Disaster Medicine and Public Health Preparedness

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Cite this article: Williams S, Jiva S, Hanchey A, Suárez-Soto RJ, Bayleyegn T, Schnall AH. Tracking hurricane-related deaths in the contiguous United States using media reports from 2012 to 2020. *Disaster Med Public Health Prep*. **17**(e234), 1–6. doi: https://doi.org/10.1017/dmp.2022.163.

Keywords:
disaster-related mortality; hurricanes; media mortality; mortality surveillance

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SDMPH
SOCIETY FOR DISASTER MEDICINE & PUBLIC HEALTH

Tracking Hurricane-Related Deaths in the Contiguous United States Using Media Reports From 2012 to 2020

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Abstract

Heavy rainfall, storm surges, and tornadoes are hazards associated with hurricanes that can cause property damages and loss of life. Disaster-related mortality surveillance encounters challenges, such as timely reporting of mortality data. This review demonstrates how tracking hurricane-related deaths using online media reports (eg, news media articles, press releases, social media posts) can enhance mortality surveillance during a response. The Centers for Disease Control and Prevention used online media reports from 2012 to 2020 to characterize hurricane-related deaths from 10 hurricanes that were declared major disasters and the flooding related to Hurricane Joaquin in the contiguous United States. Media reports showed that drowning ($n = 139$), blunt force trauma ($n = 89$), and carbon monoxide poisoning ($n = 58$) were the primary causes of death. Online media and social media reports are not official records. However, media mortality surveillance is useful for hurricane responses to target messaging and current incident decision-making.

In the United States, disasters present numerous challenges to reporting mortality data in a timely manner. These include limited timely data availability, incomplete information, and inaccurate coding of medical or death records.[1] The official process of reporting deaths in the United States involves a death certificate certified by death certifiers. Medical examiners, coroners, and other death certifiers collect death data using International Classification of Diseases codes to classify the cause of death and type of disaster through passive (vital records) mortality surveillance system. Death certificates are frequently delayed for weeks or months after death and often do not describe the circumstance of death that can be used to classify disaster-relatedness. Additional challenges include underestimating the number of deaths because of a lack of understanding the standard definitions and whether a death is a direct or indirect result of the incident.[2] All disaster-related deaths need to be identified, whether direct or indirect, to help better target messaging, evidence-based public health interventions, and other public health efforts during response and recovery.

During natural disasters such as hurricanes, it is common to have challenges tracking its impact on health, particularly identifying disaster-related mortalities. Since 2012, the Federal Emergency Management Agency (FEMA) has issued 16 major disaster declarations for hurricanes that made landfall in the contiguous United States.[3] The negative consequences of hurricanes include property and infrastructure damage, injury and death, human suffering, and associated costs.[4] For example, in 2012, Hurricane Sandy caused massive destruction, resulting in power outages that affected millions of people; deaths from drowning, blunt trauma, and carbon monoxide (CO) poisoning; and more than $62 billion in property damage.[5] During the 2017 hurricane season, Hurricanes Harvey and Irma made landfall in the contiguous United States, causing hundreds of deaths and $175 billion in property damage.[6]

Near real-time disaster-related mortality surveillance is essential to determine the number of hurricane-related deaths and identify the risk factors and circumstance of death to help mitigate further loss of life.[7,8] For example, the direct forces of a disaster, such as hurricane storm surges and structural failures during earthquakes, may affect people by causing drowning or physical trauma.[9] On the other hand, indirect causes result from unsafe or unhealthy conditions, such as power outages that led people to use generators resulting in CO poisoning and vehicle accidents during evacuation or because of unsafe roads (eg, slick, flooded, icy).[9]

During a hurricane response, epidemiologists often initiate an active mortality surveillance system to track hurricane-related deaths. For example, in 2008, during Hurricane Ike, the Texas Department of State Health Services (DSHS) set up an active mortality surveillance system to count hurricane-related deaths and determine the direct and indirect effects of the disaster. The Centers for Disease Control and Prevention (CDC) and DSHS assessed the Texas active

