REPORT FROM THE FIELD

Carbon Monoxide Poisoning in Miami-Dade County Following Hurricane Irma in 2017

Alyssa M Falise, MSPH; Isabel Griffin, MPH; Danielle Fernandez, MPH; Xeniamaria Rodriguez, MSPH; Emily Moore, MPH; Anne Barrera, MPH; Juan Suarez; Lidice Cutie, MPH; Guoyan Zhang, MD, MPH

ABSTRACT

Objective: The Florida Department of Health in Miami-Dade County (DOH-Miami-Dade) investigated 106 reported carbon monoxide (CO) exposures over a 9-day timeframe after Hurricane Irma. This report evaluates risk factors for CO poisoning and the importance of heightened surveillance following natural disasters.

Methods: Data on CO poisoning cases from September 9 to 18, 2017 were extracted from Merlin, the Florida Department of Health Surveillance System. Medical records were obtained and follow-up interviews were conducted to collect data on the confirmed CO poisoning cases. Data were analyzed using SAS v9.4.

Results: Ninety-one of the 106 people exposed to CO met the case definition for CO poisoning: 64 confirmed, 7 probable, and 20 suspect cases. Eighty-eight percent of the affected individuals were evaluated in emergency departments and 11.7% received hyperbaric oxygen treatment. The most frequently reported symptoms included headache (53.3%), dizziness (50.7%), and nausea (46.7%). Three patients expired due to their exposure to CO.

Conclusions: Post Hurricane Irma, the DOH-Miami-Dade investigated numerous cases for CO exposure. By understanding who is most likely to be impacted by CO and the impact of generators' location on people's health, education efforts can be tailored to the population most at risk and further CO exposures and related mortalities following natural disasters can be reduced. (*Disaster Med Public Health Preparedness*. 2019;13:94-96)

Key Words: public health surveillance, natural disasters, hurricane, inhalation exposure

Carbon monoxide (CO) poisoning presents a significant public health threat, as exposure to the odorless and colorless gas is difficult to detect without CO detectors and often is not suspected until the onset of illness.[1] In anticipation of category 4 Hurricane Irma, Governor Rick Scott declared Florida to be in a state of emergency on September 4, 2017; by September 10, the storm made landfall in the Florida Keys.[2] The hurricane was the largest to ever form in the Atlantic Ocean, spanning nearly 400 miles in width, and inflicting property damage, major flooding, and loss of power to an estimated 5 million residents across the state of Florida, one-fifth of whom were concentrated in Miami-Dade County.[3] Immediately after the storm's landfall, the Florida Department of Health in Miami-Dade County (DOH-Miami-Dade) experienced an increase in CO-related 911 calls, Poison Control reports, and emergency department visits in Miami-Dade County. This report details the importance of heightened CO surveillance in addition to the need for messaging and communication to generator users regarding CO exposure.

METHODS

CO exposures identified between September 9, 2017, and September 18, 2017, were included in this report. Exposures were identified through active surveillance using the Electronic Surveillance System for the Early Notification of Community Based Epidemics (ESSENCE), which requires daily monitoring of emergency department chief complaint and discharge data, Poison Control Center reports, and passive surveillance from reporting by health care providers and hospitals in Miami-Dade County. DOH-Miami-Dade identified duplicate visits through ESSENCE and Poison Control and merged these visits during analysis. Medical records were reviewed to assess whether the case met a Florida Department of Health's case definition for CO poisoning based on epidemiologic exposure and laboratory evidence.[4] Elevated carboxyhemoglobin (HbCO) concentrations in blood were used as a laboratory-confirmed indicator of CO levels. A suspect case was defined as an individual who had clinical symptoms and a history of recent CO exposure. A probable case was defined as an individual who had clinical symptoms

DOI: 10.1017/dmp.2018.67

and the same exposure as that of a confirmed case, or an individual with a HbCO between 9% and 12%, or an individual with a HbCO level between 9% and 12% and no clinical symptoms. A confirmed case was defined as an individual who had clinical symptoms and a HbCO ≥9%, an asymptomatic individual with HbCO ≥12%, or an individual with clinical symptoms and environmental evidence.

