

Residential Carbon Monoxide Alarm Use: Opportunities for Poisoning Prevention

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Abstract Prevalence of carbon monoxide (CO) alarm usage in localities where they are not required is poorly defined and the reasons for failing to have a home CO alarm have never been described. In this study, the authors conducted a computer-based survey among employees of similar major medical centers in Seattle, Washington, and Salt Lake City, Utah. Questions were asked about the prevalence of use of residential smoke and CO alarms with regard to home style and structure, ownership status, and energy use. Respondents not using home CO detectors were asked the reasons. Among 1,351 individuals participating in the survey, 98% reported residential use of smoke alarms, while only 51% used CO alarms. CO alarm use was more common among residents of Utah than Washington, among home owners than renters, and among those with single family homes rather than other styles. Reasons for failure to use CO alarms related largely to lack of knowledge about the devices and motivation.

Introduction

Carbon monoxide (CO) poisoning is responsible for an estimated 500 unintentional non-fire-related deaths in the U.S. annually (Centers for Disease Control and Prevention [CDC], 2005), along with 15,000–50,000 emergency department visits for nonfatal CO poisoning (CDC, 2005; Hampson & Weaver, 2007). While residential use of smoke alarms is mandated by virtually all states and localities according to the recommendations set forth by Article 72 of the National Fire Alarm Code (National Fire Protection Agency, 2002), these devices do not detect CO or alert occupants to its presence. Only a small minority of states or localities currently require residential use of CO alarms.

The study described in this article sought to determine the relative prevalence of use of home smoke and CO alarms among a defined population in two states where

CO alarms are not required by law in all residences. In Washington State, there is no current requirement for home CO alarms. In Utah, they are required only in new homes built since 2007 that have fuel-burning appliances (State of Utah, 2009). In addition, for the first time, the reasons for failure to use CO alarms are described in our study.

Methods

Virginia Mason Medical Center (VMMC) in Seattle is a private, nonprofit, multi-specialty integrated medical center with 4,900 employees at the time of our study. Following approval by VMMC administration and the Institutional Review Board, a 13-question survey for employees regarding their home use of smoke and CO alarms was developed and administered. Questions in the survey inquired about

use of residential smoke and CO alarms, reasons for failure to use them, nature of home with regard to style, number of floors, owner vs. renter status, energy sources, and home ZIP code.

Voluntary employee participation was solicited by a notice posted for 10 days on the institution's intranet home page. Those wishing to complete the brief survey were directed to a site where the survey questions were administered through a commercial online survey company (www.surveymonkey.com). Answers were collected in a confidential manner and access to the resultant data was password protected. A total of 574 individuals (11.7% of VMMC employees) participated in the survey at the Seattle site, where it was administered initially.

Intermountain Medical Center in Utah is a community-owned system of nonprofit hospitals and clinics with 25,000 employees. In an attempt to collect responses from a similar number of individuals as at VMMC, 1,600 randomly selected employees were sent an e-mail invitation to complete the brief online survey. A reminder e-mail was sent to nonresponders two weeks following the initial e-mail. The survey remained open for one month. Of those solicited, 777 employees (48%) completed the survey. This accounted for approximately 3.8% of the entire health system employee population.

To determine whether the samples obtained were representative of the overall VMMC and IMC employee populations and therefore capturing a broad socioeconomic background, the distribution of home ZIP codes of respondents were compared with those of all employees.

Responses were collated by institution to determine whether there were any significant

TABLE 1

Details of Homes Occupied by Survey Respondents

Survey Questions	Utah (n = 777)	Washington (n = 574)	Total (N = 1,351)
Home Type			
Single family house	614 (79.7%)	384 (71.5%)	998 (76.3%)
Apartment/apartment-type	76 (9.9%)	91 (16.9%)	167 (12.8%)
Duplex/townhouse	72 (9.4%)	51 (9.5%)	123 (9.4%)
Modular/manufactured	8 (1.0%)	11 (2.0%)	19 (1.5%)
Ownership			
Rent	129 (16.8%)	108 (20.1%)	137 (11.4%)
Own	641 (83.2%)	429 (79.9%)	1,070 (88.6%)
Number of floors in home			
1	143 (18.6%)	163 (30.4%)	306 (23.4%)
2	430 (55.8%)	255 (47.5%)	685 (52.5%)
3	156 (20.3%)	99 (18.5%)	255 (19.5%)
4+	41 (5.3%)	19 (3.5%)	60 (4.6%)
Fuel-burning appliances			
Yes	637 (83.1%)	355 (66.5%)	992 (76.2%)

