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Storm-Related Carbon Monoxide Poisoning: An Investigation of Target Audience Knowledge and Risk Behaviors

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Abstract

Carbon monoxide (CO) poisonings in the United States consistently occur when residents improperly use portable gasoline-powered generators and other tools following severe storms and power outages. However, protective behaviors—such as installing CO alarms and placing generators more than 20 feet away from indoor structures—can prevent these poisonings. This study identified knowledge, attitudes, and beliefs that lead consumers to adopt risk and protective behaviors for storm-related CO poisoning and post-storm generator use. Four focus groups (32 participants in total) were conducted with generator owners in winter and summer storm-prone areas to explore home safety, portable generator use, CO poisoning knowledge, and generator safety messages. Discussions were transcribed, and findings analyzed using an ordered meta-matrix approach. Although most generator owners were aware of CO poisoning, many were unsure what constitutes a safe location for generator operation and incorrectly stated that enclosed areas outside the home—such as attached garages, sheds, and covered porches—were safe. Convenience and access to appliances often dictated generator placement. Participants were receptive to installing CO alarms in their homes but were unsure where to place them. These findings suggest a deficit in understanding how to operate portable generators safely and a need to correct misconceptions around safe placement. In terms of behavioral price, the simple installation and maintenance of inexpensive CO alarms may be the most important strategy for ultimately protecting homes from both storm-related and other CO exposures.

Keywords

poisoning; injury; carbon monoxide; formative research

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Authors' Note
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Introduction

Unintentional nonfire-related carbon monoxide (CO) poisoning is a leading cause of poisoning death and injury in the United States, with more than 400 deaths and as many as 20,000 nonfatal events each year (Centers for Disease Control and Prevention [CDC], 2007, 2008; Iqbal, Clower, King, Bell, & Yip, 2012). In the power outage, post-storm scenario gasoline- and diesel-powered generators cause the largest number of unintentional nonfire-related CO deaths, and these poisonings typically occur in the wake of severe summer and winter storms, such as hurricanes, tornados, floods, and ice storms (CDC, 2006, 2009; Hnatov, 2011; Lutterloh et al., 2011). In fact, CO poisoning is a primary cause of both morbidity and mortality following severe weather events (CDC, 2005, 2006; Daley, Shireley, & Gilmore, 2001; van Sickle et al., 2007).

In most cases, severe storms cause prolonged loss of electrical power, and homeowners who lose power for several days typically seek alternate sources of energy, often utilizing portable gasoline-powered generators for heating or cooling their homes, cooking, refrigeration, and other necessities (CDC, 2008). Even when operating properly, portable generators emit CO. When generators are placed in enclosed or poorly ventilated areas—such as attached garages or covered porches—CO can accumulate and poison residents (CDC, 2005, 2006; Van Sickle et al., 2007).

Better understanding of storm-related CO poisoning has led to increases in consumer safety information, such as warnings on portable generators. However, few studies have explored the knowledge, attitudes, and beliefs that lead consumers to adopt risk and protective behaviors related to these products. Nor have studies addressed how best to communicate CO safety information to consumers to prevent deaths and injuries.

To address this gap, the authors conducted audience research on consumers' knowledge of CO poisoning and what attitudes and beliefs drive consumers to adopt risk and protective behaviors for storm-related CO poisoning. This research informed the development of communication materials targeting portable generator owners as well as identified effective outlets for providing CO safety information to portable generator owners.

Method

The study team conducted four focus groups in 2009 with portable generator owners in both winter and summer storm-prone regions. The groups investigated a range of topics around home safety, portable generator use, CO poisoning, and preferred communication channels. Two focus groups were conducted in Wilmington, NC, an area prone to summer storms and hurricanes; the other two groups were conducted in Asheville, NC, an area prone to severe ice and snow storms that cause power outages.

