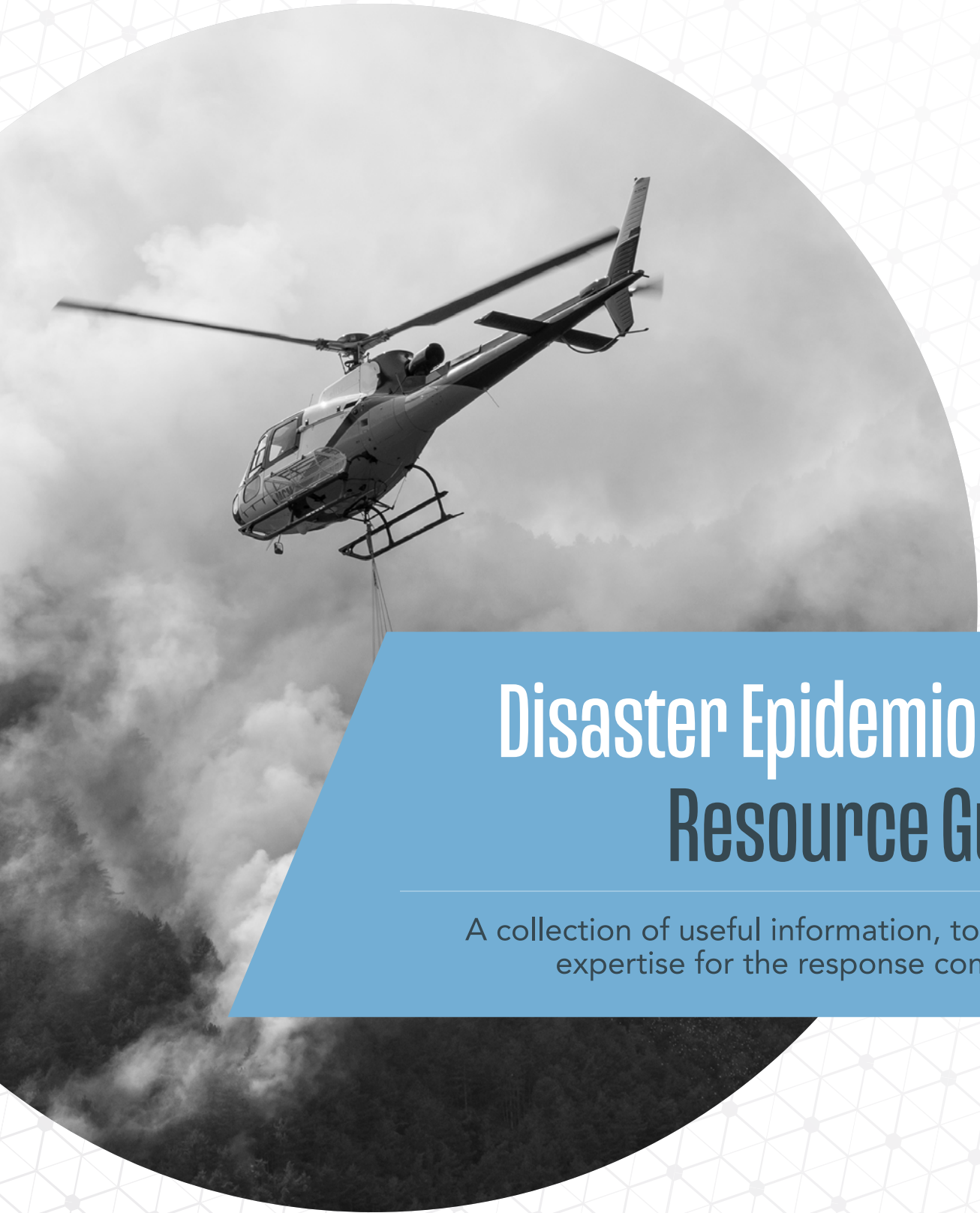


Presented by:



**CSTE**

COUNCIL OF STATE AND  
TERRITORIAL EPIDEMIOLOGISTS



# Disaster Epidemiology Resource Guide

A collection of useful information, tools, and  
expertise for the response community

July 2021



## Table of Contents

Acknowledgments .....	<a href="#">3</a>
How to Use the Guide & Chapter Summaries.....	<a href="#">8</a>
<b>Chapter 1</b> – Conducting Descriptive Epidemiology Following a Disaster: A Case Study of the West, Texas Fertilizer Plant Explosion.....	<a href="#">11</a>
<b>Chapter 2</b> – Syndromic Surveillance and Disaster Epidemiology.....	<a href="#">18</a>
<b>Chapter 3</b> – NIOSH Emergency Preparedness and Response Resources.....	<a href="#">27</a>
<b>Chapter 4</b> – Post-Disaster Surveillance .....	<a href="#">36</a>
<b>Chapter 5</b> – Disaster Epidemiology Tool: Community Assessment for Public Health Emergency Response (CASPER) .....	<a href="#">45</a>
<b>Chapter 6</b> – Assessment of Chemical Exposures (ACE).....	<a href="#">66</a>
<b>Chapter 7</b> – Shelter-Based Surveillance Systems in Post-Disaster Settings .....	<a href="#">82</a>
<b>Chapter 8</b> – Epidemiology of Behavioral and Mental Health Response to Disasters.....	<a href="#">100</a>
<b>Chapter 9</b> – Disaster Epidemiology Organizations and Tool Repositories .....	<a href="#">108</a>

*Disclaimer: This guide is a collection of chapters with multiple contributing authors providing expertise on the various disaster epidemiology methods and tools. Given this collective effort, the writing styles and formatting differ between each chapter. The information included in this document was compiled in February 2019 and published in July 2021.*

## Acknowledgments

This document is a result of work completed by the Council of State and Territorial Epidemiologists (CSTE) Disaster Epidemiology Resource Guide Workgroup, part of the CSTE Disaster Epidemiology Subcommittee. This publication was supported in part by Cooperative Agreement Number 1U38OT000143 from the Centers for Disease Control and Prevention (CDC). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of CDC. The following workgroup members developed the following guidance document:

**Hammad Akram, MD, MPH**

Infection Preventionist  
Baylor Scott & White Health

**Stephanie Alvey, BBA**

Public Health Emergency Preparedness Coordinator  
Waco-McLennan County Public Health District

**Sandi Arnold, RN**

HAI Epidemiologist  
Texas Department of State Health Services

**Tracy Barreau, REHS**

Senior Environmental Scientist  
California Department of Public Health

**Tesfaye Bayleyegn, MD**

Senior Service Fellow  
Centers for Disease Control & Prevention – National Center for Environmental Health

**Jennifer Beggs, MPH**

Emergency Preparedness Epidemiologist  
Michigan Department of Health & Human Services

**Laurel Boyd, MPH**

Epidemiologist  
(Formerly) Oregon Health Authority – Public Health Division

**Kimberly Brinker, RN, MSN, MPH**

Nurse Epidemiologist  
(Formerly) Centers for Disease Control & Prevention – National Institute for Occupational Safety & Health

**Jacqueline Cardoza, MPH**

ORISE Research Participant

*(Formerly)* Centers for Disease Control & Prevention – National Center for Environmental Health

**Mary Casey-Lockyer, MHS, BSN, RN, CCRN**

Senior Associate for Disaster Health Services

American Red Cross

**Ashley Conley, MS, CPH, CHEP, CIC**

Director of Infection Prevention

Catholic Medical Center

**Miguel Cruz, PhD, MPH**

Senior Emergency Operations Officer

Centers for Disease Control & Prevention – National Center for Environmental Health

**Lisa J. Delaney, MS, CIH**

Associate Director for Emergency Preparedness and Response

Centers for Disease Control & Prevention – National Institute for Occupational Safety & Health

**David Dickinson, MA**

Regional Administrator

Substance Abuse and Mental Health Services Administration – Region 10

**Mary Anne Duncan, DVM, MPH**

Epidemiologist

Centers for Disease Control & Prevention – Agency for Toxic Substances and Disease Registry

**Tracy Haywood**

Senior IT Geospatial Analyst

Austin Public Health

**Michael Heumann, MPH, MA**

Principal Epidemiologist

HeumannHealth Consulting, LLC

**Jennifer A. Horney, PhD**

Founding Director and Professor, Epidemiology Program

University of Delaware

**Joy Hsu, MD, MS**

Medical Officer

Centers for Disease Control & Prevention – National Center for Environmental Health

**Kazuhiko Ito, PhD**

Senior Environmental Epidemiologist  
New York City Department of Health & Mental Hygiene

**Meredith Jagger, MS, MPH**

Business Intelligence Consultant Austin Energy  
(Formerly) Oregon Health Authority – Public Health Division

**Russell Jones, MPH**

Epidemiologist  
Tarrant County Public Health

**Betsy Kagey, PhD, MSPH**

Academic and Special Projects Liaison  
(Formerly) Georgia Department of Public Health

