

Medicolegal Death Scene Investigations After Natural Disaster- and Weather-Related Events: A Review of the Literature

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ABSTRACT

Background: The number of disaster-related deaths recorded by vital statistics departments often differs from that reported by other agencies, including the National Oceanic and Atmospheric Administration-National Weather Service storm database and the American Red Cross. The Centers for Disease Control and Prevention (CDC) has launched an effort to improve disaster-related death scene investigation reporting practices to make data more comparable across jurisdictions, improve accuracy of reporting disaster-related deaths, and enhance identification of risk and protective factors. We conducted a literature review to examine how death scene data are collected and how such data are used to determine disaster relatedness.

Methods: Two analysts conducted a parallel search using Google and Google Scholar. We reviewed published peer-reviewed articles and unpublished documents including relevant forms, protocols, and worksheets from coroners, medical examiners, and death scene investigators.

Results: We identified 177 documents: 32 published peer-reviewed articles and 145 other documents (grey literature). Published articles suggested no consistent approach for attributing deaths to a disaster. Researchers generally depended on death certificates to identify disaster-related deaths; several studies also drew on supplemental sources, including medical examiner, coroner, and active surveillance reports.

Conclusions: These results highlight the critical importance of consistent, accurate data collection during a death investigation. Review of the grey literature found variation in use of death scene data collection tools, indicating the potential for widespread inconsistency in data captured for routine reporting and public health surveillance. Findings from this review will be used to develop guidelines and tools for capturing disaster-related death investigation data. *Acad Forensic Pathol.* 2017 7(2): 221-239

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INTRODUCTION

Death certificates are often considered the primary source of information used by public health officials to attribute deaths to natural or human-induced disasters (1). Data collected at the death scene, including the location and condition of the body and detailed information provided by the hospital or the decedent’s personal contacts, are taken into account when the medical examiner or coroner determines cause and manner of death. The majority of the death scene information is used to complete the death certificate. Experts in medicolegal death investigation have long discussed the need to understand what data are frequently collected at death scenes and to increase the consistency in death scene investigation and reporting for all causes of death (2, 3).

A disaster is defined as a serious disruption of the functioning of society, causing widespread human, material, or environmental losses that exceeds the local capacity to respond and results in calls for external assistance. The focus of this review article will be fatality-inducing natural disasters including tornadoes, hurricanes, and earthquakes, as well as weather events like snow storms, heat waves, and lightning. Such hazards have increased in scale and scope in recent decades (4). For public health, this adds greater urgency to the need to develop a consistent approach to collecting and reporting death scene data to accurately quantify the human health impact of disasters. Improved consistency would allow for better un-

derstanding of the cause and circumstances of these deaths to guide the development of evidence-based prevention strategies. The Centers for Disease Control and Prevention (CDC) assessed the number of deaths recorded after several recent federally declared disasters, including Hurricane Ike in 2008, the 2011 tornado outbreak in the Southeast, and Hurricane Sandy in 2012 (5, 6). These assessments found significant disparities between the final number of deaths recorded by public health and vital statistics departments, the Federal Emergency Management Agency (FEMA) funeral benefit claims database, the American Red Cross mortality surveillance system, and the National Oceanic and Atmospheric Administration (NOAA)-National Weather Service (NWS) storm database (**Table 1**) (5). Such discrepancies likely reflect current variations in how disaster-related death scene data are collected and recorded, which can impede comparisons of disaster-related deaths across geographic locations and limit the accuracy of official death tolls. They also increase the difficulty of determining death counts after disasters spanning multiple counties and states.

Data collected at the death scene are the building blocks for identifying cause and manner of death. If the key circumstance data are not collected at the scene, it is likely it will be missed or not reported. Without these data, the medical examiner or coroner may not be able to attribute the death to the disaster and would therefore not reflect this information on the death certificate. Because disaster-related death scenes can be chaotic, it is crucial to provide death

Table 1: Number of Disaster-Related Deaths Reported by Response Agencies

Disaster	Red Cross	FEMA	NOAA-NWS Storm Data	Other Agency (EOC, ME)	Vital Statistics (Search without names)
Hurricane Ike, TX (2008)	38	104	20	74	4
April 27 Tornado, GA (2011)	15	9	15	15	6
Hurricane Sandy, NJ (2012)	34	61*	12	75	24

FEMA - Federal Emergency Management Agency
 NOAA -NWS: National Oceanic and Atmospheric Administration-National Weather Service
 EOC - Emergency operations center
 ME - Medical examiner.
 *Actual number of benefit claims which required state medical examiner review.

scene investigators with guidance about a consistent approach for collecting and reporting data. Public health researchers, including epidemiologists at CDC, have frequently collaborated with epidemiologists, vital statistics, medical examiners, and coroners to improve disaster-related mortality surveillance (1). Since the 1990s, these researchers have developed more consistent approaches to identifying, collecting, and reporting disaster-related deaths to improve surveillance (3). The Centers for Disease Control and Prevention and collaborators recognize that by improving disaster death scene data, the accuracy and quality of reporting disaster-related deaths may increase. The framework used in this work is broadly based on the successful sudden unexplained infant death (SUID) investigation project, which developed guidelines and reporting forms that have improved data collection at infant death scenes and promoted uniform classification and reporting of SUID cases (7).

