Unintentional Deaths from Carbon Monoxide in Motor Vehicle Exhaust: West Virginia

ROY C. BARON, MD, MPH, RONALD C. BACKER, PhD, AND IRVIN M. SOPHER, DDS, MD

Abstract: We investigated the circumstances of unintended carbon monoxide deaths from motor vehicle exhaust. Of 64 episodes involving 82 deaths investigated by the West Virginia Office of the Chief Medical Examiner, 1978-84, 50 occurred outdoors in older vehicles with defective exhaust systems and 14 occurred in enclosed or semi-enclosed home garages. Blood alcohol was detected in 50 (68 per cent) of 74 victims tested; 34 had blood alcohol concentrations ≥0.10g/dl. We suggest increasing public awareness of the hazards of motor vehicle exhaust and enforcing vehicle inspection regulations.


Introduction

Carbon monoxide (CO) from motor vehicle exhaust is the leading cause of fatal poisoning in the United States. In 1980, it accounted for 611 (14 per cent) of the nation’s 4,331 unintended poisoning fatalities, 2.7 deaths per 1,000,000 population. High rates are more common in urban areas, in rural regions, and in areas with low per capita income.

In West Virginia, which ranks second among the 50 states in rural inhabitants (63.8 per cent) and 41st in per capita income ($6,141), motor vehicle exhaust caused 76 (33 per cent) of the 231 unintended fatal poisonings among state residents in the years 1978-82, almost three times the expected number based on the national rate in 1980 (95 per cent CI for observed/expected ratio, 2.3, 3.6).

We reviewed all unintentional deaths from CO related to motor vehicles for the years 1978-84 using data based principally from the Office of the Chief Medical Examiner (OCME).

Methods

The OCME in West Virginia has jurisdiction over all homicide, suicide, accidental, and unattended natural deaths that occur in the state and maintains a centralized file of all case records. When indicated, toxicologic analyses for blood alcohol concentration (BAC) and per cent CO saturation are performed by standard methods.

We reviewed the OCME files for the seven-year period, 1978 through 1984, to identify all unintended deaths attributed to CO from motor vehicle exhaust. Data recorded included each victim’s age, sex, BAC, and per cent CO saturation, along with the date, location, and other circumstances associated with the episode. Specific vehicle defects that might have contributed to the fatal episode were record-

ed from information either found in the OCME record or acquired through special request from local law enforcement agencies. The vehicles’ last previous dates of inspection were not available.

A review of vital statistics for in-state deaths during 1978 (ICD-8 code E873) and 1979 through 1984 (ICD-9 code E868.2) was conducted to identify additional deaths from motor vehicle exhaust, certified as unintentional, but which had not been reported to the medical examiner. These were included only in the tabulations of age, sex, and month of occurrence since blood analyses were not performed and other details were not available.

Results

For the years 1978-84, we identified 68 separate episodes of fatal unintentional exposure to CO from motor vehicles in West Virginia, resulting in 87 deaths. Four episodes (five deaths) had not been reported to the OCME. Sixty-eight (78 per cent) decedents were male. Only one victim was a child, and rates were highest among persons 15-34 years of age, who accounted for 64 per cent of the deaths (Table 1). Episodic and deaths were most common during winter and fall and least common in late spring and summer (Figure 1). With the exception of one pick-up truck and one motorized van, all vehicles were passenger cars.

TABLE 1—Deaths Due to Unintentional Carbon Monoxide Poisoning from Automotive Exhaust, by Victim’s Age, West Virginia, 1978-84

<table>
<thead>
<tr>
<th>Age of Victim (years)</th>
<th>No. Deaths (%)</th>
<th>Rate*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td>1 (1)</td>
<td>0.3</td>
</tr>
<tr>
<td>15-24</td>
<td>34 (39)</td>
<td>14.0</td>
</tr>
<tr>
<td>25-34</td>
<td>22 (25)</td>
<td>10.3</td>
</tr>
<tr>
<td>35-44</td>
<td>8 (9)</td>
<td>5.5</td>
</tr>
<tr>
<td>45-54</td>
<td>8 (9)</td>
<td>5.8</td>
</tr>
<tr>
<td>55-64</td>
<td>8 (9)</td>
<td>5.8</td>
</tr>
<tr>
<td>65+</td>
<td>6 (7)</td>
<td>3.6</td>
</tr>
<tr>
<td>All</td>
<td>87 (100)</td>
<td>6.4</td>
</tr>
</tbody>
</table>

*Deaths per 1,000,000 population per year; computations based on United States Bureau of Census enumeration for 1980.

FIGURE 1—Fatal Unintentional Carbon Monoxide Poisoning from Automotive Exhaust, Episodes and Deaths, by Month of Occurrence, West Virginia, 1978-1984

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Of the 64 episodes investigated by the OCME, 50 occurred outdoors and 14 occurred in home garages. Forty-one (76 per cent) of 54 episodes for which the information was available were estimated to have occurred between midnight and 6 am. Although not recorded routinely, car heaters were frequently reported to have been on in episodes during cooler months (September through April). Of 11 episodes that occurred during May through August, the car air conditioner had been on in at least four, and no mention of its use was recorded in the other seven.

All except four vehicles were stationary when the victims were overcome (Table 2). By available history, 42 of the 51 decedents in “other stationary” vehicles had been drinking alcohol at the time of death or were sleeping or resting in their cars after drinking earlier. Their cars were found parked in remote roadside areas (19 deaths), in empty parking lots (six deaths), outside their residences (nine deaths), or in their garages (eight deaths).