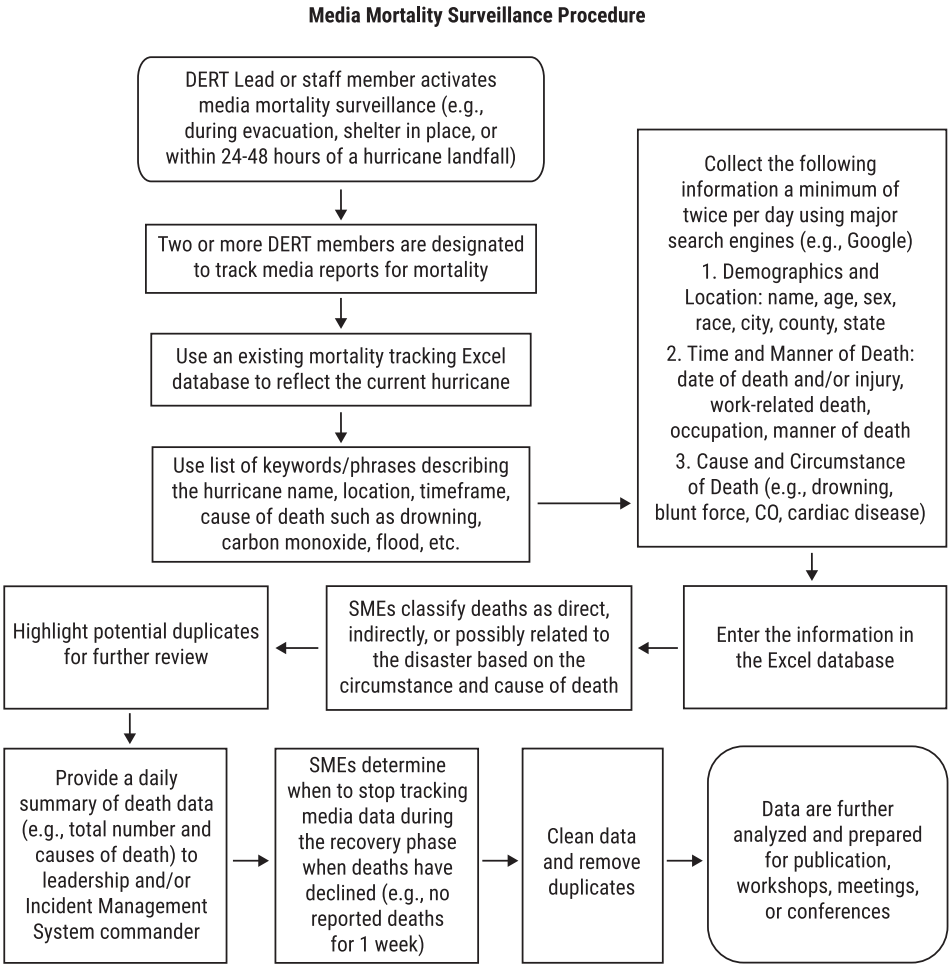

Figure 1. Media mortality surveillance procedure flow chart.

mortality surveillance system and compared it with vital statistics data which consists of complete birth and death data. CDC and DSHS found a large discrepancy in the reported numbers (74 vs 4, respectively).[7] The active mortality surveillance system used a 1-page surveillance form that helped capture more detailed information on hurricane-related causes and circumstances of death (ie, direct, indirect, unrelated, possible). The evaluation of the Texas surveillance system conducted during recovery revealed that active mortality surveillance is essential to collect detailed hurricane-related mortality data and provide specific information for situational awareness to state officials and FEMA.[7]

In 2012, during Hurricane Sandy, CDC's National Center for Environmental Health (NCEH) started tracking hurricane-related deaths reported by the media (eg, blogs, news media websites) as an alternate for timely data source for disaster-related mortality data during response. Later, the CDC evaluated the media tracking system and found that online media could improve the availability of information on disaster-related mortality during response efforts.[10] Since then, NCEH's Disaster Epidemiology and Response Team (DERT) members continued media mortality surveillance to track hurricane-related deaths using online media reports for several storms. Media mortality surveillance allows epidemiologists to gather timely information, identify current threats, and quickly respond with messaging to guide effective response efforts. In addition, media mortality data supplements datasets from official records. The purpose of using media sources to track deaths is to rapidly collect mortality data that can be used for immediate incident public health decision-making. Tracking disaster-related deaths using media sources, such as online news articles, social media, and memorial websites can help public health professionals report information to prevent further deaths during a hurricane response.[11–13] With the objective of highlighting the process and benefit of media mortality surveillance during a hurricane response, team members reviewed the hurricane-related deaths obtained by CDC from media reports during 2012-2020. This review was not considered human subjects research by the CDC's NCEH Office of Science and, therefore, it was exempt from the human subjects institutional review board's full review.