The Centers for Disease Control and Prevention has launched a similar effort to the SUID investigation project to improve data collection and reporting during the investigation of disaster-related deaths. As a first step in this project, we conducted a literature review of peer-reviewed articles and unpublished articles, guidelines, forms, toolkits, and protocols to examine what disaster-related data are being collected at the death scene and how the data from the death scene investigations are being used to determine disaster-relatedness. Disaster-related data include weather, flood conditions, and the functionality of warning or mitigation systems like mandatory evacuation orders and air conditioners. This literature review is the first step in a broader effort to identify existing practices that could be adapted and scaled to create more consistency in how disaster-related deaths are identified, classified, and reported. Improving the consistency of death scene data collection during and after a disaster will provide mortality data that are more comparable across jurisdictions. It will also increase the ability of public health agencies to accurately assess the burden of disasters and identify risks and protective factors. In addition, understanding the causes and circumstances of deaths directly or indirectly related to a disaster is important for public health messaging.

Improved data collection practices at the scene might help local and state officials better target response and recovery efforts by rapidly identifying people at greater risk for morbidity and mortality and help to refine strategies to prepare, respond, and recover from future disaster events.

By raising awareness of risks associated with certain types of disasters, we might prevent unnecessary deaths. The purpose of this literature review was not to conduct an exhaustive assessment of all death scene investigation materials, but to summarize published peer-reviewed and “grey” (unpublished) literature recommendations, variations in death investigation data collection practices, and to identify disaster-specific mortality tools in use.

METHODS

Overall Approach

We used a two-pronged approach to scan the grey literature, consisting of 1) unpublished state-level resources and documents obtained from key stakeholders and 2) a sample of published peer reviewed literature, to provide context. Both sets of materials were reviewed to identify relevant data (**Figure 1**).

Grey Literature Search

To identify real-world practices and lessons learned, we searched the grey literature (i.e., documents produced or published by organizations outside the typical academic or commercial channels). Because documents in the literature related to medicolegal death investigation are typically not publicly available, we used a two-step method to gather the relevant information. First, we used Google to conduct a state-specific search using each state name (“State” = “Arizona”) and a variety of death record terms spanning natural hazards and human-induced acts (**Table 2**). Pandemic-related fatalities were excluded. For example, “State” and “death investigation worksheet,” “State” and “death investigation form,” “State” and “death scene checklist,” and “State” and “death certificate worksheet.”

After completing the state-specific search, we solicited national medical examiner, coroner, and death investigator organizations and associations for best practices. Solicitations for available death scene forms, protocols, and worksheets went to two key listservs administered by the National Association of Medical Examiners and the International Association of Coroners and Medical Examiners. The American Board of Medicolegal Death Investigators and the Society of Medicolegal Death Investigators also sent our request to their subscribers. We also sent personalized emails asking approximately 30 persons identified as leaders in medicolegal death investigation from state and local jurisdictions to send copies of death scene investigation forms and guidelines. Those persons included practicing medical examiners, coroners, and death investigators.

Published Peer-Reviewed Literature Search

A focused search of the published, peer-reviewed literature was designed to provide context to the grey literature search, identifying the ways in which death scene investigation data are used and how deaths are attributed to a disaster. We used Google Scholar to search for available published articles pertaining to disaster-related death scene investigation and mortality reporting. The search engine allowed us to capture articles and literature in non-indexed journals that were unavailable in more traditional search tools (PubMed, Social Sciences Citation Index, etc.), which was important given the topic under review. In addition, we developed inclusion and exclusion criteria to create boundaries for our search (**Table 3**).