Information on CO poisoning cases, including resident's exposure, clinical presentation, smoking status, laboratory testing (first measurement of HbCO level), medical treatment, CO exposure type (generator, car, etc.), location of portable, gasoline-powered electric generator placement, and attack rate within the case's household were collected through client interviews and inputted into Merlin, the FLDOH Surveillance System. Investigations involving 3 deaths from CO poisoning within Miami-Dade County were reviewed for basic demographic information for epidemiologic linkage with other confirmed CO cases. Information about generator location was not available for CO-related deaths; all persons who were fatally poisoned expired prior to arrival to a health care facility.

RESULTS

Fifty-three CO-related visits were initially identified by ESSENCE, 25 by Poison Control, 9 by hospital/healthcare providers, 1 by a medical express service, 1 by media reports, and 1 by an unknown source (Table 1). Of these 106 reports, 91 (85.8%) resulted in actual cases of CO poisoning, as defined previously. The number of CO-related emergency department visits peaked 2 days poststorm and were more frequently reported during the early morning time of day. According to Miami-Dade Fire Rescue, a total of 69 CO exposure calls were received between January 1, 2017, and September 30, 2017, with 59 (85.5%) occurring in September 2017. Of the 59 calls, 42 (71.1%) were coded as "life threatening emergencies."

During the time frame of interest, 64 confirmed, 7 probable, and 20 suspect cases of CO poisoning were identified, representing a total of 91 cases. Among the 91 cases, 37 (40.7%) of the exposed individuals were male, and their median age was 31 y (range, 0-89). Pediatric cases (<18 years old) accounted for 34.1% of the nonfatal cases. Among the 3 fatal cases, all of the victims were male and median age was 65 (range, 24-74). Among both fatal and nonfatal cases, 60 (65.9%) were Hispanic, 12 (13.2%) were non-Hispanic white, and 6 (6.6%) were non-Hispanic black. Seventy-three (80.2%) cases were associated with a household cluster, which was defined as 2 or more cases of CO poisoning. Through investigation, 21 clusters of CO poisoning were identified, and the mean number of persons poisoned per incident was 4.2 (range, 1-6). Sixty-seven (73.6%) cases involved persons who reported that they were nonsmokers.

The investigation led by the DOH identified that among the 75 cases with known modes of transportation, 45 (60.0%) of the affected individuals arrived to healthcare facilities by ambulance and 30 (40.0%) arrived by personal vehicle or as a walk-in. Among 79 affected individuals who visited emergency departments, 10 (12.7%) received hyperbaric oxygen treatment. Among the 77 affected individuals who were symptomatic, the most frequently reported symptoms of CO poisoning were headache (53.2%), dizziness (60.9%), and nausea (46.8%). Seven (7.7%) were hospitalized.

The mean HbCO level among confirmed cases was 17.8% (range, 1.1%-75.0%). Fatal CO cases were more likely to have higher HbCO levels, with a mean of 51.9% (range, 12.8%-75.0%). Higher HbCO levels were also more likely to be associated with the following clinical symptoms: headache (53.8%), dizziness (46.1%), and nausea (38.5%). There was a nonsignificant correlation between the total number of reported symptoms and HbCO levels ($P = .52$, adjusted $r^2 = -0.0092$).

Among 91 cases, 90 (98.9%) reported CO exposure from a gasoline-powered portable generator, with 89 (97.8%) of these exposures having taken place at home. Among individuals reporting CO exposures via generators, 90 (100%) reported that the exposure occurred at a residence, and 26 (28.9%) reported the location of the generator as indoors (including inside the garage) and 47 (52.2%) reported the location of the generator as outdoors. Of the 47 who reported that their generators were located outside, 23 reported that the generator was an average distance of 8.5 feet (range, 0-20) from the nearest door or window, and 7 reported that the generator was an average distance of 14 feet (range, 0-70) from the nearest air conditioning unit. The majority of affected individuals (28, 31.1%) purchased their generators; however, 16 (17.8%) rented and 3 (3.3%) were given their generators. Seventeen affected individuals (18.9%) were previously instructed on how to safely use a generator and 22 (24.4%) had previously used a generator.

Questions assessing CO knowledge were asked after cases were exposed. While the majority of affected individuals knew that CO has no smell (81.5%), no taste (88.9%), and cannot be seen (88.5%), less than half (48.2%) were aware that CO does not cause the eyes to burn.

