Articles

Unintentional Deaths From Carbon Monoxide Poisoning in New Mexico, 1980 to 1988
A Comparison of Medical Examiner and National Mortality Data

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Carbon monoxide was the number 1 cause of poisoning deaths in the United States from 1980 through 1988, with the highest rates reported in the western states. We studied unintentional deaths from carbon monoxide poisoning in New Mexico during this period using the multiple-cause mortality files from the National Center for Health Statistics (NCHS) and data from the New Mexico Office of the Medical Investigator (OMI). We compared the nationally available NCHS data with the more detailed OMI data to determine the sensitivity of NCHS data for the surveillance of this preventable cause of death. The NCHS data were 88% sensitive in identifying deaths from unintentional carbon monoxide poisoning and had a positive predictive value of 81% when compared with OMI data. Half of the unintentional carbon monoxide-related deaths were attributable to a home heating mechanism of some sort, 46% involved motor vehicle exhaust, and at least 42% were associated with alcohol use. We conclude that available NCHS data are a sensitive source of surveillance information about unintentional deaths from carbon monoxide poisoning. Additional details about specific deaths can be obtained from medical examiner files when needed.

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Unintentional carbon monoxide poisoning claimed 11,547 lives in the United States from 1979 through 1988, and it was the number 1 cause of poisoning deaths during that period. Western states tended to have higher rates of death from this cause, with Alaska (1), Wyoming (2), Montana (3), Nebraska (4), and New Mexico (5) having the top five death rates for all the states. Colorado, Utah, and Idaho also had unintentional carbon monoxide poisoning death rates above the median rate for the United States.[1]

In the United States, two major sources of data have been used in epidemiologic studies of mortality from unintentional carbon monoxide poisoning: the National Center for Health Statistics (NCHS) multiple-cause mortality-data files[2] and medical examiner records.[3-5] The NCHS annually compiles these multiple-cause mortality-data files from death certificates completed in the United States. This method of quantifying rates of unintentional death due to carbon monoxide poisoning is convenient and could be used for each state, but the sensitivity of these data files in identifying true cases of unintentional carbon monoxide-related death has not been determined. The second source used to study unintentional carbon monoxide-related deaths, medical examiner records, allows further investigation of the cause and circumstances of death.[3-5] Medical examiner or coroner files are usually detailed and reliable, but are not readily available in every state. They are particularly well suited for studying unnatural, unintentional deaths due to carbon monoxide poisoning because all such deaths should have been investigated by the medical examiner or coroner, and often an autopsy has been done.[6] The NCHS data have been compared with medical examiner files in studies of deaths due to injuries.[7,8]

We studied mortality from unintentional carbon monoxide poisoning in New Mexico because New Mexico has a high death rate from this cause[1] and because mortality data were available both from NCHS multiple-cause mortality files and from the state medical examiner's office. The purpose of this investigation was to determine the sensitivity of NCHS mortality data for quantifying unintentional carbon monoxide-related deaths and to describe the epidemiology of this preventable cause of death in New Mexico.

Methods

We looked first at the NCHS multiple-cause mortality data for 1980 through 1988. Information in these files is

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ABBREVIATIONS USED IN TEXT

ICD-9 = *International Classification of Diseases*, 9th revision
NCHS = National Center for Health Statistics
OMI = Office of the Medical Investigator

abstracted from death certificates, which are gathered first at the local level, then at the state level, and finally at the federal level by NCHS. After coding the data, NCHS makes computerized files available to the general public. For each death, *International Classification of Diseases*, Ninth Revision (ICD-9),[9] codes are listed for the underlying cause of death and as many as 20 contributing conditions. Using the NCHS files, we selected death records of New Mexico residents who died from 1980 through 1988 in New Mexico. We then searched these records for those deaths with the ICD-9 code N986 (toxic effect of carbon monoxide) listed as either the underlying cause of death or as a contributing condition. From these, we selected deaths with any of the following codes: E811 through E813, E815, E816, E818, E819, E825, E838, E841, E844, E867, E868.0 through E868.9, E869.8, or E869.9. These external-cause or "E" codes could be listed as either the underlying cause of death or a contributing condition and further characterize deaths due to external or environmental factors. Finally, we excluded carbon monoxide deaths due to suicide and self-inflicted injury (E950 through E959), homicide and injury purposefully inflicted by other persons (E960 through E969), injury undetermined whether accidentally or purposefully inflicted (E980 through E989), injury caused by fire and flames (E837, E890 through E899), burns (E940 through E949), and injuries caused by explosives (E923). Many of the fire- and explosion-related deaths may have been unintentional and carbon monoxide-related, but as public health problems, their prevention falls into the category of preventing fires and explosions rather than preventing carbon monoxide poisoning.

This case definition—including the inclusion and exclusion criteria outlined above—has been used previously in conjunction with NCHS multiple-cause mortality data to study unintentional carbon monoxide poisoning deaths.[1] To determine the sensitivity of NCHS multiple-cause mortality data in identifying carbon monoxide poisoning as just defined, we compared them with data obtained from the New Mexico medical examiner's office, the Office of the Medical Investigator (OMI).

