Accidental Carbon Monoxide Poisonings in Colorado and Wyoming, 1971-73

CARBON MONOXIDE (CO) is an odorless, colorless, and tasteless gas that is found in high concentrations in urban atmospheres. The major source of CO is from automoblies (*1*) Natural sources are also large producers of CO and are estimated to produce 10 times more CO than all automotive and industrial sources combined (*1*). Although industrial standards are set at 50 ppm, levels at much lower concentrations can cause some serious problems, and today many researchers believe that chronic effects may result from long exposure to low levels of CO in the environment. Because carbon monoxide is produced by the incomplete combustion of carbon or carbonaceous materials, any flame or combustion device is likely to emit carbon monoxide. The exhaust from incomplete combustion of natural gas or petroleum fuels may contain 5 percent carbon monoxide, and an unvented natural gas heater may emit as much as 1 cubic foot of carbon monoxide per minute (*2*).

It is now believed that the sole mechanism for the physiological effects of carbon monoxide is the lowering of the oxygen-carrying capacity of the blood, and all the symptoms of CO poisoning are related to the lack of oxygen. The affinity of hemoglobin for CO is 200 times greater than its affinity for oxygen (*3*).

According to Fowler (*4*), the risk of carbon monoxide is greater above 7,000 feet altitude than it is at sea level because the lack of sufficient oxygen at high altitudes results in poor combustion, causing motor vehicles to emit much more carbon monoxide. At the same time, the human body is deprived of the blood's normal oxygen carrying capacity.

Because carbon monoxide poisoning is not a reportable disease, accurate morbidity data are not available. Lehr (*5*) noted that, based on evidence available to the Injury Control Program of the Public Health Service, at least 10,000 persons suffer chronic ill effects from exposure to sublethal but debilitating levels of carbon monoxide. Mortality data for carbon monoxide poisoning are collected from death certificates and reported annually by the National Center for Health Statistics. An example of this mortality in the United States is provided by the 1966 statistics which accounted for 1,500 deaths; of these, 900 were in homes, 100 in industry, and less than 200 on streets or highways (*5*).

Not only does the automobile contribute to the sublethal concentrations of CO in the atmosphere, but it can be a source of high-level exposure to its occupants when exhaust fumes enter the passenger compartment and build to lethal concentrations. Baker and associates (*6*), reviewed all 68 deaths in the State of Maryland from 1966 through 1971 that were caused by unintentional CO poisoning in motor vehicles. The objectives of the study were to determine the magnitude of the problem, describe the condition of the vehicles and the circumstances under which these deaths occurred, and consider possible solutions. Of the 68 deaths, 51 were associated with faulty vehicles. Rust was found to be the major factor in most cases, having caused exhaust-system defects and holes in the body of the vehicles through which fumes could enter. The majority of the victims were in stationary vehicles with the engines running to provide warmth. The authors suggested that cars built in the future be modified to safeguard against fumes entering the passenger compartment and that existing cars be inspected for defects and corrected; they estimated that more than 500 Americans die each year from CO poisoning because of vehicles that are defective due to deterioration, damage, or poor automotive design.

In 1974–75, we conducted a study to determine the number of accidental carbon monoxide poisonings from all causes shown in the records of selected hospitals in the States of Colorado and Wyoming. Hospitals included in the study were located in Brighton, Boulder, Burlington, Leadville, Meeker, Rifle, Canon City, Salida, Fort Collins, Colorado Springs, Monte Vista, Denver, Pueblo, Durango, Greeley, Grand Junction, La Mar, La Junta, Craig, and Gleenwood Springs in Colorado and Cheyenne and Laramie in Wyoming.

Methods

The records of 30 urban and rural hopsitals in both States were searched for cases of accidental carbon monoxide poisoning during 1971, 1972, and 1973. The field investigator was thoroughly trained in abstracting hospital records to collect significant epidemiologic data. The information collected included number of cases, age, sex, and race of the victims, date of onset, release time, treatment, and prognosis. Additional information included circumstances surrounding the exposure such as place of occurrence, home-work-vehicular environments, and time-place relationships

Results

A total of 237 cases of accidental carbon monoxide poisoning were studied. The places in which they occurred were as follows:

Place	*Number*	*Percent*
Vehicle	84	35.4
Home	118	49.8
Work	9	3.8
Miscellaneous	5	2.1
Unknown	21	8.9
Total	237	100.0

The number and percentage of victims, according to race were:

Race	*Number*	*Percent*
White	176	74.3
Black	9	3.8
Chicano	4	1.6
Unknown	48	19.8
Total	237	99.5

Of the 237 victims, 141 were male, 94 were female, and the sex of 2 was unknown. As the following table shows, male victims predominated in the age groups from 16 to 55 years; in these age groups, 97 males and 46 females were hospitalized. Under age 16 and over age 55, the sex difference was not significant.