Methods

To track hurricane-related deaths reported in the media, DERT members actively updated a hurricane-specific Excel database daily during active hurricane responses, using the process described in Figure 1. In 2017, DERT drafted a written standard operating procedure (SOP) to update the standardized process based on previous storm experiences. The SOP outlines how to scan the media for hurricane-related deaths, at the same time each day, using Google or a similar search engine to search for key terms. Those terms include storm name and type of disaster, (eg, Hurricane

https://doi.org/10.1017/dmp.2022.163 Published online by Cambridge University Press

Sandy, tropical storm, flood), location-specific phrases (eg, state, county, city), mortality-related language (eg, death, death toll, mortality), type of common mechanisms (eg, drown, accident, fall), and other known information from previous days (eg, name of individual, circumstance of death). In addition, team members received daily social media reports from the US Health and Human Services and clicked on the links to reported hurricane-related deaths reported in social media. Team members compiled and coded the information from the identified sources (eg, news media articles, press releases, social media posts) into the database, following guidance to identify potential duplicates, and saving each source for continued follow-up. Duplicates are identified by checking each media source and comparing the death data (ie, name, age, location, cause and circumstance of death) for each decedent. Based on the data, DERT members developed daily internal reports used for situational awareness during the disaster, support public health decision-making, and near real-time public health messaging. The reports assist public health leaders in educating communities on hurricane hazards (eg, drowning risks, proper medication storage) to guide current response efforts and current situational awareness.

For this report, DERT retrospectively reviewed 11 Excel databases created for each storm from 2012 to 2020 that triggered FEMA major disaster declarations in the contiguous United States. Team members limited the scope to the contiguous United States because of key differences in preparedness and response between the lower 48 states compared with Alaska, Hawaii, and US territories such as Puerto Rico and the US Virgin Islands.[14] Although Hurricane Joaquin was not declared a major hurricane in the United States, the extreme flooding from a connecting storm system that drew moisture from the hurricane was declared a major disaster in South Carolina and, therefore, is included in this review.

The team imported each Excel database into R 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria) and standardized the format for variable names (eg, "first.name" and "name" were renamed to "first_name").[15] After renaming, team members combined all datasets into a single database, with each record uniquely identified by the storm name and a sequence number. The team cleaned the database by recoding values to be consistent in capitalization and with correct spelling. Team members also cleaned the database to standardize blank data. All values termed as "Unknown," "unknown," "NA," or empty cells (eg, "" or " ") were coded in R as the appropriate logical NA (ie, is.na(x) returns TRUE). Team members described the number of deaths by hurricane name, demographics of decedents, circumstances of death, and relationship to the disaster, and presented the frequencies and percentages.

Results

Of the 16 FEMA major disaster declarations for hurricanes during 2012-2020, DERT collected data for 10 (62.5%) hurricanes plus the ensuing flooding related to Hurricane Joaquin. The total number of hurricane-related deaths obtained from media reports for each incident ranged from 4 to 116 (Table 1). Hurricanes Irma, Sandy, and Harvey had the highest mortality counts: 116, 115, and 99, respectively. Table 2 shows the decedent's sex, age group, and race/ethnicity reported by the media in the United States.

Of the 522 reported deaths, 204 (39.1%) resulted from indirect causes and 124 (23.7%) resulted from direct causes; the cause was unknown for 194 (37.2%) deaths (Table 3). Media reports showed 23 deaths caused by illness and 362 deaths caused by injuries. The top 3 primary causes of injury-related deaths were drowning ($n = 139$ [38.4%]), blunt force trauma ($n = 89$ [24.6%]), and CO poisoning ($n = 58$ [16.0%]). Other causes of injury-related deaths included falling trees ($n = 21$ [5.8%]), electrocution ($n = 14$ [3.9%]), and car accidents ($n = 13$ [3.6%]). Among illness-related deaths, 17 (73.9%) were for cardiac disease and 6 (26.1%) for respiratory illness. The key attributes with the highest percent of data availability were state where death occurred (100%), circumstance of death (96.6%), and sex of the decedent (79.3%) (Figure 2). Time of death (31.6%) and race/ethnicity (12.3%) had the lowest percentage of data available from media reports. Figure 3 summarizes the number of deaths and cause of death for each hurricane. Hurricane Irma resulted in the highest number of deaths at 116, with top causes being blunt force trauma ($n = 32$ [27.6%]), CO poisoning ($n = 18$ [15.5%]), and drowning ($n = 10$ [8.6%]). Hurricane Delta had the fewest deaths obtained from media reports, with CO poisoning ($n = 2$ [50%]) and drowning ($n = 2$ [50%]) as the reported causes of death.