**Katie R. Kirsch, MS**

Research Associate & Doctoral Student  
(Formerly) Texas A&M University

**Tess Konen, MPH**

Senior Epidemiologist  
Minnesota Department of Health

**Kathryn Lane, MPH, MA**

Epidemiologist  
New York City Department of Health & Mental Hygiene

**Josephine Malilay, PhD, MPH**

Associate Director for Science  
Centers for Disease Control & Prevention – National Center for Environmental Health

**Hayleigh McCall, MPH**

Program Analyst  
Council of State and Territorial Epidemiologists

**Bonnie F. Morehead, MPH**

Preparedness & Epidemiology Program Manager  
Texas Department of State Health Services

**Nicole Nakata, MPH**

Health Scientist  
(Formerly) Centers for Disease Control & Prevention – National Center for Environmental Health

**Melissa Powell, MPH**

Preparedness Surveillance & Epidemiology Team Manager  
Oregon Health Authority – Public Health Division

**Steve Ramsey, MPH**

Project Director – Disaster Research Response (DR2) Program  
National Institute of Health

**Akiko Saito, MPH**

Director of Emergency Operations  
Oregon Health Authority – Public Health Division

**Amy Schnall, MPH**

Epidemiologist  
Centers for Disease Control & Prevention – National Center for Environmental Health

**Jill Shugart, MSPH, REHS, CP-FS**

Senior Environmental Health Specialist  
Emergency Responder Health Monitoring and Surveillance Coordinator  
Centers for Disease Control & Prevention – National Institute for Occupational Safety & Health

**Alice Shumate, PhD, MPH**

Epidemiologist  
Centers for Disease Control and Prevention – National Institute for Occupational Safety & Health

**Svetlana Smorodinsky, MPH**

Disaster Epidemiologist  
California Department of Public Health

**Kahler W. Stone, DrPH, MPH**

Assistant Professor  
Middle Tennessee State University

**Erica Thomasson, PhD, MPH**

Career Epidemiology Field Officer  
West Virginia Department of Health & Human Resources/Centers for Disease Control & Prevention

**Alesha Thompson, MPH**

Program Analyst  
Council of State and Territorial Epidemiologists

**Doug Thoroughman, PhD, MS**

Acting State Epidemiologist/Career Epidemiology Field Officer  
Kentucky Department for Public Health/Centers for Disease Control & Prevention

**Angela Weber, MS**

Disaster Science Responder Research Program Coordinator  
Centers for Disease Control & Prevention – National Institute for Occupational Safety & Health

**Elizabeth Whelan, PhD**

Field Studies Branch Chief  
Centers for Disease Control & Prevention – National Institute for Occupational Safety & Health

**Jason Wilken, PhD**

Career Epidemiology Field Officer  
California Department of Public Health/Centers for Disease Control & Prevention

**Amy Wolkin, DrPh, MSPH**

Data Analytics Branch Chief  
*(Formerly)* Centers for Disease Control & Prevention – Center for Preparedness and Response

**Jessica Wurster, MPH**

Program Analyst  
*(Formerly)* Council of State and Territorial Epidemiologists

**David Zane, MS**

Epidemiologist  
Austin Public Health

## How to Use This Guide

The Disaster Epidemiology (DE) Resource Guide is designed to be a living document that provides relevant and useful information for those who are responsible for planning for, responding to, and recovering from disasters and emergencies in their jurisdiction. Each chapter of this guide provides the reader with an overview of the various methods and tools used to inform and empower the response community for the emergencies and disasters commonly confronted across the country. In addition, each chapter includes one or more examples of how the method and tools were applied in an actual disaster by a state or local public health agency. The intention is to orient the reader to these methods and tools that may be of possible interest and applicability within your jurisdiction and provide information about how they were applied during planning, response, and recovery situations.

Each chapter also includes links to specific tools and forms that are associated with the method presented. At the end of each chapter, there is additional information about other tools and evaluation documents that are related to the methods addressed in the chapter.

Finally, there is a chapter that focuses on DE tool repositories. This chapter highlights three repositories and details the kinds of information they contain, how to access them, and invites users to adapt and modify tools for their specific needs, and then to share a version of their updated tool(s) so that others can learn from their experiences. Some repositories also include evaluations and assessments of how the method and tool were used, what limitations or barriers were encountered, and how they may have been overcome. The Council of State and Territorial Epidemiologists (CSTE) plans to update and expand this DE Guide over time, so it will continue to be a resource that is of use to readers who seek to build their capacity and capabilities in this area.

**Disclaimer:** This guide is a collection of chapters with different contributing authors providing expertise on the various disaster epidemiology methods and tools. Given this collective effort, the writing styles and formatting differ between each chapter. The information included in this document was compiled in February 2019 and published in April 2021.

Application	Tool/Method	Chapter
Morbidity Surveillance	Syndromic Surveillance	<a href="#">2</a>
Worker Safety and Health	Emergency Health Monitoring and Surveillance (EHRMS)	<a href="#">3</a>
To quickly collect information on responders and other persons exposed to chemical, biological, or other harmful agents from a disaster, to identify affected and displaced people for possible future health follow-up.	Rapid Response Registry (RRR)	<a href="#">4</a>





Rapid needs assessment to determine the health status, basic needs, or knowledge, attitudes, and practices of a community	Community Assessment for Public Health Emergency Response (CASPER)	<a href="#">5</a>
Chemical exposure assessment	Assessment of Chemical Exposures (ACE)	<a href="#">6</a>
Shelter Health and Safety	Shelter Surveillance	<a href="#">7</a>
Behavioral and Mental Health Assessments	Disaster Mental Health	<a href="#">8</a>
Research methods on capturing and utilizing data during a response	Disaster Response Research(D2R)	<a href="#">9</a>

## CHAPTER SUMMARIES:

### [Descriptive Epidemiology](#)

Descriptive Epidemiology involves the investigation of disease or injury incidence and distribution by a person, time, and place. Conducting descriptive epidemiology after a disaster can be done. The disaster epidemiology case study provides an overview of the investigation, the challenges, and promising best practices.

### [Syndromic Surveillance](#)

Syndromic Surveillance systems are tools that can be used to supplement traditional public health surveillance methods during the disaster cycle. They typically include de-identified emergency department visit information, which is shared with public health agencies in near real-time.

### [NIOSH Emergency Preparedness and Response Resources](#)

Ensuring the health and safety of workers is a critical component of planning for, responding to and recovering from incident responses. The Emergency Responder Health Monitoring and Surveillance™ (ERHMS™) program has resources and tools available to help organizations protect workers during all three phases of response. Disaster Science Responder Research (DSRR) Program aims to identify research needs to protect response and recovery workers while identifying solutions to rapidly support research during emergencies.

### [Rostering and Post-Disaster Surveillance](#)

The Rapid Response Registry (RRR) is a survey tool to quickly collect essential information on responders and other persons exposed to chemical, biological, or other harmful agents from a disaster and to identify affected and displaced people for future health follow-up. Oregon and Minnesota have developed their own roster surveys and provide examples of how they utilize these emergency response planning.

## [Rapid Needs Assessment/CASPER](#)

The Community Assessment for Public Health Emergency Response (CASPER) is a specific method of rapid assessment designed to provide quickly and at low cost, household-based information about an affected community's status. The case studies provide examples and lessons learned from implementing CASPER for preparedness, response, and recovery, as well as how to use Incident Command System in CASPER implementation.

## [Chemical Release Assessments/ACE](#)

The Assessment of Chemical Exposures (ACE) is a scalable and modular set of tools developed for responding to and understanding the impacts of chemical releases. Jurisdictions can use a variety of approaches to achieve incident-specific ACE objectives and adapt ACE forms, databases, and questionnaires as necessary. The case studies provide examples of implementing ACE methodology, including lessons learned.

## [Shelter Surveillance](#)

The effects of a large disaster include the temporary displacement of individuals and families into disaster shelters, which occurs as a result of voluntary or mandatory evacuations or the direct result of damages that leave places of living uninhabitable, forcing residents to seek protection in disaster shelters. Disaster shelters bring people together, creating a need for implementing shelter-based disease surveillance systems for monitoring and identifying emerging health issues that can pose additional threats to those already impacted by a major disaster. This chapter will discuss the types of information that may be useful to collect in a disaster shelter, the challenges associated with setting up a shelter-based health surveillance system, and partnerships that are vital to a successful surveillance system.

## [Disaster Mental and Behavioral Health Response During a Disaster](#)

Once a disaster occurs, behavioral health consequences on individuals and communities occur immediately and can affect responders as well as community members who are impacted by the incident. Consequences include post-traumatic stress disorder, depression, anxiety, loneliness, fear, grief, and exacerbation of pre-existing mental health conditions, amongst other symptoms. During response and recovery efforts, disaster epidemiology techniques can be utilized to assess needs, progresses, and gaps for behavioral health programs.