TABLE 2

Number of Smoke and Carbon Monoxide Detectors in the Homes of Survey Respondents

Survey Questions	Utah (n = 777)	Washington (n = 574)	Total (N = 1,351)
Smoke detector in home			
Yes	756 (97.3%)	562 (97.9%)	1318 (97.6%)
Number of smoke detectors			
1	96 (12.8%)	103 (18.9%)	199 (15.3%)
2	172 (22.9%)	143 (26.2%)	315 (24.3%)
3	107 (14.2%)	109 (19.9%)	216 (16.6%)
4+	377 (50.1%)	191 (35.0%)	568 (43.8%)
CO detector in home			
Yes	456 (59.1%)	222 (40.6%)	678 (51.4%)
Number of CO detectors			
1	266 (58.2%)	142 (65.1%)	408 (60.4%)
2	126 (27.6%)	56 (25.7%)	182 (30.0%)
3	28 (6.1%)	13 (6.0%)	41 (6.1%)
4+	37 (8.1%)	7 (3.2%)	44 (6.5%)

differences between the two populations, and then combined for aggregate reporting. Data analysis included descriptive statistics, two-sided Fisher's Exact Test, and two-tailed paired *t*-test.

Results

A total of 1,351 individuals participated in the survey, 574 from VMMC and 777 from IMC. Results are listed in tabular form in Table 1, Table 2, and Table 3.

Home types included 998 (76.4%) single family, 167 (12.6%) apartment-type, 123 (9.8%) duplex/townhouse, and 19 (1.5%) modular/manufactured. Homes were owned by 1,070 (81.9%) and rented by 237 (18.1%). The number of floors was reported as one by 206 (17.1%), two by 685 (56.8%), three by 255 (21.1%), and four or more by 60 (5.0%). At least one home appliance was reported to burn gas, oil, or propane fuel by 992 (76.2%), while 309 (23.8%) indicated that all home appliances were electric. A significantly higher percentage of homes in Utah used fuel for a home appliance (83.2%) compared to Washington (66.5%) ($p < .0001$).

With regard to smoke alarms, 1,318 (97.6%) indicated that they have at least one in their home. Total numbers of smoke alarms in the dwelling were reported as one by 199 (15.3%), two by 315 (24.3%), three by 216 (16.6%), and four or more by 568 (43.8%).

Only 678 respondents (51.4%) reported having a CO alarm in their home. A significantly higher percentage of Utah respondents reported having a CO alarm (59.1%) compared to those in Washington (40.6%) ($p < .0001$). As can be seen in Figure 1, this difference roughly correlated with the higher percentage of homes with fuel burning appliances in Utah.

Total numbers of CO alarms per home were reported as one by 408 (60.2%), two by 178 (26.3%), three by 41 (6.0%), and four or more by 44 (6.5%). CO alarms were more common in owner-occupied homes than rentals (58% vs. 24%; $p < .0001$) and among single family homes than other styles (58% vs. 29%; $p < .0001$).

Reasons given for not having a CO alarm are listed in Table 3. Of the 84 individuals who indicated no risk for CO exposure in their homes, 28 (33.8%) also reported having at least one fuel-burning appliance.

ZIP codes of survey respondents in both states were broadly distributed among the ZIP codes of the employee population at large in each institution, suggesting that the study groups were representative cross sections of all employees.

Discussion

The near-uniform presence (97%) of smoke alarms in the homes of survey respondents is not surprising, but rather reassuring since both Utah and Washington State codes require that every dwelling unit has at least one. Each building is required to meet the building code standard in the year that it was constructed. Current laws in the two states require one smoke alarm in each sleeping room and in the hallway on each floor. Assuming that every dwelling has at least one bedroom, this means that every home should have one more smoke alarm than number of floors, at a minimum. This contemporary standard was met by only 63% in this survey, but it is not known when each home referred to by respondents was constructed and they may therefore meet the standard in effect at the time of construction.