Focus groups are an established qualitative data collection method for exploring the relevance, comprehensibility, credibility, and effectiveness of messages (Morgan, 1998). According to Patton (1980), "qualitative data consist of detailed descriptions of situations, events, people, interactions, and observed behaviors" that can inform the design of education and communication messages and approaches. By design, such data do not fit predetermined, standardized categories. Instead, they provide greater depth and detail that is inherently needed for the design of materials and communication campaigns.

Recruitment and Eligibility

Study participants had to be aged 18 and older, own a portable gasoline-powered generator, and have used it during a storm-related power outage, such as one caused by a hurricane, tornado, or winter storm. Participants also had to be the primary person responsible for operating the generator during an outage. Individuals employed in the public health, research, media, and generator manufacturing industries were ineligible.

Participants were recruited either by a professional focus group recruiting firm, which used a preexisting database of individuals who expressed interest in research studies, or from the community by placing ads on Craigslist and in local newspapers. Potential participants were contacted by telephone and screened for eligibility. If eligible, the individuals were enrolled in one of the groups and reminded of the group 48 hours in advance.

Data Collection

In July to August 2009, the research team conducted the 2-hr focus groups at a market research facility in Wilmington, NC, and a health education center in Asheville, NC. Upon arrival, participants were administered a written informed consent and asked to complete a questionnaire on demographics, product usage, and recent purchases. A trained moderator conducted each group using a semistructured guide that explored the topics of severe weather preparations, generator placement and usage, knowledge of CO and CO poisoning, CO alarm usage, and preferred sources of safety information. All of the focus group discussions were recorded and transcribed, and participants received a US $75 incentive at the end of the sessions. The study design was reviewed and approved to ensure human subjects' protection by Institutional Review Boards at RTI and CDC, the study contractor and the sponsor, respectively.

Data Analysis

Following each focus group, the study team debriefed to identify salient findings and note possible patterns and themes expressed in the discussion. After finishing data collection, the data were entered into an ordered meta-matrix that segmented responses by group and question. This approach organized the large volume of data for cross-case analysis, a common technique in qualitative research (Denzin, 2002; Miles & Huberman 1994; National Science Foundation, 1997). Three researchers independently reviewed the meta-matrix to identify patterns and themes within each topic, and the lead author refereed the few discrepancies in interpretation.

The quantitative data from the demographic and product questionnaire were entered into a spreadsheet that was used to describe the participants' characteristics (e.g., education) and behaviors (e.g., home safety purchases, smoke alarm installation). Given the study design, no statistical tests were conducted on the quantitative responses.

Findings

A total of 32 individuals participated in the four focus groups (Table 1). Participants were generally diverse in education, income, and sex. However, males were more likely to operate generators and, consequently, more likely to be eligible to participate in the focus groups. The main results focus on the following nine areas.

Storm Preparations

Participants from both the summer and winter storm groups described making several preparations in advance of storms. Many participants purchased supplies, such as groceries, pet food, water, gasoline, and batteries, from local stores and often filled vehicles with fuel in case of service station closures. Several participants also preemptively used appliances that cease working during power outages, such as filling tubs with water if on a well and cooking stovetop meals in advance. Participants reported storing lawn furniture and other items that might blow away and preparing plywood for boarding up windows before summer storms. A few participants took steps to ensure that electronic equipment, such as televisions and stereos, were raised off the ground in case of flooding. Additionally, some participants tried to prevent power outages by trimming tree limbs that hang over power lines.

Many participants reported testing their generator in advance of an anticipated power outage to ensure the device worked properly and make sure the fuel is “fresh.” Some participants also stated that they run their generator two to four times each year outside of storm season to ensure that it runs properly.

Reasons for Using a Generator and Key Items Powered

Participants were asked when they typically decide to activate their generator and what factors drive that decision. Most participants reported that, while they test the generator in advance, they wait until losing power to start their generator for continued operation. However, a few reported proactively turning on their generator in anticipation of an outage. For those who wait until power is lost, several factors influence when they start the generator. Although some participants start generators immediately after power loss, others reported contacting the power company to learn the extent of storm damage and to estimate when power would be restored. Other participants said they wait until they believe power is genuinely necessary, such as at nightfall.