## [Disaster Epidemiology Tool Repositories](#)

This chapter highlights two organizations that support the efforts of disaster epidemiologists through discussion, collaboration, and resource-sharing. These two member-based organizations are housed at the Centers for Disease Control and Prevention (CDC) and the Council of State and Territorial Epidemiologists (CSTE). Additionally, this chapter describes three tool repositories that are available through CDC, CSTE, and the National Institutes of Health (NIH), as well as an inventory of tools from the Preparedness and Emergency Response Research Centers (PERRCs). These freely available repositories house many of the disaster epidemiology tools that are available for local, state, and federal epidemiologists to use throughout the disaster lifecycle.

## Conducting Descriptive Epidemiology Following A Disaster: A Case Study of the West, Texas Fertilizer Plant Explosion

*David Zane, Kahler Stone, Hammad Akram, Stephanie Alvey, Bonnie Morehead, Sandi Arnold, and Tracy Haywood*

---

### I. Background of the Fertilizer Plant Explosion

On April 17, 2013, a fire and subsequent explosion occurred at the West Fertilizer Company plant in West, Texas. This plant is located in central Texas, in McLennan County. The explosion caused extensive damage to the homes, businesses, and schools near the plant. Because explosions of this magnitude are rare, an epidemiologic investigation was initiated to describe the fatal and nonfatal injuries caused by the explosion. The investigation found that the explosion killed 15 individuals and directly injured an additional 252 individuals.

This investigation serves as a case study on how descriptive epidemiology can be used after a disaster.

Below is an overview of the investigation, the challenges, and promising best practices.

### II. Collaboration among Multiple Governmental Partners

The investigation was implemented by the following agencies:

- Local – Waco/McLennan County Public Health District (WMCPhD)
- Regional – Texas Department of State Health Services, Health Service Region 7 (Temple)
- State – Texas Department of State Health Services, Central Office (Austin)

This multi-organization collaboration among local, regional, and state agencies was amongst the main strength of this investigation and had a direct impact on planning, logistics, implementation, data management and dissemination phases of the study. During the planning phase, the Texas Department of State Health Services (DSHS) facilitated protocol development through consultation with the Oklahoma State Department of Health and Center for Disease Control and Prevention. DSHS also assisted with the Institutional Review Board (IRB) process. To identify the acutely injured, WMCPhD and DSHS coordinated with health care facilities and hospitals most likely to have received acutely injured patients to review medical records and facilitate the data collection process.

The local health department knew the community and had existing relationships with local hospitals and healthcare organizations, which expedited the data collection process and enabled the entire team to review medical records. WMCPhD maintains a database of all healthcare facilities in the county along with schools, nursing homes, and daycare facilities routinely as part of their disease surveillance-related activities. In addition, DSHS was able to obtain contacts from the Federal Emergency Management Agency (FEMA) a list of applicants for assistance, death certificates, medical examiner reports, and mobile medical unit list. Collaboration with regional and state DSHS offices provided the team the authority to obtain data from the facilities that were outside of McLennan County boundaries. All organizations collaborated in medical record review and conducting phone interviews with injured

survivors which accelerated the investigation process. After completing the data collection and survivor interviews phases, DSHS provided data analysis, GIS, and related technical support to interpret the findings.

### III. Skills of the Investigative Team

The team consisted of five epidemiologists, one preparedness coordinator, two public health nurses, one public health planner, and one health geographer. This allowed an integrated team environment that facilitated reciprocal transfer of knowledge, expertise, and capacity.

- **Epidemiologists:** Epidemiological skills were essential in protocol/survey development, client interviews, and data management, including analysis and interpretation.
- **Preparedness Coordinator and Public Health Planner:** Coordination, planning, and logistical support; the staff was also trained in client interviews as a part of WMCPHD Epi-teams program.
- **Public Health Nurses:** Client interviews, medical records review, understanding of International Classification of Diseases (ICD) coding system, and counseling skills.
- **Health Geographer:** Analytical support, geocoding of addresses, development of map books, and mapping of individual's approximate location at the time of the explosion.

Overall this multidisciplinary team allowed for better and more efficient use of resources, minimization of costs, and led to an improvement in project-related performance and work quality. Experts with diverse skill-set provided different perspectives and solutions to problems; the team worked collaboratively and in a professional manner to complete the investigation. The team held weekly conference calls with prepared agendas and discussed team activities and goals.

### IV. Objectives of the Investigation

To understand the types and characteristics of injuries and healthcare resources that were used during and after the explosion, the investigation team sought to:

- Describe the characteristics of fatal injuries caused by the explosion
- Describe the physical injuries of survivors of the explosion
- Describe risk factors associated with injuries caused by the explosion, including the location at the time of the blast, timing of injury, and demographic characteristics.
- Quantify the number of acutely injured persons who sought medical care
- Describe the medical care received by the injured

### V. Methods

A multi-pronged approach was used to identify and collect data on injuries.

*Case definition:*

Fatal injuries due to the incident were recorded through the review of medical examiner records and death certificates of individuals who died within 1 week of post-explosion time period in the county.

Non-fatal injuries that occurred within 5 days of the explosion and related to the blast in terms of location, timing, and cause were recorded through the review of medical records from hospitals and urgent care facilities located in the county and an adjacent county.

*Data collection:*

Standardized data collection tools based on the questionnaires from the 1995 Oklahoma City bombing, 2012 Alabama tornado outbreak, and the blast injury forms developed by the Centers for Disease Control and Prevention and the American College of Emergency Physicians were referenced during the development of our data collection tools. The tools were comprised of a fatal injury abstraction form, a non-fatal injury abstraction form, and a telephone survey for survivors.

Eligible injured patients identified through medical records were contacted to participate in a survivor survey. Contact information, including residential address and telephone number, was obtained from medical records when possible. Patient records were linked with the demographic data obtained from the FEMA data on West residents whose homes were damaged or destroyed and subsequently applied for emergency assistance from the federal government. In addition, investigators conducted phone interviews with survivors to obtain additional information about their locations and whether they were indoors or outdoors at the time of the explosion. The investigation protocol and participant consent process were reviewed and approved by the state health department's IRB.

*Data analyses:*

Descriptive statistics, chi-square tests and Satterthwaite t-tests, and logistic regression models were used to analyze the data. In addition, geographical information systems were used to geocode and then map the known approximate location, at the time of the explosion, of all chart-abstracted and interviewed cases. The distance proximity of cases to the explosion's epicenter was then calculated.

## **VI. Selected Recommendations from the Investigation Findings**

Hospitals should review the results of this investigation and similar studies to better predict and plan for the types of injuries that might occur in similar emergency incidents and when and how those patients might be arriving at the medical facility, which may improve medical recognition and management of those injured. While examining apparent physical injuries, medical providers should also screen for ear and brain injuries that may result from similar emergency incidents.

Long-term care facilities (e.g., nursing homes, assisted-living facilities) should review their procedures for gathering patient medical records when evacuating or moving patients in a similar emergency and also exercise their evacuation plans regularly.

Public health entities are encouraged to use this investigation as a model for collaboration between local, regional, state, and federal agencies. A tabletop exercise using these specific incidence data and challenges would help epidemiologists improve their capacity to conduct these types of investigations in the future.

## VIII. Challenges

- Submission of study protocol to the IRB

WMCPHD and Texas DSHS staff sought IRB approval to ensure the study protocol would be appropriate and uphold the highest level of ethics through the process. Despite the investigation team already having public health authority in the state to investigate this incident, IRB approval was thought to be the best approach in light of this high-profile incident. The IRB process took approximately three months to complete. The team spent over two months developing the study protocol including the data abstraction tools, survivor interview forms, and detailed plans for data analysis and retention. Perhaps the most time-consuming element for the investigation team was deciding on the appropriate case definitions. The expedited review process by the IRB took one month before approval was granted. The time-consuming nature of submitting an IRB application should be noted for future investigations, though this IRB process helped the team carefully craft the study protocols.

- Communication of the case definitions to data sources

Several case definitions (described above) were crafted by the team, with varying complexity. Case definitions were developed to clearly and easily identify which persons were considered a case and associated with the explosion and which were not. The team contacted and provided acute care facilities with case definitions to aid in querying medical records for abstraction. Unfortunately, the case definitions often confused the health facility personnel, which necessitated further communication with them to clarify issues. This resulted in delays receiving relevant medical records and subsequent quality checks from the investigation team to ensure the appropriate records were being abstracted and that no additional records were missed. Having points of contacts and relationships with medical records departments at acute care facilities sped the process up.

- Intense media interest

Naturally, with a disaster of this magnitude, there was a great deal of sustained interest from local and state media on the investigation. The media was interested in learning more about the methodology of the investigation (e.g., counting acute physical injuries versus mental health conditions, hospital-based focus versus physician offices surveillance, future plans for long term tracking of survivors), costs, status, and timeline. The public information officers from the local and state health department worked closely with the epidemiology team on these inquiries; there was an excellent collaboration among the public information officers from the local and state health department themselves, to timely, consistently, and accurately respond to these media inquiries.