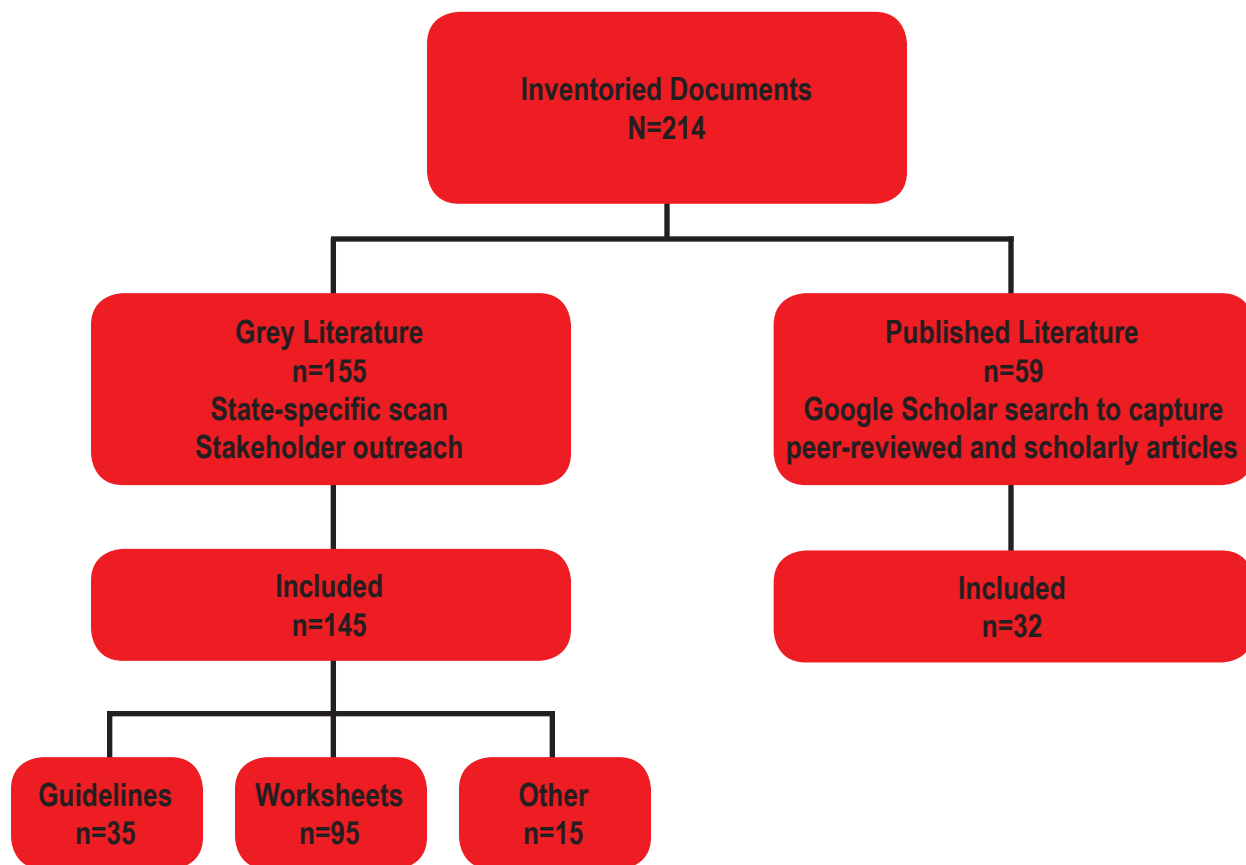


Figure 1: Approach to searching the literature for death scene investigation related to disasters and flow chart of documents included in the review.

To determine appropriate search terms, we conducted a preliminary review of articles and protocols and held several discussions with subject matter experts. Ultimately, we created three filters (categories) for our search. Filter #1 included death record search terms, filter #2 was the disaster search term, and filter #3 was the associated event search term (**Table 2**). Each search included a combination of terms: one term each from filters #1 and #2 (e.g., “death scene investigation AND snow storm”) or from filters #1, #2, and #3 (e.g., “death scene investigation AND snow storm

AND carbon monoxide”). Two analysts conducted the search of the published peer-reviewed literature in parallel, using different filters. Named disasters for filter #2 were selected based on the size and scope of the event as well as the year in which the event took place, with preference for more recent disasters.

Document Inventory and Final Literature Review

After we completed the published and grey literature searches (including solicitation of best practices), we

Table 2: Search Filters for the Literature Review of Disaster-Related Death Scene Investigation and Disaster-Related Mortality Surveillance

Filter #1 - Death Record	Filter #2 - Disasters	Filter #3 - Associated Event
Search Terms	Search Terms: Natural Hazards	Search Terms
Death scene investigation Scene investigation Death investigation Death certificate Scene worksheet Death scene protocol Death scene guideline Death scene checklist	Snow storm Ice storm Rain storm Extreme temperature Heat wave Extreme heat Heavy rain Thunderstorm Hurricane Marine hazards Tornado Earthquake Volcanic activity Volcano Tsunami	Carbon monoxide Power outage Heat Fire Wildfire Cold Wind chill Flood Mud slide Land slide Wind Hail Lightning Storm Surge High seas Rip current Debris Structural failure Ash Gas Lava Motor vehicle collision Blunt force trauma Burns Crush Drown Electrocution Fall Fire Smoke inhalation Hypothermia Hyperthermia Radiation poisoning Chemical poisoning Suffocation Trauma Traumatic injury Exposure
	Search Terms: Human-Induced Events	
	Radiation emergency Chemical spill Bombing Blast	
	Search Terms: Named Disasters	
	Hurricane Sandy Hurricane Irene West Texas explosion Colorado flash floods Oso mudslide Hurricane Katrina	

inventoried the resulting documents in a spreadsheet summarizing the source, topic, and relevance. Conditions for inclusion included: original research, review, or systematic review; focus on death scene investigation processes within the United States; focus on at least one of the topic areas outlined in the search terms; and publication between 1990 and October 2015. Exclusion criteria included: publication prior to 1990; editorial, commentary, or letter to the editor; international focus; publication in a language other than English; and unrelated to a death or death investigation (**Table 3**). In total, we found 214 potentially relevant documents. After further examination, 37 were excluded from this review because they did not relate directly to, or have implications for, processes or guidelines about collecting data at a disaster scene or reporting these data (**Figure 1**).

RESULTS

A total of 177 documents were included in this review; 145 were grey literature and 32 were published peer-reviewed articles.

Grey Literature

The 145 unpublished documents identified in this review included guidelines (n=35), death scene investigation worksheets (n=95), and other documents (n=15), including scene operations documents and mass fatality plans currently used by specific jurisdic-

tions or created as a template of a form or protocol that could be used. In general, the documents found in the grey literature search included 1) those used at or during a death scene investigation and 2) those completed after a scene investigation.