In contrast, only about one-half of total survey respondents (51%) have CO alarms in their homes. This number is slightly higher than that seen in the limited information available from previous studies. In a 2002 random telephone survey on issues of home safety, 29% reported having a CO alarm in the home (Runyan et al., 2005). They were more common among higher income individuals and those living in owner-occupied homes. An unpublished 2004 survey of Maine residents found that 37% had CO alarms, and high income married couples living with children were more likely to have them (State of Maine, 2007).

Several reasons explain why the current survey respondents have a higher rate of CO alarm use than prior studies might suggest for the general population. Contributing factors may include (1) the devices have become more well known since prior studies were conducted four to six years ago; (2) both surveyed populations were all people who worked in the health care industry and therefore likely have a higher awareness of the dangers of CO; and (3) since all were employed, they likely had

TABLE 3

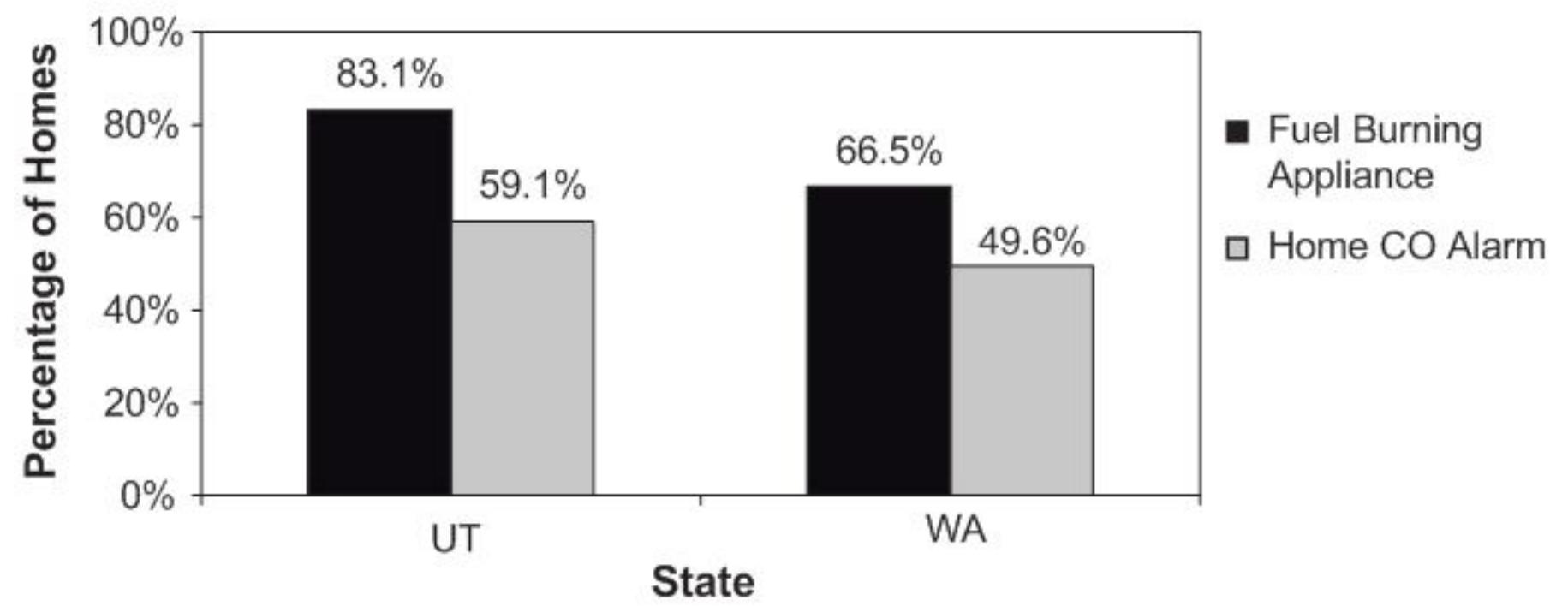
Reasons Given for Not Having a Home CO Alarm*