- Timeliness issue of the completed report

Perhaps one of the greatest challenges the investigation team encountered was the time required to fully complete the study, write, and publish the final report. It took one year to publish the first public health report from the initial investigation meeting and almost three years to publish the study as a manuscript in a peer-reviewed journal. Each phase of the study (i.e., medical record abstraction, survivor interviews, analysis) was underestimated for the time required, pushing the completion of the study back. By the time the study reached the report-writing phase (almost one year later), other workplace duties competed for time and priority. Once all data were collected and analyzed, the team spent two months writing the final report, passing drafts back and forth frequently. Knowing there was intense media interest, the report was carefully crafted to ensure ultimate clarity with little room for misunderstanding or misinterpretation from the results. The final report can be accessed at: <http://www.waco-texas.com/userfiles/cms-healthdepartment/file/pdf/West-Texas-Report-6-2014.pdf>. In addition, the investigation was published in a peer-reviewed journal.<sup>1</sup>

## IX. Promising Best Practices

- Designated coordinator for investigation

This investigation, as already noted, took significant time to complete. To keep the investigation moving forward, one member of the team served as coordinator to facilitate weekly calls to discuss progress, issues, and task assignments. Having a designated coordinator to keep the multidisciplinary team focused was critical to the completion of this investigation and highly recommended for similar future investigations.

- Existing epidemiology capacity at local, regional, state levels

Existing epidemiology capacity at the local, regional, and state levels was critical for the successful completion of this investigation. As noted above, the epidemiology capacity consisted of protocol/survey development, client interviews, and data management, including analysis and interpretation. But it also included a willingness to apply these capabilities in response to a disaster to describe what happened and to provide subsequent recommendations for hospitals, long-term care facilities, and public health agencies. This capacity was supported by local, state, and federal funding.

- Consultation with blast and disaster experts

Because explosions of this magnitude are rare, the epidemiologic team reached out for advice to state and federal public health colleagues that had conducted similar investigations. As noted above, conference calls were held with epidemiologists that responded to the 1995 Oklahoma City bombing and the 2012 Alabama tornado outbreak. These conversations yielded valuable insights which contributed to the development of the epidemiologic investigation approach to this disaster. Talking with colleagues with similar experience was extremely valuable and built confidence that this investigation would be successful.

- Established working relationships with hospitals and urgent care facilities

The investigation team reviewed 654 patient records at 14 facilities, including 11 hospitals and 3 urgent care facilities. Access to hospital medical records is key to this type of investigation; therefore, it was very valuable for DSHS and WMCPHD to have established relationships with those hospitals and urgent care facilities. Due to the complexity of the case definitions, extensive communication with the facility staff was necessary to ensure all records that pertained to the investigation were included. WMCPHD clinic staff and epidemiologists work with hospital staff in a variety of different capacities daily. Existing contacts from these staff were able to direct the investigative team to the appropriate department contacts who could release the needed records. Medical facilities must take every effort to protect the health information of their patients, and existing confidentiality and privacy laws can create a barrier to accessing the medical record data. Being a trusted partner agency with existing information sharing mechanisms makes the process quicker.

- Mental health training/awareness provided to medical abstraction and interview teams

The epidemiologic plan was for team members to review medical charts and interview survivors of the explosion. It was anticipated that reading graphic descriptions of injuries, listening to survivors' vivid stories of their experiences, and acknowledging the enormous grief in the community may impact the mental health of the epidemiology team. As such, early on, a psychiatrist colleague provided mental health training to the team so that they would better equip them in to recognizing, processing, coping, and seeking professional assistance with emotions and feelings that might be experienced during the investigation.

- Access to FEMA data

The local health department contacted state FEMA representatives and requested permanent and temporary residential address and alternate telephone numbers on West residents whose homes were damaged or destroyed and subsequently applied for emergency assistance from the federal government. The goal was to obtain this information as part of the epidemiologic plan to conduct survivor interviews. A Centers for Disease Control and Prevention colleague had informed us that a request of this nature to FEMA was allowed, as announced in the Federal Registry, incidentally published just two weeks after the explosion.<sup>2</sup> The request for FEMA individual assistance files is allowed "for the purpose of contacting FEMA applicants to seek their voluntary participation in surveys or studies concerning effects of disasters, program effectiveness, and to identify possible ways to improve community preparedness and resiliency for future disasters." FEMA representatives provided the requested information quickly.



- Use of GIS in injury mapping

Mapping was an invaluable tool in this epidemiologic investigation. Geocoding the approximate location, at the time of the explosion, of all chart-abstracted and interviewed individuals allowed for the calculation of their distance proximity to the explosion's epicenter. This led to the conclusion that patients located closer to the explosion were more likely to be admitted to the hospital for treatment of injuries than were those who were located further away.

*Prepared by David Zane, Kahler Stone, Hammad Akram, Stephanie Alvey, Bonnie Morehead, Sandi Arnold, and Tracy Haywood (8/4/2017)*

## References

<sup>1</sup> Metzger K, Akram H, Feldt B, Stone K, Alvey S, Henley S, Hernandez A, Melville S, Haywood T, Zane D. Epidemiologic Investigation of Injuries Associated with the 2013 Fertilizer Plant Explosion in West, Texas. *Disaster Med Public Health Prep.* 2016 Aug;10(4):583-90.

<sup>2</sup> Disaster Assistance Recovery Files, Notice of Privacy Act System of Records, 78 Federal Register 25282, 48765-6, April 30, 2013.

## Syndromic Surveillance and Disaster Epidemiology

*Meredith Jagger<sup>1</sup>, Laurel Boyd<sup>2</sup>, Kazuhiko Ito<sup>3</sup>, Kathryn Lane<sup>3</sup>, Melissa Powell<sup>2</sup>*

<sup>1</sup>Austin Energy; Formerly Oregon Health Authority, Public Health Division <sup>2</sup>Oregon Health Authority, Public Health Division

<sup>3</sup>New York City Department of Health and Mental Hygiene

---

Syndromic surveillance systems are now available in many public health jurisdictions, and the combination of clinical and non-clinical data captured in such systems can enhance situational awareness before, during, and after an event of public health importance. Sources of data for such systems typically include medical records, such as emergency department (ED) visits, which are captured in near real-time, and they can include non-clinical data, such as prescription refills, school absenteeism, veterinary disease reports, or weather [1]. The concept of syndromic surveillance was developed in the late 1990s as a response to the increased awareness of and perceived potential for bioterrorism attacks [1, 2]. The theory is that by categorizing and monitoring the baseline levels of patients' stated reasons for seeking medical care (e.g., my stomach hurts; rash on arms and itchy eyes; wheezing and coughing) aberrations in these trends, which might indicate a disease outbreak, including one that stems from bioterrorism, can be identified more quickly than with traditional surveillance mechanisms [2]. These systems are thus tools to complement, not replace, other public health data-gathering techniques [2].

Today, the focus of syndromic surveillance has shifted and expanded beyond bioterrorism and epidemic detection. Primary uses now include situational awareness, outbreak characterization, and resource allocation [3]. The advent of Meaningful Use (a component of the American Recovery and Reinvestment Act of 2009) has incentivized the submission of standardized data from hospital electronic health records to participating public health authorities [4]. A small number of jurisdictions had created syndromic surveillance systems before the advent of Meaningful Use (which began in 2012), but many more have had the opportunity to set up such systems since. The Centers for Disease Control and Prevention's (CDC) National Syndromic Surveillance Program (NSSP) uses a version of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE), which was developed and is supported by The Johns Hopkins University Advanced Physics Lab [5]. Many state and local public health agencies also use commercially available platforms such as ESSENCE or Real-time Outbreak and Disease Surveillance (RODS). Others like New York City and North Carolina use locally developed ones.

Regardless of location, the core of most syndromic surveillance systems is emergency department (ED) visit data [3, 6, 7]. Such systems receive automated data feeds with a 48- or 24-hour delay, while others get it hourly or even faster. These (Meaningful Use) data usually contain the patient's chief complaint for the visit (i.e., why they are seeking care), date and time of visit, healthcare facility information (e.g., location, healthcare system, facility type), and patient demographics. As a patient progresses through their visit, other fields such as triage notes and eventually discharge diagnosis codes may be added to the visit record automatically [3].

For disaster epidemiologists, there are several important uses for syndromic surveillance data. First, before an event or incident, these data provide excellent baseline information. It is important to think about the underlying population demographics, know which facilities report, and understand the pre-existing queries or syndromes for categorizing types of visits. Reviewing known hazards for the region or season can help contextualize likely post-disaster outcomes.