Age group	*Male*	*Female*	*Percent of total (N = 237)*
Under 5	8	10	7.6
6–15	15	14	12.2
16–24	25	17	17.7
25–39	36	16	21.9
40–55	36	13	20.7
56–70	16	14	12.5
70 and over	3	5	3.4
Unknown	2	5	3.8
Total	141	94	99.8

The home environment accounted for the largest number of accidental carbon monoxide poisonings—a total of 118. The sources of carbon monoxide in the home environment were as follows:

Source	*Number*	*Percent*
Car in garage	40	33.9
Defective flue or furnace	35	30.0
Space heater	2	1.6
Defective heater	7	5.9
Charcoal burner	2	1.6
Blocked exhaust fan	1	0.8
Defective appliance (stove, butane burner)	12	10.2
Gas leak	2	1.6
Fire in home	2	1.6
Home (unclassified)	15	12.8
Total	118	100.0

☐ *Dr. Savage is professor and chief, chemical epidemiology section, Mr. Tessari is an analytical chemist, and Mr. Malberg and Mr. Wheeler are associated with the Institute of Rural Environmental Health, Department of Microbiology, College of Veterinary Medicine and Biomedical Sciences, Colorado State University. Tearsheet requests to Dr. E. P. Savage, Institute of Rural Environmental Health, Colorado State University, Spruce Hall, Fort Collins, Colo. 80523.*

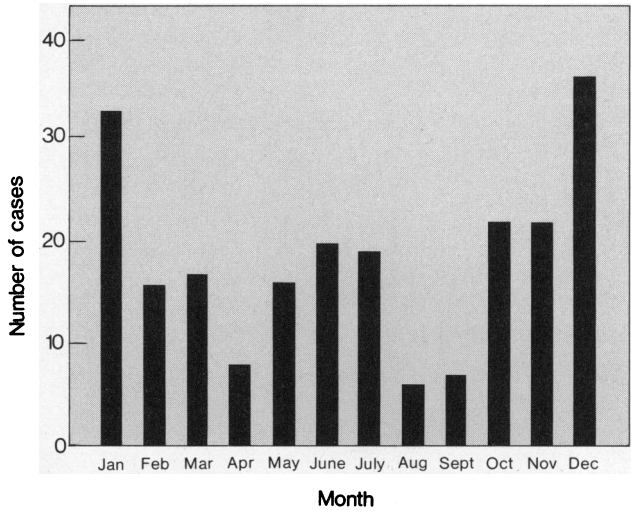
Vehicular-related accidents accounted for 84 cases, as follows:

Vehicular source	*Number*	*Percent*
In car or truck	63	75.0
Burning vehicle	1	1.2
Trailer heater	9	10.7
Camper heater	1	1.2
Camper gas burner	2	2.4
Trailer or camper refrigerator	4	4.8
Camping (unclassified)	1	1.2
In camper	3	3.5
Total	84	100.0

The occupational environment accounted for only 9 cases in our study; 4 of these were from a saw motor, 3 from a furnace, and 1 each from a compressor and a restaurant stove.

The number of cases peaked in December and January, and the lowest number occurred during August and September (see chart). The month of occurrence was not known for 10 victims.

Accidental poisonings due to carbon monoxide, by month, Colorado and Wyoming, 1971–73



NOTE: Month of occurrence not known for 10 victims.

Discussion

If the number of accidental carbon monoxide poisonings are to be reduced, emphasis must be placed on the cause and prevention of home and vehicular carbon monoxide accidents. Our study findings indicate that flues and furnaces should be checked before the winter season; these two items caused far more poisonings than did defective appliances. The low number of cases caused by occupational exposure to carbon monoxide is probably related to the strides made by occupational health workers to maintain carbon monoxide levels below the health hazard level.

The Memphis and Shelby County health departments in a 1964–65 study of carbon monoxide poisonings, found that flame impingement on metal surfaces, clogged air-mixing inlets, poorly designed appliances, failure to vent gas appliances, leaks in combustion chambers, improperly installed or clogged vent pipes, malfunctioning fuel regulator valves, and improper rise of fuel fumes were important factors contributing to the unsafe levels of carbon monoxide in the home (7). In our study, the role of appliances was not as important as we had anticipated.

The role of accidental CO poisoning by automobile exhausts in attached garages is hard to evaluate. Some cases resulted when people worked on cars in closed garages. A few cases were questionable as to whether they were accidental or of suicidal intent.

The increased number of males in the working-age groups is explainable because these males were frequently exposed to CO sources when repairing cars or camping on hunting trips.

The importance of altitude should not be overlooked. The rate per 100,000 population from cities above 6,000 feet was 102, as compared to a rate of 23 per 100,000 at altitudes less than 6,000 feet. The altitude-CO relationship needs further investigation. The interrelationship between nonclinical levels of carbon monoxide and driver-judgment accidents may be a more severe problem in the high altitudes of the Rocky Mountain States than originally expected.

The month of occurrence is also an important factor. A large number of cases occur in the winter months as a result of faulty furnaces. During the summer months, cases increase because of exposure to CO from automobiles. If the total number of accidental exposures to carbon monoxide poisoning in the United States is to be reduced, those responsible for public health will have to play a more active role.

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