DISCUSSION

During the 9 days post-Hurricane Irma, 91 CO poisoning cases were identified among Miami-Dade County residents. As preparations for the 2018 hurricane season begin, this report serves to remind officials that many people using generators during and after hurricanes may have no prior experience with them and may not have been instructed on how to safely use them. This report highlighted that although residents are familiar with traditional messages

https://doi.org/10.1017/dmp.2018.67 Published online by Cambridge University Press

TABLE 1

Characteristics of Confirmed, Probable, and Suspect Carbon Monoxide Poisoning Cases Post-Hurricane Irma, Miami-Dade County, Florida, September 2017 (N = 91)[a]

Characteristics	Total (N = 91)	Nonfatal (n = 88)	Fatal (n = 3)
Sex, n (%)			
Male	37 (40.7)	34 (37.4)	3 (3.3)
Female	54 (59.3)	54 (59.3)	0 (0.0)
Race/ethnicity, n (%)			
Non-Hispanic white	12 (13.2)	12 (13.2)	0 (0.0)
Non-Hispanic black	6 (6.6)	5 (5.5)	1 (1.1)
Hispanic	60 (65.9)	59 (64.8)	1 (1.1)
Other	7 (7.7)	6 (6.6)	1 (1.1)
Unknown	6 (6.6)	6 (6.6)	0 (0.0)
Age, mean, median (range)	33.3, 31 (0-89)	32.6, 31 (0-89)	54.3, 65 (24-74)
Age groups, n (%)			
<1 y	1 (1.1)	1 (1.1)	0 (0.0)
1-17 y	29 (31.9)	29 (31.9)	0 (0.0)
18-65 y	51 (56.0)	50 (54.9)	1 (1.1)
>65 y	10 (11.0)	8 (8.8)	2 (2.2)
Insurance status, n (%)			
Insured	45 (49.5)	44 (48.4)	1 (1.1)
Uninsured	11 (12.1)	11 (12.1)	0 (0.0)
Unknown	35 (38.5)	33 (36.3)	2 (2.2)
Smoking status, n (%)			
Smoker	7 (7.7)	7 (7.7)	0 (0.0)
Nonsmoker	67 (73.6)	67 (73.6)	0 (0.0)
Unknown	17 (18.7)	14 (15.4)	3 (3.3)

[a]The column representing the total number of individuals provides column percentages and the columns describing the individuals' mortality status provide cumulative percentages.

regarding generator use and outdoor placement, there is a need to further define safe generator use practices to include recommendations regarding enclosed attached areas or areas in which air conditioning units are present. In the future, focused efforts should be placed on educating the community on proper generator use to mitigate potential CO exposures and poisonings. Similarly, residents would benefit from enhanced messaging regarding the signs and symptoms of CO poisoning to ensure timely medical evaluation postexposure.

A limitation of this report is the inclusion only of individuals who sought medical care for CO exposure; as such, this report likely reflects only severe cases of CO poisoning in which the affected individuals sought health care and thus underestimates the true magnitude of poisonings during this time frame. Those that answered knowledge questions were asked after their health care visit and treatment, so it is likely that they learned more about CO after their exposure.

About the Authors

Florida Department of Health in Miami-Dade County, Epidemiology, Disease Control, and Immunization Services, Miami, Florida (Ms Falise, Ms Griffin, Ms Fernandez, Ms Rodriquez, Ms Moore, Ms Barrera, Mr Suarez, and Dr Zhang), and Miami-Dade County Fire Rescue, Doral, Florida (Ms Cutie).

Correspondence and reprint requests to Alyssa M. Falise, Florida Department of Health in Miami-Dade County, 8175 NW 12th Street, Suite 314, Miami, FL 33126 (e-mail: Alyssa.Falise@flhealth.gov).

Acknowledgments

Infection control practitioners at hospitals in Miami-Dade County. Debbie Summers at the Florida Department of Health in Miami-Dade County.

REFERENCES

1. Carbon Monoxide Poisoning. Center for Disease Control, National Center for Environmental Health. https://www.cdc.gov/co/. Published 2017. Accessed September 30, 2017.
2. Alvarado F, Berman M, Somashekhar S. Florida officials begin ordering evacuations as Hurricane Irma intensifies to a Category 5 storm. *The Washington Post*. https://www.washingtonpost.com/news/post-nation/. Published September 5, 2017. Accessed September 30, 2017.
3. Power tracker map. Florida Power and Light. www.fplmaps.com/. Published 2017. Accessed September 30, 2017.
4. Carbon monoxide poisoning case definition. Florida Department of Health. http://www.floridahealth.gov/. Published 2017. Accessed September 30, 2017.

https://doi.org/10.1017/dmp.2018.67 Published online by Cambridge University Press