During an event of public health importance, monitoring the total number and types of visits can help decision-makers understand the extent of the impact on the healthcare system and allocate limited resources wisely. There may be a delay in individuals' seeking care or significant changes in care-seeking patterns (e.g., patients going EDs if urgent cares and primary care offices are closed), which will be important to know about during a response and into the recovery phase [6]. Comparing syndromic data with data from other sources, such as information on hospital staffing capacity or available beds, can provide a better picture of a developing situation. After a disaster, continued monitoring of syndromic surveillance data is important because some health outcomes may be delayed (e.g., with longer incubation periods of some communicable diseases) or are more likely during a clean-up phase (e.g., injury or exposure to a toxic substance) [8]. A return to expected visit counts, types of complaints, and demographics mark an important milestone during a recovery phase.

There are many examples of syndromic surveillance being used for disaster epidemiology purposes. Fortunately, the large-scale bioterrorism incidents that early developers of syndromic surveillance anticipated have not materialized, but this type of data has been used after human-caused incidents. The State of Oregon supported monitoring of visits made by residents of a rural area after an oil train derailed (for more see Case Study 1 below). The Washington State Department of Health did surveillance after a tunnel collapsed at the Hanford nuclear site and shared the queries with Oregon, as there was concern about the worried well-seeking care across state borders [9]. The New York City Department of Health and Mental Hygiene (DOHMH) tracked asthma visits after a large building collapse and subsequent fire (for more see Case Study 2 below).

The governmental response to natural disasters can also benefit from syndromic surveillance data. For climate-sensitive hazards, CSTE has recently published a comprehensive guidance document [10] and has workgroups developing syndrome definitions for heat [11] and cold exposure. The Kansas Department of Health and Environment has retrospectively analyzed storm- and tornado-related injuries [12]. The Florida Department of Health has significant experience using permanent and temporary data feeds after tropical storms and hurricanes [13]. The Oregon Health Authority has supported local and state surveillance of wildfires and resultant hazardous air quality. When Jackson County, Oregon, was afflicted by wildfires and wildfire smoke during August and September 2017, local public health monitored sudden or sustained increases in ED visits and PM<sub>2.5</sub> (particulate matter  $\leq 2.5$  microns in diameter). Surveillance findings were documented in The Wildfire Smoke and Health Impact Surveillance Report and shared with Jackson County Commissioners [14]. The New York City DOHMH has used syndromic data to track cold-related illness during periods of extreme winter weather and following Superstorm Sandy. They also use time-series regression models to assess whether observed visit counts are higher than typically observed for the time of year and weather conditions [15].

It should be noted that in situations in which infrastructure at either the healthcare facility or the public health agency is damaged (e.g., in a catastrophic earthquake or prolonged power outage), syndromic surveillance would not be immediately or even quickly available. In such cases, other data-gathering techniques, like active surveillance, may be necessary. However, the possibilities for syndromic surveillance data use for disaster epidemiology are expansive. Collaboration among data-system managers, users, and decision-makers before an event of public health importance is key to the timely and wise use of data.

### *Citations for Chapter:*

- [1] Lombardo, J., Burkom, H., Elbert, E., Magruder, S., Lewis, S. H., Loschen, W., ... Pavlin, J. (2003). A Systems Overview of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE II). *Journal of Urban Health, 80(Suppl)*, i32–i42. doi: 10.1007/PL00022313.
- [2] Henning, K. J. (2004, Sept 24). Overview of Syndromic Surveillance What is Syndromic Surveillance?. *Morbidity and Mortality Weekly Reports, 53(Suppl)*, 5-11. Retrieved from <https://www.cdc.gov/mmwr/preview/mmwrhtml/su5301a3.htm>.
- [3] Yoon, P. W., Ising, A. I., & Gunn, J. E. (2017). Using Syndromic Surveillance for All-Hazards Public Health Surveillance: Successes, Challenges, and the Future. *Public Health Reports, 132(Suppl)*, 3S-6S. doi: 10.1177/0033354917708995.
- [4] Office of the National Coordinator for Health Information Technology. (2015). EHR Incentives & Certification: Meaningful Use Definitions & Objectives. Retrieved from <https://www.healthit.gov/providers-professionals/meaningful-use-definition-objectives>
- [5] Centers for Disease Control and Prevention, Division of Health Informatics and Surveillance. (2017). National Syndromic Surveillance Program (NSSP). Retrieved from <https://www.cdc.gov/nssp/index.html>.
- [6] Hughes, H. E., Hughes, T. C., Haile, A., Smith, G. E., McCloskey, B., & Elliot, A. J. (2017). Syndromic Surveillance Revolution? Public Health Benefits of Modernizing the Emergency Care Patient Health Record in England. *Public Health Reports, 132(Suppl)*, 12S-15S. doi: <https://doi.org/10.1177/0033354917706955>.
- [7] Lall, R., Abdelnabi, J., Ngai, S., Parton, H. B., Saunders, K., Sell, J., ... Mathes, R. W. (2017). Advancing the Use of Emergency Department Syndromic Surveillance Data, New York City, 2012-2016. *Public Health Reports, 132(Suppl)*, 23S-30S. doi: <https://doi.org/10.1177/0033354917711183>.
- [8] Endericks, T. (2015). Chapter 2: Legacy and Evaluation. In Public Health England and World Health Organization (Eds.) *Public Health for Mass Gatherings: Key Considerations*. Retrieved from [http://apps.who.int/iris/bitstream/10665/162109/1/WHO\\_HSE\\_GCR\\_2015.5\\_eng.pdf?ua=1&ua=1](http://apps.who.int/iris/bitstream/10665/162109/1/WHO_HSE_GCR_2015.5_eng.pdf?ua=1&ua=1).
- [9] Harry C., Washington State Department of Health. Personal Communication. 2 November 2017.

[10] Harduar Morano L., Jagger M.A., Barrett E.C., Berisha V., Borjan M., Heitzinger K., ... CSTE Climate and Health Syndromic Surveillance Workgroup. (2017). *Syndromic Surveillance Climate and Health Guidance Document*. Council of State and Territorial Epidemiologists. Retrieved from [http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/Syndromic\\_surveillance\\_clima.pdf](http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/Syndromic_surveillance_clima.pdf).

[11] Berisha, V., Braun C.R., Cameron, L., Hoppe B.O., Lane, K., Mamou, F., ... Wurster, J. (2016). *Heat-related Illness Syndrome Query: A Guidance Document For Implementing Heat-related Illness Syndromic Surveillance in Public Health Practice*. Council of State and Territorial Epidemiologists. Retrieved from [http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/CSTE\\_Heat\\_Syndrome\\_Case\\_Defi.pdf](http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/pdfs/pdfs2/CSTE_Heat_Syndrome_Case_Defi.pdf).

[12] Stein, Z. M. (2017). Creation of a Kansas Spring Extreme Weather Syndrome Definition and Unique Records. *Online Journal of Public Health Informatics*, 9, 1. Retrieved from [http://www.syndromic.org/storage/documents/2016\\_Conference/abstracts/posters/isds16\\_pos\\_creation%20of%20a%20kansas\\_stein.pdf](http://www.syndromic.org/storage/documents/2016_Conference/abstracts/posters/isds16_pos_creation%20of%20a%20kansas_stein.pdf).

[13] Centers for Disease Control and Prevention, National Syndromic Surveillance Program. (2017). NSSP Update: Three Hurricanes with Difference Support Scenarios. Retrieved from <https://www.cdc.gov/nssp/documents/nssp-update-2017-10.pdf>

[14] Phillips T., Jackson County Health & Human Services. Personal Communication. 2 November 2017.

[15] Lane K., Lall, R., Wheeler, K. Ito, K., and Matte, T. Evaluating Utility of Cold-Injury Syndromic Surveillance Data in New York City. *Online Journal of Public Health Informatics*, 5, 1. Retrieved from <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3692768/>

## Case Study 1: Oil Train Derailment in Mosier, OR

In the early afternoon of Friday, June 3, 2016, a train carrying multiple cars filled with oil derailed within Mosier, a small town on the Oregon side of the Columbia River Gorge (across the river from the State of Washington). An Oregon Public Health Division preparedness liaison immediately contacted the Preparedness Surveillance and Epidemiology Team at the Oregon Public Health Division for assistance in monitoring regional public health consequences using Oregon ESSENCE, Oregon's statewide syndromic surveillance platform.

Oregon ESSENCE began accepting emergency department data in 2011 and now captures syndromic data from all 60 eligible hospital EDs in Oregon in addition to data from urgent care centers, the Oregon Poison Center, and several other sources. In 2016, Oregon ESSENCE had regional coverage with ED data, including this region of the state. Participating hospitals sign a data-use agreement that allows for routine use of these data for situational awareness during emerging events by local and state public health professionals. Required data fields include basic demographic information, chief complaint, and diagnosis codes associated with the visit. These records do not include identifiers such as patient name, address, or date of birth.