We searched data from the files of the OMI from 1980 through 1988 for deaths that occurred in New Mexico to persons whose state of residence was either listed as New Mexico or was unlisted. We searched these records for those deaths coded by the OMI as due to, or involving, carbon monoxide (coded as C12). We then searched these deaths for cases with a manner of death code of A37, which signifies a death due to nonabusive inhalation. This code excludes deaths due to suicide, homicide, fires, and explosions, as well as deaths for which the manner of death is unknown. Thus, these two codes, C12 and A37, were used to define deaths possibly from unintentional carbon monoxide poisoning in the OMI files. Finally, we reviewed the circumstances of each death as described in the medical examiner's record and selected only those deaths for which the narrative description of the circumstances of death was consistent with unintentional carbon monoxide poisoning.

TABLE 1.—*Unintentional Deaths Attributed to Carbon Monoxide (CO) Poisoning in New Mexico from 1980 through 1988 as Recorded in Files of the Office of the Medical Investigator (OMI) or in the National Center for Health Statistics (NCHS) Multiple-Cause Mortality Files*

NCHS Deaths	OMI Deaths, No.		
	CO-Related	Other*	Unmatched†
CO-related	60	14	1
Other*	8		
Unmatched†	6		

*"Other" refers to cause of death recorded as unintentional CO poisoning in 1 data file, but recorded as something other than an unintentional CO-related death in the other data file.
†"Unmatched" refers to CO-related deaths recorded in 1 file that could not be matched to any death in the other file on the basis of age, sex, and month, day, and year of death. The unmatched NCHS death was listed as a nonresident death in the OMI data set.

Using age, sex, and month, day, and year of death, we matched deaths listed in the NCHS multiple-cause mortality files as being from unintentional carbon monoxide poisoning with carbon monoxide-related deaths from the OMI files. We manually reviewed those deaths that matched on sex and month and year of death but did not match on age or day of death; we considered the deaths to be matches if only one of these variables prevented a perfect match. We then calculated the sensitivity and the predictive value of the NCHS data in identifying unintentional carbon monoxide-related deaths that were also identified in the OMI files. Finally, we performed a more in-depth review of the OMI records to characterize the victims of carbon monoxide poisoning and the circumstances surrounding their deaths. We used United States census data from 1980 to calculate mortality rates.

Results

Using NCHS multiple-cause mortality-data files, we found 75 unintentional carbon monoxide-related deaths occurring in New Mexico among residents of the state during 1980 through 1988 (Table 1). Of these, 74 were matched to deaths in the OMI files. The unmatched death was labeled a nonresident death in the OMI files. Using the OMI files, we found 74 deaths from unintentional carbon monoxide poisoning occurring in the state among residents during this same time period. Of these, 68 were matched to deaths in the NCHS data. We found 60 unintentional carbon monoxide-related deaths present in both data sets. Seven of these were matched manually: six mismatched only on age, and one mismatched only on day of death.

Eight matched deaths were labeled as unintentional carbon monoxide-related deaths in the OMI files but had other diagnoses in the NCHS files. Three of these deaths were classified in the OMI files as being unintentional carbon monoxide-related deaths, but the underlying

cause of death in the NCHS files was "unknown" (ICD-9 code, 799.9). In five cases, there appeared to be coding errors in the NCHS files.

Of the 74 matched deaths, 14 were labeled as unintentional carbon monoxide-related deaths in the NCHS files but were listed as having other causes in the OMI records. Of those deaths, the medical examiner case reports revealed that 5 were due to fires, 4 were suicides, 3 were due to motor vehicle accidents, 1 was attributed to asthma, and another to heart disease.

Of the 68 matched deaths from unintentional carbon monoxide poisoning confirmed by the OMI data, the NCHS data were successful in identifying 60, for a sensitivity of 88.2%. The probability that 1 of the 74 matched deaths identified from NCHS data as due to unintentional carbon monoxide poisoning could be confirmed as such with OMI data was 81.1% (positive predictive value).

To gain further insight into the demographic characteristics and causes of death for the 74 people whose deaths were identified as unintentional carbon monoxide-related deaths by the OMI (68 matched and 6 unmatched), we reviewed the circumstances of death for each decedent. Of the 74 people, 55 (74%) were male. Their median age was 35 years, with a range of 4 months to 87 years. More than half (55%) were white, 27% Hispanic, 11% American Indian, and 7% African American. The annual death rate per 100,000 persons was 2.41 for blacks, 0.83 for American Indians, 0.47 for Hispanics, and 0.46 for whites. We noted a pronounced seasonal trend, with the greatest number of deaths occurring in the winter months (Table 2). The number of deaths has declined in recent years (Table 3).