Documents Used At or During a Death Scene Investigation

We identified four general types of worksheets and protocols in the grey literature that are intended for use at the scene of a death investigation or during a disaster. These included 1) general death scene investigation guidelines and protocols, which provide information on how to conduct a safe and thorough investigation of the scene; 2) mass fatality scene operations and protocols that could be used at the scene of some disasters; 3) death scene investigation worksheets, which are typically data collection forms that scene investigators complete as they are investigating the death; and 4) disaster mortality surveillance reports, which allow personnel involved in disaster response or surveillance to record information on each decedent from data gathered at the scene or from medical examiner and coroner offices.

General Scene Investigation Guidelines and Protocols

The identified death scene investigation protocols often described 1) the types of deaths that require a

Table 3: Primary Inclusion and Exclusion Criteria for the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Include	
1.	Original research, reviews, or systematic reviews
2.	Articles that focus on death scene investigation processes within the United States
3.	Articles that address at least one of the topic areas outlined in the search terms
4.	Articles published between 1990 and October 2015
Exclude	
1.	Articles published prior to 1990
2.	Editorials, commentaries, and letters to the editor
3.	International articles
4.	Articles in languages other than English
5.	Articles that are not related to a death or death investigation

scene investigation (e.g., accidental deaths, homicides, suicides, sudden unexplained infant deaths, motor vehicle); 2) procedures for arrival at the scene (e.g., ensuring scene safety, establishing command, establishing chain of custody and involvement of different agencies, interviewing witnesses, determining time of death); 3) recommendations for documenting and evaluating the scene in writing or by photography; and 4) suggestions for working with witnesses and families (8-19). Most of the identified guidelines focused on general death scene scenarios. We did not identify any guidelines for specific disaster scenarios; however, some guidelines have specific protocols that could be applied during disaster situations, such as

protocols for environmental exposure and drowning (9, 10, 13, 14). **Table 4** summarizes guidelines and highlights key topics, data sharing, and references to disasters from scene investigation guidelines and protocols selected to represent the breadth of available information.

Mass Fatality Scene Operations and Protocols

We identified 15 mass fatality protocols and plans that provided guidance about conducting death scene investigations. Most of these documents define a mass disaster as an incident resulting in a number of deaths that exceeds the response capacity of the medical ex-

Table 4: Select General Scene Investigation Guidelines and Protocols, Identified Through the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Name	Source	Scene Investigator	Key Topics in Scene Investigation Protocol	Reference to Disaster
Arkansas County Coroner's Procedures Manual (9)	Association of Arkansas Counties	Coroner and coroner office personnel	Notification Response Location of the body Describing the victim Estimating time of death Transportation of victim Positive identification and notifying next of kin Opinion on cause and manner of death	Lists officials who should be notified promptly if the death appears to be the result of a fire, explosion, or drowning*
There was no title in the documents we received (10)	Coroner Division at the Orange County Sheriff's Department	Coroner and personnel from coroner's division	Receiving the initial call Response Arrival at the scene	Includes guidelines for death from carbon monoxide poisoning, drowning, electrical sources, exposure, fire, and motor vehicles
Standard Operating Guidelines and Scene Worksheet Details (13, 14)	Mesa County (CO) Coroner's Office	Coroner and coroner office personnel	Duties/Objectives Determination of death Reporting deaths Investigations – scene of death Notification of next of kin Evidence Death certificates	Briefly mentions emergency operations. Includes details for completing worksheets for deaths related to aircraft crashes, carbon monoxide, drowning, electrical sources, exposure, lightning, and motor vehicle collisions
Practice Guidelines for Florida Medical Examiners (11)	Florida Association of Medical Examiners	Medical examiners and personnel from medical examiner's office	Agency responsibilities Medical examiner involvement in scene investigations Guidelines for death scene investigation (e.g., documentation, evidence collection, etc.)	None

* Also states, "It is important that during times of crisis the dead are located and recovered with dignity. The killer tornado that hit Joplin, Missouri resulted in mishandling and misidentification of dead persons. The Arkansas Department of Emergency Management, the county Judges Association of Arkansas and the Arkansas Department of Health are working together on establishing a mass fatality resource inventory and forming mutual aid agreements. This important emergency management project seeks to assure mass transit accidents such as trains, buses, planes or boats make mass casualty readiness vital."

aminer, coroner, emergency services, or law enforcement staff (20-32). That definition of mass fatality will not include all disasters related to weather and associated events, only those that result in sufficient deaths to overwhelm local medicolegal systems. The identified mass fatality plans do not always explain the definition of a disaster, although many specify that the plan applies to human-induced and natural disasters. Mass fatality plans generally included sections that describe incident command staff and their responsibilities, search and recovery operations, scene safety, scene management, and postmortem identification (20-32). **Table 5** describes data collection at the scene of a mass fatality event from three selected mass fatality plans identified in this review. Exhibits were selected to reflect several different approaches to data collection following a disaster.