Initial information about the incident indicated that at least some of the oil cars were on fire; by the afternoon, news media began to report explosions from some of the cars. Interstate 84, the highway that runs parallel to the railway lines, was closed to traffic in both directions. What was not known on Friday afternoon was whether citizens were being evacuated, whether the fire had damaged power lines, the extent to which the oil was leaking into the Columbia River or the municipal water supply, and whether air quality was affected by fire or fumes. Based upon this initial information, Oregon epidemiologists developed a surveillance strategy on Friday afternoon to be implemented the following day (because data are delayed by one day). ESSENCE automatically highlights statistically significant increases in visits, and it can create a daily report or dashboard, simplifying trend identification. Epidemiologists created queries in the ESSENCE interface and an event-specific report that was shared back with the liaison. The report displayed charts of total emergency department visits and those indicating:

- Asthma or headache potentially related to poor air quality due to fire or fumes
- Rash or exposure due to skin contact with crude oil
- Words such as “train” or “derailment” specific to the event
- Injuries related to evacuation or clean-up
- Motor vehicle accidents from evacuation or road closure
- Heat-related symptoms due to hot summer temperatures

Because this event occurred near the Washington-Oregon border, Oregon epidemiologists contacted Washington colleagues on Friday afternoon to alert them and discussed the possibility of surveillance at a nearby Washington hospital.

These queries were monitored over the weekend and into the next week. Beginning June 3 and stretching into June 8, this region experienced a heat wave, with temperatures ranging from 90–99°F (unseasonably warm for the region).

Surveillance findings in the several days following the incident did not identify ED visit trends related to the derailment. For several reasons, the system may not have been able to identify increases. The tools may not have been able to capture trends where they existed, because increases in visits among residents from a small town may not have been apparent at local regional hospitals; or because residents might have sought care outside emergency departments—e.g., in primary-care or outpatient-care centers—visits to which are not captured by Oregon’s ESSENCE. It is also possible the residents were evacuated before they were exposed to event-associated hazards. Several days after the event, ESSENCE identified increases in visits for asthma and heat-related illness in this region as the temperatures increased (a routine finding for heat waves). These increases did not appear to be directly related to the train derailment, but they did indicate that the surveillance tool was sufficiently sensitive to have captured increases in these types of visits in the wake of the incident.

Large-scale incidents and evacuations can cause or exacerbate mental health issues, including post-traumatic stress disorder [1, 2]. Syndromic surveillance at emergency departments may not be the best tool for this type of monitoring, as visitors may have varied or non-descriptive reasons for seeking care, not easily classified with text parsing, and with long-term follow-up impossible for ESSENCE because it

does not capture patient identifiers. Nevertheless, this type of surveillance is routinely used for human-caused incidents, weather events, and mass-gathering surveillance in Oregon. Since 2016, Oregon epidemiologists have refined and improved this surveillance, which is now routinely incorporated into the Oregon Public Health Division Incident Management Team and shared with the Public Health Director and other leadership. Often, the *absence* of an increase in health events is as important to identify as is a sudden swell in visits. These findings add context to risk communications and can address rumors about events in nearly real time.

#### *Citations for Case Study 1:*

[1] Galea S, Nandi A, Vlahov D. The Epidemiology of Post-Traumatic Stress Disorder after Disasters. 2017; 27(November): 78–91.

[2] Dirkzwager A, Grievink L, Van der Velden P, Yzermans CJ. Risk factors for psychological and physical health problems after a man-made disaster Prospective study. *Br J Psychiatry*. 2006; 189: 144–9.

#### **Case Study 2: Asthma Surveillance Following Unexpected Building Collapses and Fires**

Smoke and dust from building fires or collapses of buildings are potentially hazardous to health [1,2]. Air pollution, including fine particulate matter (PM<sub>2.5</sub>), is known to exacerbate asthma, [3] and studies have reported short-term associations between air pollution and asthma emergency department (ED) visits in New York City (NYC) and other cities [4,5].

The NYC Department of Health and Mental Hygiene’s (DOHMH) Bureau of Environmental Surveillance and Policy, in collaboration with the Bureau of Communicable Disease’s syndromic surveillance unit, conduct syndromic surveillance to inform situational awareness and support public messaging and response. The health department assessed potential respiratory health effects following the collapse of two buildings (caused by a gas leak) in 2014, a 7-alarm fire and collapse of 3 buildings following a gas leak in 2015, and several large warehouse fires in 2014 and 2015.

Our analyses were conducted within days after the incidents because we were able to utilize existing syndromic surveillance infrastructure [6]. Since 2002, DOHMH’s syndromic surveillance unit has collected daily data on ED visits. Syndromes representing several major illness categories, including asthma, have been developed over the years. We also have a protocol in place, approved by the agency’s Institutional Review Board, that covers the surveillance methods and data.

We built time-series models of daily asthma ED visits to determine whether asthma visits increased as a result of the disasters. (See Figure 1 below for an example from the 2015 East Village Fire.) Asthma ED visits in NYC have strong seasonal (e.g., pollen reactions in the spring and school-opening-related viral infections in the fall) and day-of-week patterns. First, a simple over-dispersed Poisson model was built with day-of-week and smooth functions (natural cubic splines) of day-of-year and year for the citywide asthma ED visits syndrome. The regression model was built on the past years’ data (e.g., 2002–2014 for the 2015 event) and predictions were made for about one month before and up to 10 days after the event. Because the syndromic data include the residential zip code for each ED visit, it was possible to

repeat the process for the “affected” zip codes and the rest of the city, with each area’s prior years’ data to build the models.

For all the fire and building-collapse incidents, our models demonstrated that ED visits for asthma did not increase, either citywide or in the affected areas. We found that asthma ED visits for the day of the events and for several days afterward were within the prediction intervals of the model.

Surveillance findings were shared with DOHMH agency leadership. For the 2015 building collapse, city leadership was able to respond to questions from the press regarding the health impacts of local air quality. Through this experience and ad-hoc analyses following other building collapse and fire events ,however, we also identified several methodological limitations that require addressing: (1) difficulty in defining an “affected area” due to the lack of spatially- and temporally-resolved near-real-time exposure data; (2) larger prediction confidence bands due to smaller numbers of ED visits in sub-areas; (3) challenges in assessing the health effects of disaster events that occur during strong seasonal peaks, such as during spring pollen and fall viral-infection periods: previous events did not happen during these periods, but they might in the future.

To address these limitations and to better prepare for future disaster events, we are developing a routine asthma ED visits syndrome prediction model that will incorporate weather and air-pollution data as predictors and with a better estimation of the spring and fall peak impacts.



*Figure 1. Neighborhood affected by the 2015 East Village Fire; taken during the response in New York City.  
Photo credit: Kazuhiko Ito.*



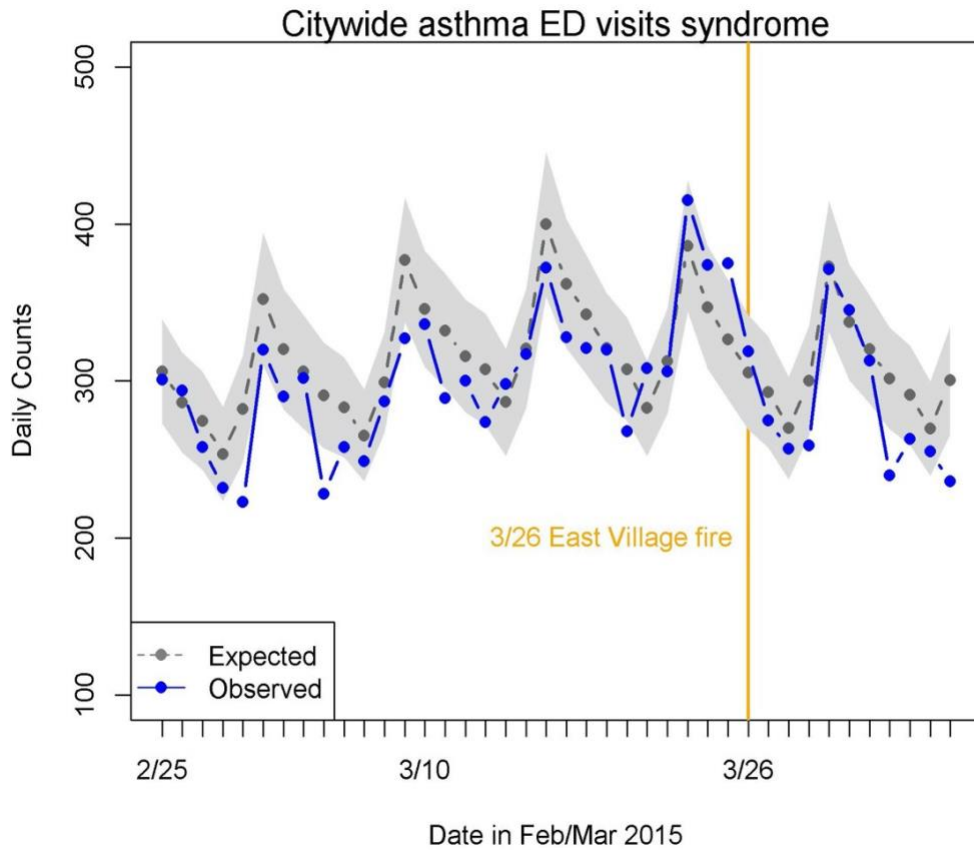


Figure 2. Figure produced during the 2015 East Village Fire response.