Half of the deaths (37) were due to a home-heating mechanism of some sort, and 34 (46%) were caused by motor vehicle exhaust. Two thirds of the deaths (68%, 50 persons) occurred in a residential setting, in either a home or a garage. A total of 34 deaths (46%) occurred in carbon monoxide poisoning episodes that involved other persons, some of whom survived. In all, 7 deaths (9%) resulted from the use of makeshift heating devices such as hibachi grills (2), a lantern (1), an army helmet filled with charcoal (1), or buckets used for burning wood indoors (3). Outside the home or automobile, deaths also occurred in such places as the workplace (2), in the back of a camper (3), in a motel (1), and in recreational settings such as a van (1) or houseboat (2).

TABLE 2.—*Unintentional Deaths Due to Carbon Monoxide Poisoning in New Mexico From 1980 to 1988 as Recorded in the Files of the Office of the Medical Examiner by Month of Occurrence*

Month	Deaths, No.
January	13
February	9
March	7
April	5
May	1
June	0
July	4
August	2
September	1
October	8
November	11
December	13
Total	74

TABLE 3.—*Unintentional Deaths Due to Carbon Monoxide Poisoning in New Mexico from 1980 to 1988 as Recorded in the Files of the Office of the Medical Investigator by Year of Occurrence*

Year	Deaths, No.
1980	10
1981	11
1982	7
1983	11
1984	13
1985	8
1986	6
1987	5
1988	3
Total	74

A detectable alcohol concentration of 0.1 grams per liter (0.01 grams per dl) or greater was present in either antemortem or postmortem blood specimens of 31 (42%) of the decedents. In 17 of these 31, the level was 1.0 grams per liter (0.1 grams per dl) or greater. Of the 31 deaths associated with alcohol consumption, the median age was 33 years, 26 (84%) occurred among men, 18 (58%) were associated with automobile exhaust, and 10 (32%) were related to the use of a heating device.

Discussion

In this study, we compared the use of NCHS data with that of OMI data for the surveillance of unintentional carbon monoxide-related deaths in New Mexico. Compared with the OMI data, the NCHS data had a sensitivity of 88.2% and a positive predictive value of 81.1% for identifying deaths from this cause. The NCHS data provide national coverage and are available within two to three years. Although not available for all states, medical examiner or coroner data are usually more detailed and can be used to supplement NCHS data with more specific information about the characteristics of a decedent and the circumstances of death. By using data from two sources, as was done in this study, researchers conducting descriptive epidemiologic studies can add to the existing body of knowledge about the causes and possible means of preventing unintentional carbon monoxide-related deaths in a particular region.

Other studies of unintentional carbon monoxide poisoning done in other states and in the United States as a whole have revealed that unintentional carbon monoxide poisoning tends to occur in the colder months of the year, and states with cold winters or with high-altitude areas have higher mortality rates in general. Motor vehicle exhaust is typically the most common cause of death, but many deaths occur in the home, often

due to old or poorly ventilated heating systems. Men have higher carbon monoxide-related death rates than women, and death is frequently associated with the use of alcohol.[1,3-5]

The earliest symptoms of poisoning from carbon monoxide are nonspecific and may resemble a flulike illness, with headache, fatigue, and mild central nervous system symptoms of drowsiness or lethargy. Early evidence of poisoning is commonly overlooked, allowing exposure to continue insidiously. With further exposure, somnolence, seizures, coma, and eventually death may result. In cases of severe nonfatal poisoning, residual neurologic impairment may occur, and this may be delayed by several weeks after the original insult. Deaths from carbon monoxide poisoning may occur in clusters and often involve otherwise healthy persons; in retrospect, these deaths are usually preventable. Little information exists regarding the occurrence of nonfatal poisonings, and it has been hypothesized that a substantial amount of morbidity from carbon monoxide poisoning remains undiagnosed.[10]

The cause of death in many cases of carbon monoxide poisoning can be attributed to faulty equipment or a lack of awareness of risk. Proper installation and regular maintenance of home-heating appliances, cleaning of obstructed chimneys, and careful attention to ventilation during the use of butane and kerosene space heaters, wood stoves, and charcoal grills will reduce risk. In many states, the local gas company will check the heating system of a home for carbon monoxide leaks at little or no charge.

Education of both health professionals and the public is also essential to prevent such deaths. Educational efforts should be directed toward those at highest risk, including young male drivers and the elderly or others who live in homes with old heating systems. The health risk of running motor vehicles in closed spaces needs to be reemphasized, particularly among young male drivers. The relation between alcohol consumption while using a motor vehicle and risk for carbon monoxide poisoning also needs further emphasis, perhaps in driving education courses.

Physicians need to be aware of the classic signs and symptoms of carbon monoxide poisoning when seeing patients at risk for this problem. In severe cases, treatment with hyperbaric oxygen may improve the chances of survival. Prevention education may be particularly timely in the autumn before the cold weather months and seasonal increases in carbon monoxide poisoning occur.

Affordable carbon monoxide detectors for residential use, which have been certified according to standards set by Underwriters Laboratories, are now available.[11] These may eventually be substantially cost-effective in preventing carbon monoxide poisoning deaths similar to the way smoke detectors have prevented deaths from residential fires.[12]

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