Death Scene Investigation Worksheets

The death investigation worksheets found in the review could be categorized into general scene worksheets that apply to a wide range of scenarios and more tailored scene worksheets for specific events (e.g., fire, drowning), settings (e.g., hospitals, nursing homes), and ages (e.g., infant, child, teenager). General scene worksheets typically captured information about the decedent in relation to the scene, the per-

son's medical history, a description of the body, and a narrative summary of circumstances surrounding the death (33-38). Some forms have specific sections about disaster-related risk factors that could contribute to the cause of death. These include tobacco use as cigarette smokers have elevated blood levels of carbon monoxide, alcohol use because impairment can hinder proper disaster preparedness, chemical exposure resulting from the event itself, and motor vehicle accident details (35-44). Most of the identified worksheets (n=11) include a narrative section allowing the death investigator to describe how a disaster contributed to a death, rather than dedicated disaster-specific questions or checkboxes (33-38, 40-42, 45, 46). Few forms explicitly ask the investigator if the death is related to a disaster (35, 36). **Table 6** lists questions about environmental factors and disaster conditions from four general investigation worksheets selected to represent a variety of approaches to describing the circumstances surrounding the death.

The tailored worksheets varied widely in scope and format. We identified worksheets for a range of potential disaster-related situations and causes of death including aircraft crashes, blunt and sharp force trauma, carbon monoxide poisoning, drowning, contact with electrical current, exposure, extreme temperature (hypothermia and hyperthermia), falls, fires, infectious

Table 5: Select Mass Fatality Scene Operations and Protocols, Identified Through the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Document Name and Source	Mass Fatality Definition	Types of Mass Fatalities or Disasters	Data Collection and Reporting at the Scene
Mass Fatality Plan, Arapahoe County Coroner's Office (ACCO) (20)	An event that results in a number of fatalities that overwhelms the normal capacity of the coroner's office	A disaster may include but is not limited to the following: major motor vehicle accident, natural disaster, act of terrorism, or industrial accident	Directs teams to set up a tracking system that will facilitate evidence collection
Scene Operations Field Operations Guide, Regional Mass Fatality Management Response System NY-NJ-CT-PA (29)	An incident that produces human fatalities of a sufficient number or complexity that special operations and organizations are required	Mass fatalities may be man-made (e.g., transportation accidents or terrorist attacks) or the result of natural disasters (e.g., tornadoes, floods, hurricanes, or pandemics)	The Review Incident Characterization Form allows for documentation of an incident to determine the extent of the medical examiner/coroner response. Includes sections for scene description and type of incident (e.g., natural, accident, or criminal/terrorist)
Mass Fatality Management Planning Toolkit, Texas Department of State Health Services (31)	An incident, disaster or public health emergency where more human deaths have occurred than can be managed with local or regional resources	Not specified	Directs those who are helping with recovery of human remains to record their findings on a form, such as the Recovery Site Report. This records detailed information about the recovery and may help determine how the incident occurred or what caused the incident

diseases, lightning, and motor vehicle crashes (13, 48-54).

Tailored worksheets typically asked targeted questions about the circumstances surrounding the death. Similar to the general worksheets, the tailored worksheets allow the investigator to describe disaster circumstances in a narrative format, but lack specific questions or checkboxes related to disasters. **Table 7** lists questions about environmental factors and disaster conditions found on some of these tailored investigation worksheets, selected to illustrate the greater specificity of questions in tailored worksheets compared to general worksheets.

Disaster Mortality Surveillance Reports

Only one worksheet, from the Mesa County (CO) Coroner's Office standard operating guidelines, is designed to allow the scene investigator to record an initial overall disaster evaluation (e.g., weather conditions) and assessment (e.g., estimated number of fatalities) (13).

Documents to be Completed After a Scene Investigation

We identified four general types of worksheets and protocols in the grey literature that are intended for use after a death scene investigation. These include 1) mass fatality plans and procedures that describe operations after a death scene investigation; 2) guidelines for reporting deaths and completing death certificates, which focus on instructing medical certifiers on the correct way to fill out the cause and manner of death; 3) death certificate worksheets, which are forms that medical certifiers fill out to complete the death certificate; and 4) disaster mortality surveillance worksheets, which allow personnel involved in disaster response or surveillance to record information related to the victims of the event.

Mass Fatality Plans and Procedures

Most of the mass fatality plans reviewed (n=13) described protocols for operations after the death scene investigation was completed. These plans typically

Table 6: Select General Scene Investigation Worksheets, Identified Through the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Name	Source	Select Questions about Environmental Factors	Questions/Sections that Could Describe Disaster Conditions
Death Scene Investigation Report (35)	Michigan Public Health Institute	Means of Death, Vehicle: Road/Weather Conditions: _____ Means of Death, Fire/Burn: Functional Smoke Detector: (Yes/No/Not Available/Unknown) Means of Death, Fall: Surface Conditions _____	Means of Death: Vehicle, Fire, Fall, Drowning Means of Death, Other: Answer options 1) Exposure to the Elements, 2) Electrocution /Lightning Strike, 3) Other (explain) _____ Scene Information: Notes Regarding Place of Incident, Describe How Injury Occurred
Worksheet of Investigation By Medical Examiner/Investigator (36)	Commonwealth of Virginia, Department of Health, Office of the Chief Medical Examiner	Means of Death, Fire: Smoke Detector (Yes/No), Operational (Yes/No) Means of Death, Vehicle: Circumstances Resulted in Drowning	Known Circumstances: Death Related to Declared Emergency Means of Death, Fire: Suspected Cause
Report of Coroner's Investigation (47)	North Dakota Department of Health, State Forensic Examiner	None	Narrative of Circumstances
Coroner Investigation Report (37)	Kentucky Coroner's Association	None	Narrative/Comments
Death Report (40)	Dudley's <i>Death and Accident Investigation Protocols</i> (48)	None	Other comments