Not surprisingly, winter storm residents stated that powering heating devices is a primary motivation for starting the generator, particularly for individuals whose homes are heated electrically. Among summer storm participants, preserving food in freezers and refrigerators and cooling homes with air-conditioning units and fans were important reasons for operating a generator. Both segments mentioned powering televisions and radios to provide news updates and entertainment for children, and many use generators to power microwaves, hot water heaters, and computers. When using a generator, participants reported cycling through appliances, such as powering stoves and refrigerators during the day and then powering heaters and televisions at night.

Generator Placement

Almost all participants have a standard, predetermined location for their generators. However, these locations varied considerably, including attached garages or carports, screened porches, covered patios, basements, standalone utility buildings/sheds, detached garages, and outside in yards. Generators placed outside were located anywhere from 2 to 50 feet from the house. Two participants also mentioned building a small covered concrete pad in their yard to house their generators in a storm.

Among summer storm participants, access to appliances and power boxes was cited as the primary determinant of generator placement. The winter storm participants more often reported the generator's noise and exhaust as determinants of generator placement. Other factors determining location included length of power cords and accessibility to the unit for refueling and switching cords used to power different appliances. Because outages can last for days, participants stated that they need to access the generator regularly to switch power cords and add fuel. A few participants mentioned theft as a concern, but most did not consider this a serious threat, in contrast to some previous findings (Van Sickle et al., 2007).

Participants also mentioned ventilation as an issue in generator placement, with a few participants specifically mentioning avoiding "carbon monoxide." When asked where they would not place the generator, most participants agreed they would not operate one indoors or in the house. Notably, many individuals did not conceptualize covered structures, such as attached garages and porches, as being "in the house," and participants disagreed with one another about whether placing a generator inside an attached or detached garage was safe. A few participants stated that operating a generator in a garage is fine if the door is open and the structure is well ventilated. Others said they would never do so. In general, when asked about the safety of their usual generator placement, participants were confident that the location they had selected was safe for operation, reasoning that they had used that location previously without noticing any adverse health effects.

Participants were also asked to describe their generator setup. Most participants reported they use extension cords ("drop cords") and run them to individual appliances, such as freezers or window air-conditioning units. However, some participants connect the generator to the central power box, which then runs power to their entire house. They then switch off the power breakers for the rooms or appliances they do not wish to operate. A few participants mentioned having a dedicated input outlet for their generator in their circuit breaker box, along with a shutoff switch for the outside power.

Perceived Risks of Generators

Electrical safety and possible electrocution were participants' most common concerns when using generators. Almost all participants cited this danger, and many participants explained that although they take precautions, the risk of electric shock is extremely serious. In addition to personal safety, participants were concerned about overloading the generator and accidentally shocking power line workers by sending electricity back into the power grid.

Ventilation, fumes, and CO poisoning were the second most common concerns among participants. Almost all participants talked about the need to properly ventilate generators.

Several participants cited keeping the generator away from the house and keeping it "well ventilated" as an important precaution. However, participants were unable to define what it meant for a generator to be well ventilated and, after some discussion, suggested that a generator is properly ventilated if the exhaust is pointed away from the house. Others said opening a garage door or having a semi-open space, such as a covered patio, is sufficient.

When asked what they do to avoid or minimize these risks, participants outlined a handful of precautions. Several participants said they check their generator and power cords regularly to ensure they are working properly. Others cited general safety precautions, such as following instructions, ensuring the generator and power cords are dry, and using "common sense." Very few participants mentioned using a CO alarm as a precaution.

Carbon Monoxide Knowledge

Most participants were familiar with CO and had heard about CO poisoning. Specifically, participants were familiar with its characteristics (e.g., colorless, tasteless, odorless), knew it often affects sleeping individuals, and recalled that victims were unlikely to know they were being poisoned. None of the participants acknowledged that their generator placement might have exposed them to some level of CO in the past.