The median age of the 50 vehicles involved in outdoor episodes was 10 years (range five to 18), substantially greater than the six year median for all passenger vehicles registered in West Virginia as of July 1982. Information from postmortem inspections, available for 41 of these vehicles, revealed that 40 had defective exhaust systems, with or without other body damage. Specified defects included: rust holes in the tailpipe or muffler, loose connections between the manifold and the exhaust pipe, short or missing tailpipes, and partial obstruction of tailpipes with dirt or snow. Damage noted on the car body included corrosion of the floorboards, side panels, or trunk linings.

Six of the 14 episodes in home garages occurred with the main garage door open and three others occurred with only an access door or a garage window left open. Circumstances in the remaining five garage-related episodes, ruled as accidental by the OCME, suggested that the main door had been left closed inadvertently.

Analyses performed on 74 adult decedents revealed 68 per cent with detectable BAC (Table 3), ranging up to 0.35 g/dl. These included 43 (73 per cent) of 59 men and seven (47 per cent) of 15 women. In the majority of persons positive, BACs were >0.10 g/dl. The presence of blood alcohol was more common and observed in higher concentrations among persons found in “other stationary vehicles” than among all other decedents combined.

### Discussion

Unintentional deaths from CO in motor vehicle exhaust occur year-round in West Virginia, generally in the late evening or early morning hours when people are likely to seek rest, companionship, privacy, or shelter in their automobiles. Consistent with previous reports,9,10 most of the deaths occurred in older model vehicles that were outdoors and stationary and had badly worn, altered, rusted, or partially obstructed exhaust systems.

A majority of the garage-related episodes occurred despite open garage doors or windows, underscoring the failure of passive ventilation to be a reliable means of removing CO from semi-enclosed spaces. Since the affinity of hemoglobin for CO is approximately 220 times greater than that for oxygen,11 even low concentrations of CO can be hazardous during prolonged exposure.

Prevention of CO deaths in motor vehicles depends, in part, on increasing public awareness of the hazards of motor vehicle occupancy while the engine is idling, particularly in older model vehicles or when the vehicle is snowbound or in semi-enclosed spaces. Drinking behavior was a predisposing factor. Since much alcohol use among victims of fatal injury is associated with problem drinking,12 however, more ratio-
nal behavior may not be a reasonable expectation. Measures to reduce the hazard should be more effective than those requiring modification of behaviors or attitudes that are difficult to change or that require frequent implementation.13

All motor vehicles in West Virginia are required by statute to undergo an annual inspection that includes "a complete and thorough check of the exhaust system, including manifolds, gaskets, muffler, exhaust lines, brackets, and clamps." The law lists specific standards and provides for rejection if they are not met. Unfortunately, the law does not encourage compliance by requiring evidence of inspection as a condition for annual registration, and is enforced only by rare roadway spot checks for valid stickers. Furthermore, there is currently no control over the quality of the inspections. Because we were unable to obtain the interval since last inspection, we cannot specify the number of episodes that might be averted by better compliance. Including such information as part of the routine investigation of unintended deaths from CO in motor vehicles would be important to understand the value of more effective enforcement.

REFERENCES

The Inaccessibility of Seat Belts in Taxicabs
RONALD M. DAVIS, MD, MA

Abstract: The accessibility of seat belts was determined in a total sample of 200 taxicabs waiting to pick up passengers at eight city airports. A rear seat belt was "accessible" (able to be fastened within 10 seconds) in 111 (55.5 per cent) taxicabs. The proportion varied by city from 16.0 per cent (New York City) to 96.0 per cent (Minneapolis-St. Paul) and was higher for taxicabs in cities covered by mandatory state seat belt legislation. (Am J Public Health 1989; 79:330–331.)

Introduction

In 1985, there were 1.91 billion passengers in 144,235 taxicabs in the United States.1 The safety of transportation in taxicabs could be compromised for several reasons. Taxicabs are driven an average of 52,000 miles per year,1 a distance that might increase the risk of mechanical failure. Because of long hours on the road, taxicab drivers may be prone to fatigue, and economic incentives may encourage taxicab drivers to drive at excessive speeds. Seat belts, if present, may not function properly, or may be less accessible to passengers by falling underneath or behind the seat cushions.

There is anecdotal evidence that seat belts are inaccessible in many taxicabs.2–4 This article describes an investigation of the accessibility of seat belts in taxicabs in eight cities.

Methods

From May 1986 through September 1986, I assessed the accessibility of seat belts in taxicabs at a major airport in eight cities: Washington, DC (National Airport); Oklahoma City (Will Rogers World Airport); Atlanta (Hartsfield Airport); Chicago (O'Hare Airport); New York City (LaGuardia Airport); Minneapolis-St. Paul (Minneapolis-St. Paul International Airport); Ft. Lauderdale, Florida (Hollywood International Airport); and Las Vegas (McCarren International Airport). At each airport, taxicabs were randomly selected from among those waiting to pick up customers, until information had been collected for 25 taxicabs. Limousines were excluded.

I positioned myself in the rear seat of each taxicab on the far right-hand side, the most likely position to be occupied by a passenger. A seat belt was defined to be accessible if it could be fastened within 10 seconds. This was assumed to be the maximum length of time that a typical passenger would spend attempting to locate and fasten the seat belt. Seat cushions were not moved to facilitate the extraction of seat belts, but I attempted to grasp seat belts by probing between the seat cushions.

Information was collected from the drivers of the taxicabs on the year that the car was manufactured, the taxicab company, and the availability of an infant car seat for use by passengers. The existence of legislation mandating the use of seat belts among adults was also ascertained.

Miettinen test-based confidence limits were calculated for rate ratios.

Results

Information was obtained for 25 taxicabs in each of the eight cities. Seven taxicab drivers refused to participate in the study (three in Atlanta and one each in four other cities).