addressed morgue operations, family assistance procedures, public communications, and logistics for releasing the bodies of decedents (21-25, 27, 29-32). In addition, most mass fatality plans included some information about issuing death certificates during a mass fatality and working with state or national offices of vital records and statistics, but did not include information about how to report the disaster as a contributing factor among the circumstances of the death (20-23, 25, 27, 30, 32). **Figure 2** shows a good example of such guidance. (23)

Guidelines for Reporting Deaths and Completing Death Certificates

Eleven documents in the grey literature provided guidance on improving cause of death reporting and accurately completing death certificates (56-66). Some guidelines instructed medical certifiers on how to accurately identify the manner of death for the decedent, which generally fell into six categories: 1) natural, 2) accident, 3) suicide, 4) homicide, 5) could not be de-

termined, or 6) pending investigation (56, 57, 63-65). When discussing accidental manners of death, some guidelines outline factors that could be related to a disaster, including crushing by a falling object, drowning, electrical shock, explosion, exposure, falls, carbon monoxide poisoning, and heat exhaustion (56, 57, 63, 65). However, few death certificate guidelines that we reviewed provided explicit instruction on identifying, certifying, and reporting deaths associated with a disaster.

Although most of the documents that addressed approaches for reporting information on disaster-related deaths were found in the grey literature, one key article in the published literature proposes a matrix to help systemize how disaster-related deaths are defined and classified (3). This paper defines a natural disaster as a “*time- and place-specific event that originates in the natural environment and [results in the] disruption of the usual functions and behaviors of the exposed human population*” (3). The authors define direct deaths as those caused by the physical forces of the

Table 7: Select Tailored Death Scene Investigation Worksheets, Identified Through the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Name	Source	Select Questions about Environmental Factors	Questions/Sections that Could Describe Disaster Conditions
Preliminary Heat Death Reporting Form (50)	Office of the Jackson County, MO Medical Examiner	Fan: on /off /broken/not applicable (NA) Approximate distance from fan Air conditioner (AC): on/off/broken/NA Approximate distance from AC Windows: open/closed/NA Approximate distance from window	Circumstantial Factors, Other:_____
Carbon Monoxide Poisoning Reporting Form (49)	Florida Department of Health	None listed	Brief description of incident
Washington State Open Water Drowning Reporting Tool (51)	Seattle Children’s Hospital and the Washington State Department of Health Injury & Violence Prevention Program	Event contributing to drowning: (e.g., airplane crash) Water current: (strong/moderate/weak/none/NA/unknown) Waves: (calm/choppy/rough/unknown)	Describe what happened and sequence of events. Make sure to include any details not previously listed that may be of importance to the investigation
Lightning Worksheet (13)	Mesa County (CO) Coroner’s Office Standard Operating Guidelines	If raining at the time of the strike, describe intensity of the rain: (hard/moderate/light/sprinkling/drizzling/foggy) Describe the environment where the lightning struck (evidence of burning, soil dampness, man-made electrical structures, etc.)	Weather conditions at time of strike? (cloudy/clear/rainy/windy/other_____) Describe the scene in general
Fire Death Worksheet (55)	Dudley’s <i>Death and Accident Investigation Protocols</i> (47)	Any evidence of flammable materials in the area: yes/no. If yes, explain Describe any exits available Describe smoke detectors at scene Describe fire extinguishers at scene Describe installed fire alarms Fire detection equipment operable: yes/no/unknown	Describe how fire started Where did fire start

disaster and indirect deaths as those caused by unsafe or unhealthy conditions that occurred because of the anticipation or occurrence of the disaster. They then create a flow chart that enables a medical examiner or coroner to determine whether the death was a result of a disaster and a classification matrix to identify the disaster and circumstances of the death.

Death Certificate Worksheets

We identified seven death certificate worksheets in the literature that were generally intended to be completed by a physician, medical examiner, or coroner. Most worksheets (n=6) asked for information about poten-

tial contributing factors to the cause of death, such as pregnancy, injuries, or tobacco use (67-72). Although the identified death certificate worksheets did not have specific sections to denote the involvement of a disaster, most included a “Describe how injury occurred” section that could be used to indicate the role of a disaster (68-73).

Disaster Mortality Surveillance Worksheets

Our search yielded several documents that highlighted disaster-related surveillance forms and systems. First, CDC has a “Disaster-Related Mortality Surveillance Form” that allows medical examiners, cor-

Step 3: What is the Medical Examiner/Coroner Office Role?