Participants also recalled most symptoms of CO poisoning (e.g., headache, drowsiness, dizziness) and knew that it could be fatal. However, a few participants incorrectly thought they would smell CO and conflated CO emissions and natural gas leaks. When asked, participants identified several sources of CO, including cars, gas furnaces/appliances, portable stoves/appliances, portable heaters, grills, generators, gas log fireplaces, and hot water heaters.

Almost all participants were aware of the connection between CO and generators, although a few admitted that they had not made the connection previously or "didn't give it much thought." Most participants said they were not highly concerned about CO poisoning. Further discussion revealed that, although participants thought CO poisoning was serious, most believed they are adequately ventilating their generators and consequently are at low risk of CO poisoning. Other participants stated they live in an "all electric home" (e.g., no gas furnaces or appliances), which eliminates their risk for CO poisoning.

Carbon Monoxide Alarms

Almost all participants were aware of CO alarms and their purpose, although only half of participants had CO alarms installed in their homes. A few participants have CO alarms as part of a home security system (e.g., ADT). However, many home security systems may not be fully functional in the event of a power outage (CDC, 2006), a point that participants did not acknowledge. Several again mentioned living in all electric homes, which they believed eliminated the need for a CO alarm.

Participants correctly stated they could purchase CO alarms from hardware stores (e.g., Home Depot, Lowes, and Ace Hardware) and other retailers. Several participants said they would likely purchase alarms at Wal-Mart, eBay.com, or Amazon.com as well.

All participants said they understood the difference between CO alarms and smoke alarms, and most understood that CO alarms should be installed in different locations. However, participants were generally unclear on where CO alarms should be installed and why their placement should be different than the placement of smoke alarms. Regarding installation, most participants believed that CO alarms would be easy to install, and several participants had installed the alarms themselves.

For participants who have CO alarms, the devices are located in various places around their homes. One common misconception repeated in the groups was that CO alarms should be placed in kitchens or near gas appliances. Several participants thought that CO alarms should be located in the ceiling (near smoke alarms); others thought they should be near the floor.

Most participants recognized that they should change their smoke alarm and CO alarm batteries twice a year. Several cited the recommendation to change batteries when changing the clocks for daylight saving time. Nevertheless, many participants do not follow this recommendation. Residents most commonly stated that they change the batteries when the alarms are low on power and chirp.

Participants were asked how they would respond if they discovered CO in their home. All participants said they would evacuate the house, and almost all said they would call 911 as well. Several participants would also turn off the main natural gas valve, and others would try to ventilate the home by opening windows and doors before evacuating.

Preventing CO Poisoning

Most participants viewed CO alarms as the best way—and, in some cases, the only way—to protect themselves and their family from CO poisoning. Some participants also suggested primary prevention strategies, such as not idling cars in the garage, visually inspecting gas appliances, and scheduling an annual furnace inspection.

Asked about CO safety when using a generator, participants echoed their comments about improving ventilation. Several participants said they would improve generator ventilation by opening garage doors or closing windows near an outdoor generator to prevent CO from entering the home. Others indicated that they would place the generator in a safe location, such as outside in the yard or away from the air-conditioning units.

Sources of CO Information

Participants had previously encountered several sources of CO safety information. Most participants remembered news stories about fatal and near-fatal poisonings on local television news broadcasts, on television magazine programs (e.g., Dateline, 20/20), and on the Discovery Channel. Most of these stories covered poisonings that occurred after hurricanes and storms, but some highlighted nonemergency poisonings or intentional exposures. Other participants recalled that local television and radio news stations broadcast generator safety tips before major storms. In addition, a few participants remembered receiving information from hurricane preparedness booths at local shopping malls.