Table 1. Number of hurricane-related deaths recorded from media reports — United States, 2012–2020

Hurricane (year)	Number of deaths
Sandy (2012)	115
Joaquin (2015)	21
Matthew (2016)	35
Harvey (2017)	99
Irma (2017)	116
Florence (2018)	50
Michael (2018)	38
Laura (2020)	32
Sally (2020)	5
Delta (2020)	4
Zeta (2020)	7

Table 2. Demographic of disaster-related deaths reported by media in United States – 2012-2020

Variable	Value	No.	Percent (%)
Sex			
	Female	128	24.5
	Male	286	54.8
	Unknown	108	20.7
Age group			
	≤17 years	25	4.8
	18–64 years	202	38.7
	≥65 years	140	26.8
	Adult[a]	37	7.1
	Unknown	118	22.6
Race/ethnicity			
	Asian	3	0.6
	Black	17	3.3
	Hispanic	17	3.3
	White	27	5.2
	Unknown	458	87.7

[a]Some media sources describe the decedent as an "adult" instead of providing a specific age.

https://doi.org/10.1017/dmp.2022.163 Published online by Cambridge University Press

Table 3. Number of disaster-related deaths reported by media and their relationship to the disaster in the United States, 2012 – 2020

Cause of death		Direct	Indirect	Unknown	Total
Illness					
	Cardiac disease[a]	0	15	2	17
	Respiratory	0	3	3	6
Injury					
	Drowning	90	22	27	139
	Blunt force trauma	31	48	10	89
	CO poisoning	0	44	14	58
	Falling tree	2	0	19	21
	Electrocuted	0	10	4	14
	Car accident	1	2	10	13
	Fall	0	2	3	5
	Fire	0	2	3	5
	Hyperthermia	0	5	0	5
	Hypothermia	0	0	4	4
	Unspecified injury	0	0	3	3
	Gunshot	0	2	0	2
	Stroke	0	1	1	2
	Sepsis	0	1	0	1
	Suffocation	0	0	1	1
Total		124	204	194	522
Unknown		0	47	90	137

[a]Cardiac disease consists of the following: heart attack, myocardial infarction, cardiac disease, and cardiac arrest.

Discussion

This is the first review of all hurricane-related deaths captured by DERT members by means of media reports of mortality during 2012-2020. To enhance overall public health surveillance, timely data on the number of disaster-related deaths is an essential metric of a hurricane's impact on a population. Media mortality reports are a source of information for relatively real-time situational awareness to monitor the ongoing disaster impact and present the circumstance of death that death certificates cannot provide. For example, release of death certificates often is delayed for several weeks or months after the death. In addition, death certificates often do not indicate circumstance of death that helps to determine disaster-relatedness. Supplemental data sources such as media reports can provide essential information for situational awareness to assist in immediate public health decision-making for emergency response officials to determine trends and potential risk factors for death. Although media reports might lack official confirmation of the cause of death, they typically identify the circumstance of death, which can aid the public health decision-making process and continued crafting of relevant and targeted public health messaging.

In this review, majority of the reported hurricane-related deaths by media were preventable. The 3 primary causes of death from hurricanes over the past decade reported in the media were drowning, blunt force trauma, and CO poisoning. Messaging can be communicated to disproportionately affected groups during hurricane preparedness and response. The evidence-based information can be shared with communication experts to craft appropriate messages and communicate to prevent further deaths. For example, the leading cause of death was CO poisoning for Hurricane Laura in 2020, whereas motor vehicle accidents and drowning were the primary causes of death for Hurricane Michael in 2018. The targeted messages in these 2 events differed in addressing the specific situation.