Y-axis: Daily counts of asthma-syndrome ED visits for all city ZIP codes of residence.

X-axis: Dates in late February through early April 2015. Orange vertical line: March 26, 2015 (the date of the fire). Blue line: Observed "asthma-syndrome ED visits. Gray dotted line: "asthma-syndrome ED visits predicted from day of week, day of year, and long-term trend. Gray shade: Estimated 95% confidence bands of daily predicted values.

## Citations for Case Study 2:

[1] Stefanidou, M., Athanasis, S., & Spiliopoulou, C. (2008). Health impacts of fire smoke inhalation. *Inhalation Toxicology*, 20(8), 761-6.

[2] Centers for Disease Control and Prevention (CDC). (2003). Potential exposures to airborne and settled surface dust in residential areas of lower Manhattan following the collapse of the World Trade Center-- New York City, November 4-December 11, 2001. *Morbidity and Mortality Weekly Report*, 52(7), 131-6.

[3] Koenig, J. Q. (1999). Current reviews of allergy and clinical immunology - Air pollution and asthma. *The Journal of Allergy and Clinical Immunology*, 104(4), 717-722.

[4] Peel, J. L., Tolbert, P. E., Klein, M., Metzger, K. B., Flanders, W. D., Todd, K., ... Frumkin, H. (2005). Ambient Air Pollution and Respiratory Emergency Department Visits. *Epidemiology*, 16 (2), 164-174.

[5] Spira-Cohen, A., Chen, L. C., Kendall, M., Lall, R., & Thurston, G. D. (2011). Personal Exposures to Traffic-Related Air Pollution and Acute Respiratory Health among Bronx Schoolchildren with Asthma. *Environmental Health Perspectives*, 119(4), 559-565.

[6] Heffernan R, Mostashari F, Das D, Karpati A, Kulldorff M, Weiss D. (2014) Syndromic surveillance in public health practice, New York City. *Emerg Infect Dis*. 10(5), 858-64.

Compiled by Meredith Jagger 8/21/2018

## NIOSH Emergency Preparedness and Response Resources

*Lisa J. Delaney, MS, CIH, Jill Shugart, MSPH, REHS, Angela Weber, MS*

---

### Introduction

The National Institute for Occupational Safety and Health (NIOSH), established by the Occupational Safety and Health Act of 1970, is a research agency that focuses on the study of worker safety and health, including response and recovery workers. NIOSH is part of the Department of Health and Human Services (HHS), Centers for Disease Control and Prevention (CDC), and serves as the lead agency for occupational safety and health during emergency and incident responses. Response and recovery workers are a common denominator in any emergency response or incident regardless of type or size. Safeguarding the health and safety of these response and recovery workers is critical to ensure they can continue providing response and recovery support. Following the 2001 attacks on the World Trade Center and Pentagon and the anthrax letter attacks, NIOSH created a coordinated emergency preparedness and response program to ensure that occupational safety and health knowledge were adequately represented in federal planning and response efforts. Initially, the program focused on terrorism events, but it has subsequently broadened to address a range of incidents including major natural and chemical disasters, terrorist attacks or threats, nuclear accidents, and infectious disease outbreaks.

The NIOSH Emergency Preparedness and Response (EPR) Program is coordinated by the [NIOSH Emergency Preparedness and Response Office \(EPRO\)](#) located in Atlanta, GA. NIOSH EPRO staff are on call 24 hours a day, seven days a week, and 365 days a year to respond to emergencies. NIOSH is equipped to provide a broad range of field responses and consultative expertise across a wide range of emergency types, either during pre-event planning or during responses. Additionally, NIOSH has developed a robust [Emergency Preparedness and Response Resources website](#) that provides tools and communications materials on common hazards faced while responding, and guidance on how to protect response and recovery workers. For this chapter, NIOSH describes two priority areas of NIOSH EPR work: the Emergency Responder Health Monitoring and Surveillance™ (ERHMS™) Framework and the Disaster Science Responder Research (DSRR) Program. ERHMS™ is a framework that describes how an organization can monitor the health and safety of emergency responders and recovery workers throughout the phases of a response. The DSRR Program was stood up in 2014 to improve and support the conduct of occupational safety and health disaster research either before or during an emergency.

## Emergency Responder Health Monitoring and Surveillance™ (ERHMS™) Framework

Due in large part to the demonstrated need to better protect, equip, and promote the health and safety of emergency responders and recovery workers during previous emergency events, including the 9/11 attacks and Hurricanes Katrina and Rita, NIOSH collaborated with federal agencies, state health departments, volunteer organizations, and unions to create the ERHMS™ program. ERHMS™ is a framework that allows an organization to monitor the health and safety of emergency responders throughout the pre-deployment, deployment, and post-deployment phases of a response. The goals of ERHMS™ are to prevent short-term and long-term illness and injury in all emergency responders and recovery workers and to ensure workers can respond safely and effectively to current and future emergencies. Traditional groups of workers that typically respond to emergencies include law enforcement, fire, hazardous materials teams, emergency medical personnel, and construction, and utility workers. They may also include public health agency staff such as epidemiologists, environmental health specialists, industrial hygienists, mental health professionals, and volunteers such as the Medical Reserve Corps and the American Red Cross.

ERHMS™ aims to ensure specific activities are conducted to protect the health and safety of emergency response and recovery workers during each of the three phases of a response (Figure 1). During the [pre-deployment phase](#), organizations should ensure workers are properly rostered, credentialed and trained, fit for duty, and that the organization can store this information in a secure manner. During the [deployment phase](#), health monitoring and surveillance should be conducted while workers perform their job tasks to ensure the prompt identification of potential exposures so that appropriate corrective measures are taken to eliminate further exposure. This includes making sure workers have appropriate personal protective equipment, access to potable water, safe food, and secure housing. During the [post-deployment phase](#), workers should be properly demobilized, and it should be determined if a referral for medical evaluation or long-term tracking is needed. After action meetings should be conducted, and lessons learned documented in order to improve future responses continually.

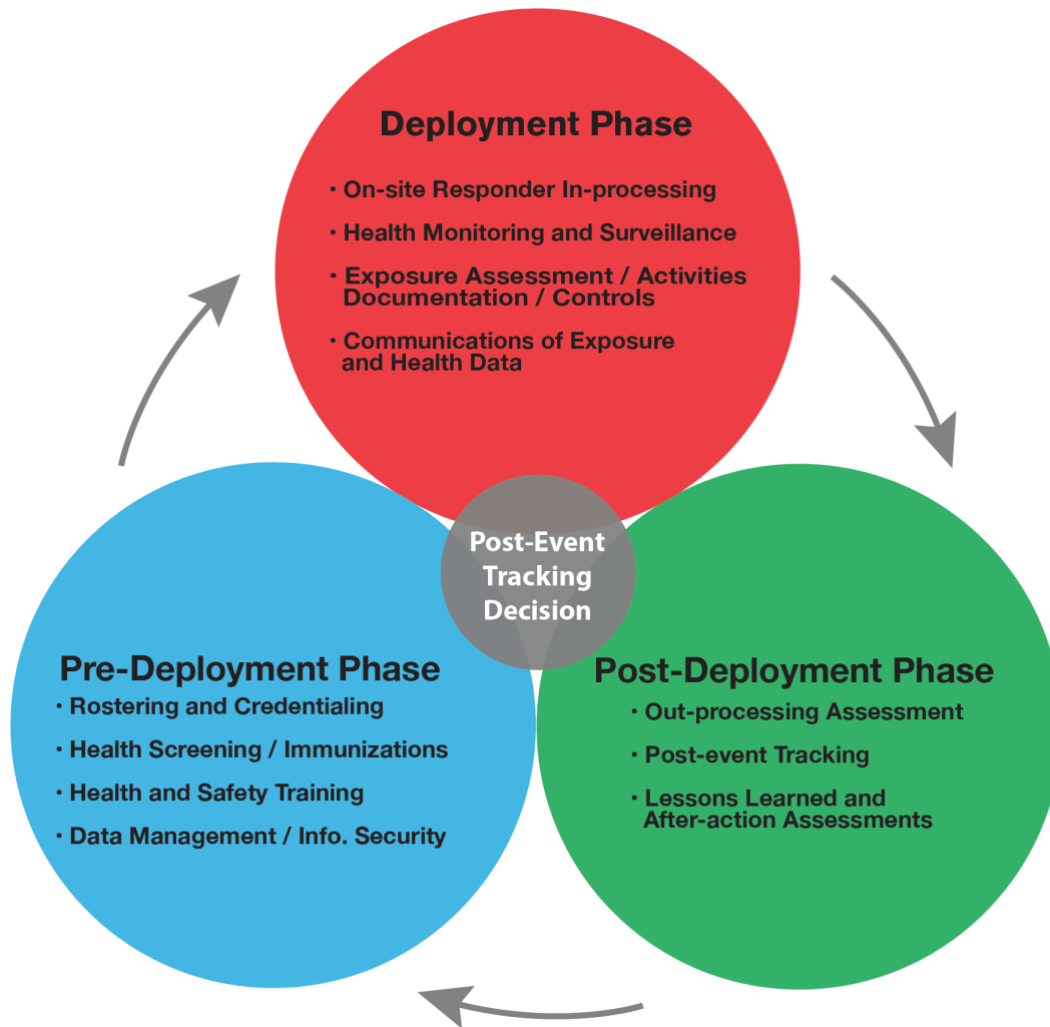


Figure 1: Three Phases of ERHMSTM

NIOSH led an effort to test ERHMS™ in a large-scale response during the 2010 Deepwater Horizon (DWH) oil spill. NIOSH staff incorporated the ERHMS™ framework primarily by rostering workers at the event and conducting health surveillance of workers during the pre-deployment phase and deployment phase of the response. NIOSH staff were able to manually roster over 55,000 workers working in three different states (Alabama, Mississippi, and Florida). NIOSH also analyzed and prepared reports of injury and illness data occurring among DWH responders in all locations and conducted exposure assessments of on and off-shore workers.