Upon determination of a mass fatality incident in California, the medical examiner/coroner (ME/C) office is responsible for:

- Contacting the Policy Manager of the State Office of Vital Records (OVR). The Policy Manager will request that a list of all known fatalities be provided to OVR and the local registrar’s office.
- Updating this list as additional information becomes available, including the type of certificate, court ordered or standard, that will be prepared for each decedent.
- Filing a single verified petition using the latest version of the Court Order Delayed form with the Superior Court to judicially establish the fact, time, and place of death for individuals who die in the mass fatality, but for whom no remains are found and/or identified.
- Not preparing a standard certificate if remains are later located and identified for an individual where a court-ordered delayed certificate was prepared.
 - o Requests to replace a court-ordered certificate with a standard certificate must be referred to the OVR Policy Manager.
 - o If remains are found after a court-ordered delayed certificate has been filed, the remains should be disposed of following regular state laws and guidelines. The court-ordered delayed certificate may be amended to reflect the disposition of remains.

The OVR will work closely with the ME/C and local registrar’s office to ensure that all certificates are registered in an expedited manner and that only one certificate is registered for each fatality.

Figure 2: Issuing death certificates during a mass fatality event, excerpt from “Death Certificates and Permits for Disposition of Human Remains” in *Managing Mass Fatalities: A Toolkit for Planning* (22).

oners, hospitals, nursing homes, or funeral homes to identify the number of deaths related to a disaster and provide basic mortality information to a designated public health officer (74). This form has a “Type of Disaster” section that allows the respondent to check one of eight choices: hurricane, heat wave, tornado, technological disaster, flood, terrorism, earthquake, or other. Some states, such as Kentucky, are using the CDC form for their own disaster operations (75). Other states, such as Texas and North Carolina, are using disaster mortality surveillance forms that do not contain the disaster checkboxes, but still allow the user to describe the circumstances of death (76, 77). Second, the American Red Cross has a “Disaster Health Services Mortality Report Form” that allows disaster relief operations staff to record information about the disaster and the decedent, including whether the death was directly or indirectly caused by a disaster (78).

Published Peer-Reviewed Literature

Of the 32 peer-reviewed journal articles included in this review, 19 examined mortality associated with a specific disaster, such as Hurricane Katrina or the Chicago heat wave, where researchers used various methods to estimate the number of disaster-related deaths and mortality rates (79-97). Additionally, most of the studies examined the circumstances surrounding the death to better characterize risk factors for these disaster-related deaths and to develop public health messaging to prevent deaths. The other peer-reviewed journal articles identified included systematic reviews on carbon monoxide and high ambient temperature (98-100) and guidance to medical examiners and coroners on a variety of related topics (101-104).

No consistent approach for determining deaths attributable to a disaster was found among the identified articles in the published literature. **Table 8** shows the variety of data sources used in these research articles. The authors generally used data recorded on the death certificate to identify disaster-related deaths (79-81, 83, 84, 86-91, 94). However, several studies used additional sources to supplement their assessment of whether the death was disaster-related (79-93, 95-97). These other data sources included medical exam-

iner and coroner reports, police reports, and medical records.

Most (12 of 19) of the published studies that examined the mortality associated with a specific disaster used death certificates as a primary data source. Cases were identified in vital statistics databases by using a specific period and searching for cases with cause of death consistent or reported as associated (either directly or indirectly) with the disaster. Depending on the type of disaster, the method to identify the deaths varied by inclusion of certain *International Classification of Diseases, 10th Revision* (ICD-10) codes and specific key words. For example, in a heat wave, heat or heatstroke might be listed as the cause of death (81, 84, 87, 89, 95). For a hurricane, deaths might be included if they were coded as a victim of cataclysmic storm (ICD-10 code X37) during the study (disaster) period (79, 83).

Five of the studies relied on active or passive surveillance systems as one of the data sources used to track disaster-related deaths (79-81, 88, 97). Two studies evaluated the use of these systems. New York City used its electronic death registration system to conduct active mortality surveillance during and after Hurricane Sandy, and the Texas Department of State Health Services pilot tested an *ad hoc* active mortality surveillance system during Hurricane Ike in 2008 (6, 105). These studies described how mortality surveillance systems successfully identified hurricane-related deaths and allowed jurisdictions to rapidly direct their public health response. In addition, the detailed information collected as part of the disaster surveillance system was a valuable resource for assessing disaster-related deaths because it includes more information about the circumstances of the death than reported on the death certificates (6).

Using a variety of data sources to identify disaster-related deaths can cause inconsistent reporting of disaster-related mortality. This inconsistency was described in a 2005 study that reviewed heat- and cold-related deaths in the United States (106). The study found that results can vary depending on the database used to identify these deaths (106).

Table 8: Data Sources Used in Disaster-Related Death Studies, Identified Through the Literature Review of Disaster-Related Death Scene Investigation and Mortality