Media data often are incomplete in providing demographic information. In this review, of those reports that did have sex listed, more deaths occurred among men than among women. In the aftermath of Hurricane Harvey, 70% of the deaths occurred among males and 30% among females.[16] Among those deaths, 81% were caused by drowning and 19% for indirect causes (eg, lack of medical treatment, electrocution, car accidents, infections from contaminated floodwater).[16]

Age and race are also important in terms of response efforts. Again, more than half of these data were missing from media reports. However, data on age and race are more complete for more recent storms since CDC began using the current protocol and with more detailed reporting by the media. Yet, this information is often dependent on the perceived impact of the disaster (eg, more "newsworthy") and competition with other issues during the news cycle. Of those that did report age, most deaths were among persons aged 18–64 years. In addition, data collected during Hurricane Matthew revealed that older adults are disproportionally affected by disasters.[17] For example, roughly 54% of the decedents were aged 18-64 years and 42% were 65 years and older.[17] Hurricane Irma was another example of older adults disproportionally impacted by the disaster. Images of older adults sitting waist-high in floodwater were reported when an assisted living facility in Texas was denied evacuation during the hurricane, reinforcing the age-related effect of disasters and the need to create culturally appropriate messaging during a response.[18] DERT members are working with partners such as state epidemiologists, medical examiners, and coroners to improve messaging and reporting from traditional mortality data sources (eg, vital records) to obtain more consistent and accurate death toll data.

Limitations

This review is subject to several limitations, including missing data. Depending on the variable, missing data ranged from zero (state) to approximately 88% (race). Therefore, results should be interpreted with caution. Although the SOP has been updated to improve media mortality surveillance efforts, no official protocol or standardized database was in use until the 2017 hurricane season. Consequently, data collected before the protocol is missing some information and has some inconsistencies. Six hurricanes were not tracked and excluded from this review because of the lack of death data, staffing limitations, and no official hurricane response activation (Isaac, Hermine, Nate, Barry, Dorian, and Isaias). Two hurricanes had only 1 death each, 1 (Hurricane Isaias) was not tracked because of staffing limitations during the COVID-19 pandemic, and 3 (50%) were not tracked for other reasons (eg, no official or unofficial emergency operations center activation). Two of the 6 missed storms had more than 10 deaths and, therefore, could have provided important information to this review. This review was limited to the contiguous United States because of the incompleteness of data and differences in response efforts between the contiguous United States and island territories.[15] However, it is important to include all US states, territories, and tribal nations in the future. Finally, online media and social media reports are not official records and are subject to errors. Because of challenges in timely reporting of mortality data through vital records and the possible lack of information about

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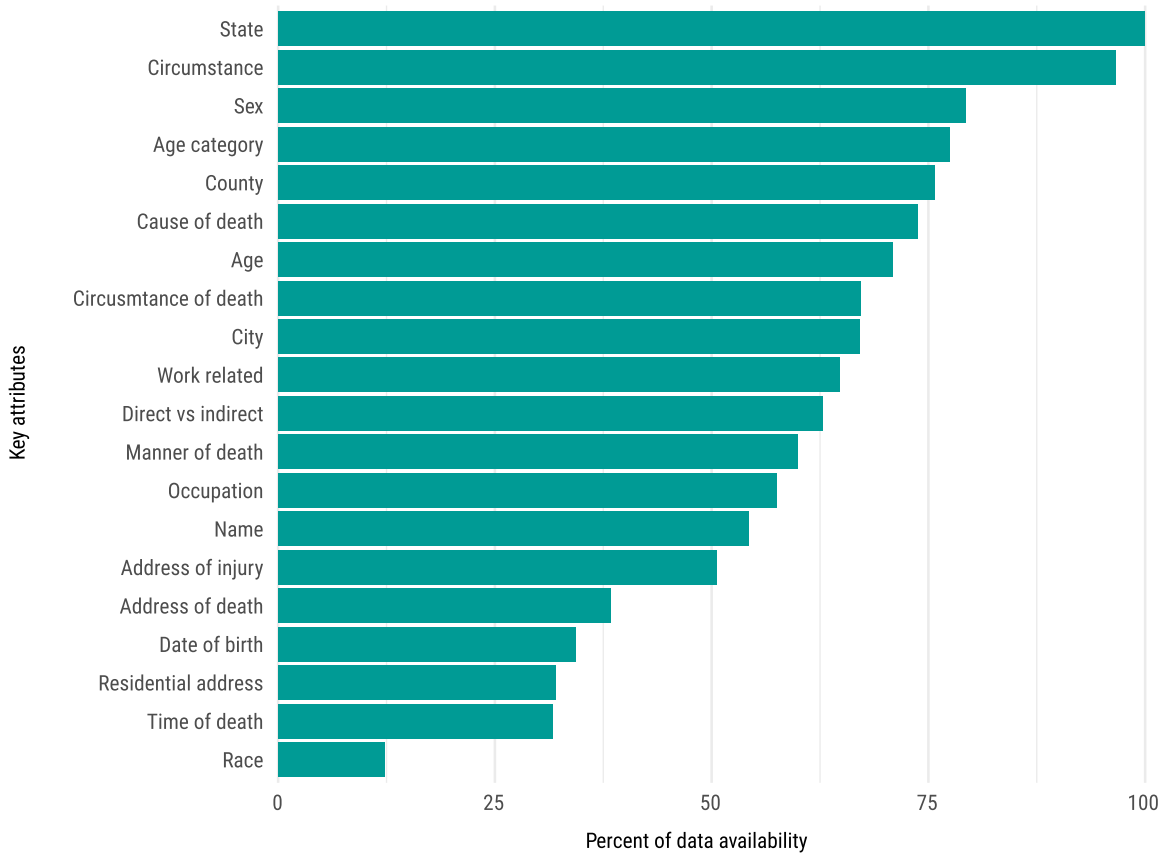