Participants had mixed feelings about the value of this information. Most participants saw the information—especially news coverage of poisonings—as a general reminder of CO safety rather than a truly instructional resource. Because most of the information is after-the-fact news, the sources rarely provided safety tips or discussed CO poisoning in depth. Similarly, several participants said that news stories rarely mentioned sources of CO, even when covering fatal poisonings.

Promoting CO Alarms

Participants offered several ideas for encouraging CO alarm installation. Most participants cited advertising, especially television advertising, as an effective strategy for promoting CO alarms. A few participants suggested that retailers—such as Lowes, Home Depot, and Sam's Club—sell generators and CO alarms in combination. One participant also suggested having social workers check homes for CO alarms. She explained that social workers often visit homes for other reasons (e.g., check on families receiving social assistance) and already check for smoke alarms and other safety features. Finally, one participant suggested promoting CO alarms to the "captive audience" at hurricane shelters in the days following a major storm.

Participants also recommended a number of outlets for promoting CO alarms, such as television and radio stations, newspapers, and community Internet sites. Several participants suggested that gas and utility companies enclose a promotional notice or reminder with the monthly bill. Others thought homeowner insurance companies should offer discounts for CO alarm installation or that local code ordinances should require CO alarms in new homes. In addition, several participants recommended hosting fire department safety demonstrations at home-and-garden shows, shopping malls, and city schools.

Finally, respondents identified several reasons people may not have or want a CO alarm. Most participants thought being unaware of CO and its severity was the biggest obstacle to alarm installation. Others suggested that if people have all-electric homes, they may not need a CO alarm. Cost, or perceived cost, of CO alarms was cited as a barrier. Several participants also pointed out that individuals who rent may not consider CO alarms their responsibility, typically because a landlord or owner installed the smoke alarms in their residence.

Discussion

This study explored consumer knowledge, attitudes, and behaviors related to CO poisoning in summer and winter storm scenarios. In particular, the study explored consumers' risk and protective behaviors when operating portable gasoline-powered generators, a product commonly associated with CO exposure, and explored consumers' knowledge and familiarity with CO alarms.

Focus group participants were generally knowledgeable about CO poisoning. Nevertheless, many participants reported putting themselves and household members at risk by placing their generators in semi-enclosed areas, such as garages and attached porches. They chose these locations for several reasons: proximity to key appliances (e.g., refrigerators, freezers, air conditioners, and space heaters); a desire to minimize noise; and the belief that the location is well ventilated. However, participants had mixed and contradictory definitions of a well-ventilated area, which may explain the many unsafe placements cited by participants. This is consistent with earlier studies that found a lack of knowledge of ventilation requirements, frequent location of generators in garages, and proximity to refrigerators in particular as a determining factor for placement (Hampson & Zmaeff, 2005). A recent review (Iqbal, Clower, Hernandez, Damon, & Yip, 2012) of CO poisoning reports related to post-disaster scenarios since the 1990s similarly found the most frequent problematic behavior related to generators is placement in garages or other locations from which fumes could enter living areas. Several participants also dismissed the risk of CO poisoning by saying they lived in an all-electric home despite the fact that they admitted using gasoline-powered generators, automobiles, and gas log fireplaces. Many participants knew that they need a CO alarm but were unsure how many to purchase, where to place them, and what constitutes adequate coverage. Among participants, home improvement retailers and gas stations were common stops in prestorm preparations and could be effective outlets for disseminating safety information and selling preventive supplies, such as CO alarms and extension cords.

These findings have several implications for preventing storm-related CO poisoning (Table 2). In particular, future health communication efforts can clarify what constitutes a well-ventilated location and might target consumers who place generators in attached garages and covered patios, the most common inappropriate locations cited in the focus groups. It may also be helpful to dovetail CO safety messages with electrical safety, a more common concern for consumers.

