symptoms associated with CO poisoning can mimic other acute illnesses, confusing both patient and practitioner. Elevated CO levels in residential settings are usually the result of malfunctioning combustion appliances and inadequate ventilation.

TREATMENT AND PREVENTION

The use of hyperbaric oxygen has been a recent advance in medical treatment for severe acute poisoning. Giving oxygen is helpful in reducing COHb levels for less severe cases. Public health measures to prevent death from unintentional CO poisoning have focused on improvements in home-heating appliances and prevention education. Future goals include stricter exposure standards and requirements for ventilation of all combustion appliances.

CO poisoning is preventable. Ventilating combustion products to the outside and keeping combustion appliances well-maintained offer the best protection. In addition, home CO detection devices can alert occupants to the presence of the gas before toxic levels are reached. However, cost and apparent false alarms are barriers to wider acceptance of such devices.

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Pesticide Overexposure Workshop

OHSU's Center for Research on Occupational and Environmental Toxicology (CROET) is presenting a series of morning workshops with expert speakers addressing patient assessment, biological sampling, and local case histories of pesticide overexposure. Sessions will be held at five locations in March and April (*infra*).

In the afternoons, the Oregon Health Division will be sponsoring an interactive workshop for medical and social service providers, employers, and others interested in strategies to protect farm workers and how to respond to pesticide poisoning reports. Representatives of the Oregon Department of Agriculture, Oregon OSHA and the OSU Extension Service will also discuss relevant laws and prevention efforts.

- Medford March 7*
- Salem March 20
- Hood River March 21
- Pendleton April 3
- Ontario April 4

The cost of the workshops will be $75 for both sessions or $40 for the morning or afternoon alone. For more information, call CROET (494-2514 in Portland area; 800/457-8627 elsewhere). Limited funds are available to subsidize persons from local health departments and migrant/rural health clinics. For information about these scholarships, contact the Health Division (503/731-4025).

* better hurry for this one.