Figure 2. Key attributes of disaster-related deaths captured by media - United States, 2012-2020.

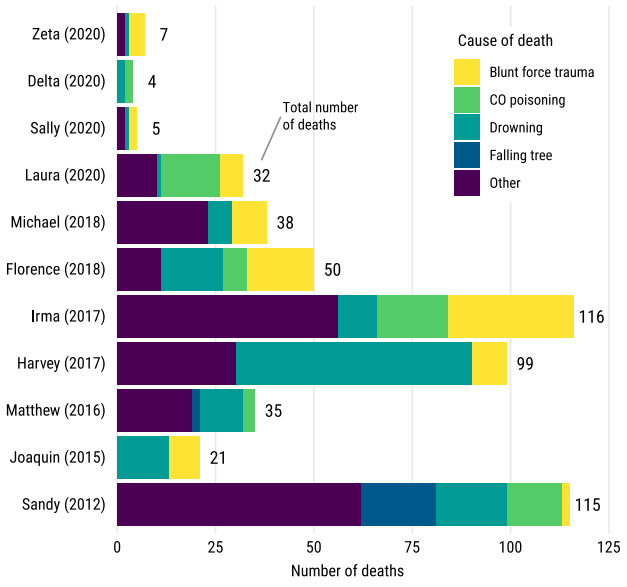

Figure 3. Number of disaster-related deaths and cause of deaths reported by media - United States, 2012-2020.

disaster-relatedness on death certificates, social media reports help provide near real-time data on hurricane-related deaths. Although online media and social media reports were not verified with vital records, media reports provide timely data during hurricane responses, which has been found useful as a supplemental source of information for situational awareness during disaster response.[10] The purpose of this review is to highlight the process and benefit of using media reports to collect immediate data by tracking hurricane-related deaths. Furthermore, DERT will continue to use the work of onsite reporters telling stories about the current situation and turning those stories into data.

Conclusions

Media data provide useful information that can be used to support public health decision-making during hurricane response. Death certificates are often delayed and lack information on the disaster-related circumstance of death. Media sources supplement official records and provide data in a timely manner. This review of mortality reports in the media has shown that drowning, blunt force trauma, and CO poisoning are the primary causes of hurricane-related deaths in the contiguous United States. These near real-time media reports provide the circumstance of death and essential situational awareness to help target continued messaging and limit future loss of life. Therefore, this process should be expanded beyond hurricanes to other disasters and used as an additional data source for current incident decision-making and immediate public health action during a response.

Conflicts of interest. The authors have no conflicts of interest to declare.

Disclaimer. The findings and conclusion of this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

https://doi.org/10.1017/dmp.2022.163 Published online by Cambridge University Press

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