When reaching consumers with potential messages and information, field research by CDC revealed that the key time for communicating the hazards of storm-related CO poisoning is in the days leading up to a severe weather event. In a review of disaster-related CO poisoning prevention activities, Iqbal, Clower, Hernandez, Damon, and Yip (2012) found that predisaster communication is a key component of education in preventing disaster-related CO poisoning. By contrast, during Hurricane Ike in 2008, local and state health authorities made rigorous efforts to educate residents about CO poisoning. However, these efforts largely occurred post-landfall when many communication channels were compromised and homeowners were already in the process of taking recovery actions. Although recurring education is important, such efforts may be most effective in preventing nonemergency CO poisoning associated with furnaces and other household appliances (Rupert, Poehlman, Damon, & Williams, 2013).

Most individuals receive their warnings about impending severe weather from the popular media, making it crucial that public health officials reach out at both the national and the local levels to media outlets to elicit cooperation in warning the public about CO poisoning as part of these severe weather warnings, and more generally as the severe weather season approaches (Hampson & Stock, 2006). In addition, most homeowners can logically be targeted for education at the point of purchase for portable generators (e.g., major retail outlets) with messages about CO safety, proper placement of the generator, and proper use of battery-powered or battery backup CO alarms. Finally, generator owners can be targeted at another point of purchase: the service station at which they purchase fuel for the generator.

As a result of this research, the study team developed the Carbon Monoxide Poisoning Prevention: A Toolkit—Working Together to Keep Communities Safe (CDC, 2010), which is available for no cost online at http://www.nphic.org/news/newsletters/cat_view/66-emergency-communications/101-carbon-monoxide/510-cdc-carbon-monoxide-poisoning-prevention-toolkit.

The toolkit was developed primarily to support the CO poisoning prevention efforts of public information officers working within state departments of health, emergency management and preparedness, and consumer safety officers at the federal, state, municipal, and community levels and therefore includes customizable materials for local prevention campaign planning. However, nongovernmental and other groups may also be interested in adopting the strategies and materials in the toolkit. The toolkit summarizes the most common scenarios for CO poisoning; identifies at-risk populations; and describes attitudes, beliefs, and behaviors that put individuals at risk. It also highlights the audience-tested awareness and prevention messages described in this report and offers strategies for establishing state and local partnerships for CO prevention. The toolkit especially emphasizes increasing public awareness of the risk of CO poisoning, motivating homeowners and renters to install battery-operated or battery backup CO alarms, reminding consumers how to operate portable gas-powered generators safely and reminding homeowners to maintain their furnaces and other fuel-burning appliances.

Limitations

This study has several limitations. First, because of the small sample size and limited geography, this study is exploratory and the findings may not be representative of the general U.S. population. In particular, the study was conducted in North Carolina, and residents of the state may be more aware of CO because of public health efforts in the state. Second, all the beliefs and attitudes surrounding storm-related CO poisoning may not have been discussed, and using a larger sample may have uncovered additional results. Third, the study focused on a single CO poisoning scenario, storm-related CO exposure, and did not explore CO poisoning caused by motor vehicles, home heating systems (e.g., furnaces), recreational activities (e.g., boats, private airplanes), or industrial equipment. These other CO poisoning scenarios are likely associated with different risk and protective behaviors.

As qualitative data, such findings cannot be generalized to larger populations. In the case of this study, North Carolina populations, who arguably have a heightened awareness of CO issues owing to public health efforts in North Carolina and the frequency of power outage events there, provided a useful depth of feedback on the topic, but their knowledge and attitude levels may not be representative of the entire U.S. population who will have had different levels of education and experience.

Conclusions

A clear challenge to reducing unintentional CO poisoning from portable gasoline-powered generators in the wake of severe storms is the reinforcing nature of experience. Individuals who have placed their generators in unsafe locations but have not been poisoned believe their generator is properly located. As evidenced in the focus groups, many participants clearly identified compromised or unsafe locations for generator operation yet described the placement as safe. This suggests the importance of educating generator owners with clear information, particularly at time of purchase or when first setting up the generator. Information on what constitutes safe generator placement is critical. Recent research by the National Institute of Standards and Technology emphasizes that portable generators need to be placed at least 20 feet from a home. These findings should be shared in new CO poisoning prevention efforts (Wang & Emmerich, 2009; Wang, Emmerich, & Powell, 2010).