Article Name	Death Certificates	Death Investigation Reports or Medical Examiner/Coroner Reports	Interviews with Surrogates (e.g., Next of Kin)	Disaster Surveillance Data	Telephone Interviews with Medical Examiners/Coroners	Police Reports	Inspection of Residences	Medical Records	Data from National Center for Health Statistics
Carbon Monoxide Poisoning Deaths in the United States, 1999 to 2012 (90)	X								X
Deaths Related to Hurricane Andrew in Florida and Louisiana, 1992 (82)					X				
Environmental Hyperthermic Infant and Early Childhood Death Circumstances, Pathologic Changes, and Manner of Death (85)		X							
Heat-Related Death and Mental Illness During the 1999 Cincinnati Heat Wave (84)	X	X	X						
Heat-Related Deaths During the July 1995 Heat Wave in Chicago (89)	X	X	X			X	X		
Heat-Related Fatalities in Wisconsin During the Summer of 2012 (81)	X	X		X					
Heat-Related Mortality During a 1999 Heat Wave in Chicago (87)	X	X				X			
Heat-Related Mortality in Selected United States Cities, Summer 1999 (95)					X				
Hurricane Isabel–Related Mortality—Virginia, 2003 (83)	X					X		X	
Hurricane Katrina Deaths, Louisiana, 2005 (79)	X			X					
Keraunopathology: An Analysis of 45 Fatalities (93)		X				X			
Mortality From a Tornado Outbreak, Alabama, April 27, 2011 (80)	X			X					
Mortality in Chicago Attributed to the July 1995 Heat Wave (94)	X								
Mortality Surveillance 2004 to 2005 Florida Hurricane-Related Deaths (88)	X	X		X					
Motor Vehicle–Related Drowning Deaths Associated with Inland Flooding After Hurricane Floyd: A Field Investigation (96)		X	X			X			
Overview of Deaths Associated with Natural Events, United States, 1979–2004 (92)									X
Sudden Cardiac Death Triggered by an Earthquake (86)	X	X				X		X	
The Effect of Hurricane Sandy on Cardiovascular Events in New Jersey (91)	X							X	
Tracking Deaths Related to Hurricane Ike, Texas, 2008 (97)				X					

DISCUSSION

This literature review yielded a wide range of forms and documents used to collect death scene information, but few of those captured comprehensive disaster-specific information. Death certificates were the most common data source to identify and count disaster-related deaths. Our review found, however, that officials and researchers often relied on other data to supplement the death certificates, including medical examiner and coroner reports, for additional evidence to attribute the death to the disaster and to better understand the circumstances and risk factors surrounding the disaster-related death. For example, one tailored worksheet for drowning directs the investigator to “Describe what happened and sequence of events. Make sure to include any details not previously listed that may be of importance to the investigation” (51). The reliance on supplemental data was an important finding that highlights the critical importance of consistently and accurately collecting and documenting death scene information, which is typically included in medical examiner and coroner reports. Review of the grey literature further confirmed the lack of available death scene investigation tools that could be used to investigate suspected disaster-related deaths. This also increases the difficulty of aggregating data to identify population-level trends in risk and protective factors.

When opportunities in worksheets and tools existed to encourage medical examiners, coroners, and other certifiers responsible for completing death certificates to record disaster-related information, the wide variety of guidelines available may make it difficult to do so consistently. For example, tools that could be adapted for investigating a death during a disaster, such as carbon monoxide (CO) death reporting forms, differed significantly in the data collected. The heterogeneity of these CO reporting forms indicates the potential for widespread inconsistency in collecting and reporting of CO deaths across jurisdictions and events. A guide, CDC’s *Medical Examiners’ and Coroners’ Handbook on Death Registration and Death Reporting*, has examples for describing circumstances of injury or violence in the “how the injury occurred”

section of the death certificate when the death was the result of an external cause (65). One of these examples states, “Slipped and fell while shoveling snow,” which demonstrates how a weather-related disaster could be recorded on the death certificate. However, individual investigators may record this information differently.

Understanding the current variation in death scene data collection during and after a disaster supports the development of tools to improve the consistency of this process. In addition, there is a public health need for information about risk and protective factors, and comprehensive data collection after disasters can provide such evidence. Recognizing the considerable public health benefits to having this information, CDC will facilitate the development of a disaster-related death scene investigation toolkit. Many of the tools in this review can be adapted and combined to create disaster-specific death scene investigation resources. For example, the mass fatality plans we reviewed did not emphasize the importance of recording disaster-relatedness on the death certificate. However, it could be added to sections that detail the death certificate process if applicable. Additional resources that could be developed include death scene investigation forms for common types of disasters (e.g., hurricanes, tornadoes) and guidelines for completing these forms by death scene investigators.

Although this literature review has many strengths, it also has several limitations. The primary limitation is that it is not a systematic literature review as we did not follow the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines and did not analyze the objective merits or weaknesses of each piece of identified literature. A systematic approach was used to identify grey and peer reviewed literature, but the scope of the literature review was narrowly focused. Therefore, our results are only reflective of the literature we reviewed in this study; potentially relevant mortality epidemiologic study articles may have been excluded. The grey literature search may have also missed some existing guidelines; however, we endeavored to minimize this risk by sending out requests for tools to two major professional listservs.

CONCLUSION

This literature review was a first step toward understanding what information is collected at the death scene after a disaster. The Centers for Disease Control and Prevention has convened a workgroup composed of medical examiners, coroners, death scene investigators, forensic pathologists, epidemiologists, and law enforcement officials to develop guidelines and supplemental forms for disaster-related death scene investigations. These disaster-specific data collection tools might improve the ability of death scene investigators to gather consistent information on disaster deaths and consequently allow the medical certifier to link deaths to particular disasters in their case management systems and on the death certificate. In addition, these tools will allow for additional data, such as information on risk and protective factors, to be collected immediately after a disaster-related death. This will help public health officials develop strategies for reaching at-risk persons and preventing disaster-related deaths.

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