Reasons Given	n (%)
I have not gotten around to it.	313 (48.9%)
My landlord does not provide one.	120 (18.8%)
I am not at risk for CO exposure in my home.	85 (13.3%)
I do not know where to buy one.	49 (7.7%)
They are too expensive.	48 (7.5%)
I did not know they existed.	41 (6.4%)
They are not required by local code.	36 (5.6%)
I have a smoke detector and do not need one for carbon monoxide, too.	26 (4.1%)
Other	111 (17.3%)

* By the 640 respondents who indicated that they did not have one in their dwelling. Total is greater than 640 because some respondents provided more than one reason.

FIGURE 1

Percentage of Homes Reported to Have at Least One Fuel-Burning Appliance and CO Alarm



higher than average income levels and a higher percentage of owner-occupied homes. Despite these influences, alarm use rates of only one-half make the current findings even more compelling.

As noted, use of CO alarms was more common in Utah (59%) than Washington (41%). Several explanations are possible. CO alarms were seen to be more common in owner-occupied and single family homes, but these characteristics were similar between the two populations surveyed (Table 1). They were

also more common, however, in homes with fuel-burning appliances and there were significantly more of these in Utah than Washington State. In fact, the difference in use of CO alarms (18%) was almost exactly equal to the difference in prevalence of fuel-burning appliances (17%) (Figure 1). Since subjects were not asked the age of their residence, the additional effect of legislation in Utah requiring CO alarms in new construction containing fuel-burning appliances since 2007 cannot be assessed.

While it is somewhat encouraging that the rate of usage of CO alarms has risen since prior reports, even a 51% usage rate of home CO alarms is disappointing. CO alarms have been demonstrated to have the potential to reduce nonfatal and fatal CO poisonings (Yoon, Macdonald, & Parrish, 1998; CDC, 2004). Legislation is the obvious solution, as evidenced by the overwhelming compliance with utilization of smoke alarms by respondents in this survey. As of June 2008, only nine states had comprehensive laws regarding CO alarms that cover both existing residential buildings and new construction (First Alert USA, 2009). An additional 10 states had either legislation pending or have enacted limited laws covering such things as new construction, residential buildings with specific types of fuel-burning appliances, or child care facilities.

In the absence of legislation, the reasons given in this survey for not having a home CO alarm provide significant opportunities for public health intervention. It is clear that a public education campaign could convey significant benefit, as 18% of respondents were unaware that CO alarms exist, did not know where to buy one, or believed they are not necessary if a smoke alarm is present in the home. An additional 19% do not

have one because their landlord does not provide it. Many CO alarms are portable, can be plugged into a wall power outlet by renters, and taken when the renters move. Another 13% of respondents did not believe themselves to be at risk for CO poisoning, despite the fact that one-third of that group have appliances in their homes that burn carbon-based fuel. Even those with all-electric appliances are at some risk, as CO poisonings can occur from motor vehicles left running in attached garages, electrical generators operated too close to windows or air conditioner intakes, and other such causes, as repeatedly described in the lay media and medical literature.

The fact that 49% of respondents report that they simply “have not gotten around to it” suggests that they may be aware of the risk presented by CO and potential for prevention by CO alarms. A campaign by local governments, employers, or retail outlets to bring the devices to the public could have significant impact on use.

A potential limitation of this study is the population surveyed. The survey did not include those with no income because all respondents were employed. Based upon prior studies (Runyan et al., 2005; State of Maine, 2007), however, this likely served only to overestimate the use of CO alarms in the

community at large. It is felt that the results do represent individuals across a broad spectrum of income levels since the ZIP codes of respondents were similar to those of the entire institutional employee population, which includes positions ranging from housekeepers to physicians.

In conclusion, this study demonstrates an extremely high rate of use of home smoke alarms among two populations living in regions where they are mandated by law. At the same time, only one-half have CO alarms, which are not uniformly required by law. The reasons for failure to have a CO alarm suggest that public education campaigns have the potential to increase the use of alarms by a significant degree, at least until legislation mandating their use is enacted. ■■■

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