Nonetheless, the current lack of understanding as to what constitutes a “well-ventilated” location for generator placement and individuals’ apparent satisfaction with current placement may point to a broader need to make CO alarms a more common fixture in homes. Given people’s familiarly with smoke alarms, the effort required to integrate CO alarms as part of routine home safety and storm preparedness activities may be less than that required to change views on generator placement. This may require making CO alarms easily available, jointly packaging them with portable generators and educating consumers on how to properly locate, install, and maintain CO alarms in their homes.

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Table 1

Carbon Monoxide Poisoning Focus Group Participant Characteristics.

Characteristic	Summer Storm Focus Groups (*n* = 17)	Winter Storm Focus Groups (*n* = 15)
Age (average, yrs)	51 (*SD* = 8.3)	47 (*SD* = 13.7)
Sex		
Male	11	13
Female	6	2
Education		
Less than high school	—	—
High school	20%	21%
Technical school/some college	60%	50%
College graduates	10%	22%
Post college degree	10%	7%
Annual income		
US$10,000–US$29,000	14%	—
US$30,000–US$49,000	36%	30%
US$50,000–US$69,000	29%	20%
US$70,000–US$89,000	7%	20%
US$90,000–US$119,000	7%	10%
>US$120,000	7%	20%

Note. *SD* = standard deviation.

Table 2

Summary of Recommendations for Improving Portable Generator Safety in the Wake of Severe Weather.

Topic	Recommendation
Generator use	• Make safe generator placement (i.e., at least 20 feet from house) more convenient. Cord length, access to appliances/power box, and ease of attending to the generator were consistently cited as key factors in generator placement • Target individuals who place generators in attached garages and covered patios, which seem to be the most common “dangerous locations” for generators. Emphasize that (a) any structure with a roof is not sufficiently ventilated and (b) opening a garage door is not sufficient to ventilate a generator • Noise was identified as a factor in generator placement and may be useful in reinforcing the need to locate the generator away from the house
Carbon monoxide knowledge	• Clearly define “well ventilated” for consumers. Individuals want to make sure the generator is well ventilated; however, they are not sure what “well ventilated” means and how to achieve it • Debunk the “all-electric house” myth. If individuals use a generator, they do not have an all-electric house. If individuals have an attached garage, they do not have an all-electric house. If individuals have a fireplace, a wood stove, a gas dryer or a gas water heater, they do not have an all-electric house. Participants commonly cited this reason for not having a CO alarm, so emphasizing that very few, if any, homes are all-electric could be effective • Dovetail CO safety with electrical safety. Individuals are concerned about electrical safety when using generators and appear willing to learn more about it. If electrical and CO safety messages are combined, individuals may be more likely to heed them • Propose safe ways to protect generators from winter weather. This is a major concern, which often leads individuals to place generators in covered areas
Carbon monoxide alarms and prevention	• Educate individuals about CO alarm placement. Few individuals place CO alarms in bedrooms, common areas, or garages; most install them in the basement or attic near the furnace. Although there is no recommendation from CDC or any other federal agency regarding placement, these devices should be placed where they can be heard and where they will wake sleeping individuals
Trusted sources/ incentives	• Gas stations and other convenience-type stores may be good outlets for promoting CO safety and CO alarms because consumers tend to gas up vehicles prior to a storm and purchase fuel for generators • Grocery stores may be another strategic outlet for promoting CO safety. Many individuals purchase groceries and supplies before a storm • Explore innovative routes for CO safety education, such as school demonstrations, home-and-garden shows, hurricane shelters, and gas/utility bill notices • Include CO safety messages on utility company hotlines during power outages. After a storm, individuals often call the hotline to estimate when power will be restored

Note. CO = carbon monoxide; CDC = Centers for Disease Control and Prevention.