As a result of these activities, NIOSH collected many lessons learned that included:

- Begin worker rostering immediately and integrate it into response activities as soon as possible to ensure all workers have the opportunity to participate
- Have a ready to use roster form prepared that can be quickly adapted and cleared
- Direct the rostering program through the incident/unified command
- Explore the feasibility of incorporating rostering into existing response programs to improve efficiency
- Develop mechanisms to encourage and facilitate employer participation
- Maximum advantage should be taken of existing data streams that could be used for health surveillance of workers during the response
- Federal, state, and local agencies should consider the development of standardized instruments for baseline occupational surveillance and post-event occupational data collection and analysis that could be easily adapted to specific events and used by various organizations
- Improved occupational injury and illness surveillance may be achieved through enhanced integration and coordination with other surveillance activities at the HHS/CDC and other agencies

NIOSH published these lessons learned in a report (NIOSH 2011).

## Examples of ERHMS™ Implementation

Organizations are implementing aspects of the ERHMS™ framework. For example, during the 2014 Ebola outbreak, NIOSH assisted the CDC with expanding their “Responder Readiness” program by implementing the ERHMS™ framework into their response structure. Specifically, a pre-deployment coordinator position was established to work with responders before they deployed to ensure they met all the health screening requirements and were properly trained. Several NIOSH staff served as safety officers in affected countries in order to conduct health and safety monitoring of staff during the deployment phase. Finally, a post-deployment coordinator position was created to determine if any long-term monitoring should be conducted, including any mental health needs. Many of these activities were also continued during the 2016 Zika response at CDC.

In 2016 as Hurricane Matthew was fast approaching, the Georgia Department of Public Health (GA DPH) adapted their newly created Responder Safety, Tracking, and Resilience (R-STAR) system to incorporate ERHMS™. GA DPH staff sent out surveys to responders to self-register their deployment activities and to complete a health and safety check. According to Funk (2018), feedback from participants indicated responders valued someone checking in on them during their deployment and supervisors could verify their responders were accounted for and unharmed. By incorporating ERHMS™, the GA DPH would be able to meet Capability 14 (*Responder Safety and Health*) as part of their CDC Public Health Emergency Preparedness (PHEP) cooperative agreement (CDC 2011). Any state receiving this funding can implement ERHMS™ as a way to complete tasks in Capability 14 or 15 (*Volunteer Management*).

As a result of NIOSH staff providing ERHMS™ training at West Virginia University in March of 2016, the Monongalia County Health Department was able to implement ERHMS™ during a multi-agency, statewide emergency drill, Operation Dawson Storm. The drill was conducted in July 2016 in Morgantown, WV with military, emergency medical personnel, law enforcement, and public health officials and focused on potential exposure to a radiological source. The health department focused on conducting health monitoring of first responders before the drill and after the drill and developed pre- and post-drill questionnaires. Data were obtained from 52 responders pre-drill and 33 responders post-drill.

Between 2013–2016, the state of Idaho worked to implement ERHMS™ through the following incremental activities with sub-grants with Public Health Districts: 1. review PHEP Capability number 14 (*Responder Safety and Health*), 2. complete training for monitoring staff and leadership, and 3. pilot test ERHMS Info Manager™. In October 2016, Idaho's preparedness field assignee from the CDC developed and facilitated a hands-on exercise to deepen ERHMS™ capabilities and share how the ERHMS™ framework and ERHMS Info Manager™ can be implemented among Public Health Districts. Participants included representatives from state and local epidemiology and preparedness programs. Data were obtained from 15 (79%) of the 19 participants (Arkin 2017).

For more information on how ERHMS™ was implemented in Oregon, see the Disaster Mental Health section (chapter 8) in this guide.

## Tools and Resources

Resources and tools have been developed to assist organizations with implementing ERHMS™ during each of the response phases and include free training and ERHMS Info Manager™ software. Training has been conducted at a total of nine health departments, and 317 public health professionals were trained across the United States from 2013-2016. The trainings were made possible by a successful CDC funding proposal in partnership with NIOSH, the Agency for Toxic Substances and Disease Registry's (ATSDR) [Assessment of Chemical Exposures \(ACE\) program](#), and the CDC's [Community Assessment for Public Health Emergency Response \(CASPER\) program](#).

In 2017, NIOSH staff was also able to train the following organizations per their request: the West Virginia Bureau for Public Health along with local public health staff at West Virginia University in Morgantown, WV, Oregon Medical Reserve Corps unit in Portland, OR, and individuals attending a professional development course (PDC) at the Tennessee Valley Section American Industrial Hygiene Association in Knoxville, Tennessee. More than 200 public health professionals were trained at these locations.

The guidance for how to implement these activities and specific tools that can be utilized during each phase of the response can be found in the [National Response Team Technical Assistance Document](#) (NRT 2012). In order to increase an organization's ability to implement and adopt ERHMS™, NIOSH has recently developed [ERHMS Info Manager™](#), a free custom-built software product that uses Epi Info™ for all calculations and analyses. This product allows for the collection of data as outlined in ERHMS™ throughout all three phases of a response. For example, ERHMS Info Manager™ will allow users to

manage staff readiness by collecting information on rostering, training, and medical screening, thus improving the organization's preparedness prior to an emergency. NIOSH has also developed a user's manual and training videos to accompany the software and has partnered with Epi Info™ to ensure technical support is available to all users. In addition, NIOSH has free training on ERHMS™ available online and in-person on a case-by-case basis. Continuing education credits are available for these trainings.

For more information on ERHMS™ or ERHMS Info Manager™, visit the website at [www.cdc.gov/niosh/erhms](http://www.cdc.gov/niosh/erhms). [We welcome you to share your experiences and successes with implementing ERHMS™ by emailing us at erhmsonline@cdc.gov.](mailto:erhmsonline@cdc.gov)

## References

Arkin K (2017). Advancing implementation of emergency responder health monitoring and surveillance in Idaho. Paper presented at the 2017 Council for State and Territorial Epidemiologist (CSTE) Annual Conference, Boise, Idaho, June 6, <https://cste.confex.com/cste/2017/webprogram/Paper7623.html>.

Centers for Disease Control and Prevention. (2011). National standards for state and local planning. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, Office of Public Health Preparedness and Response, [https://www.cdc.gov/phpr/readiness/00\\_docs/DSLRL\\_capabilities\\_July.pdf](https://www.cdc.gov/phpr/readiness/00_docs/DSLRL_capabilities_July.pdf).

Funk, R. (2018). Applications: Emergency Responder Health Monitoring and Surveillance: Successful Application. In: Horney, J eds. Disaster epidemiology: methods and applications. San Diego, CA: Academic Press.

National Institute for Occupational Safety and Health. (2011). Lessons Learned from the Deepwater Horizon Response. Cincinnati, OH: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH Publication No. 2012-117, <https://www.cdc.gov/niosh/docs/2012-117/pdfs/2012-117.pdf>.

National Response Team. (2012). Emergency Responder Health Monitoring and Surveillance: National Response Team Technical Assistance Document (TAD). Washington, DC: U.S. National Response Team, [https://www.nrt.org/sites/2/files/ERHMS\\_Final\\_060512.pdf](https://www.nrt.org/sites/2/files/ERHMS_Final_060512.pdf).



## Disaster Science Responder Research (DSRR) Program

Conducting responder health and safety research in the disaster environment requires researchers to address many challenges unique to emergency response and recovery efforts. These challenges include the immediate emphasis on critical response activities, capabilities, and resources; limited access to emergency management leadership who would need to approve research activities involving the responders under their charge; and timely recognition of important occupational safety and health risks during the response or recovery operations. Issues related to conducting responder health and safety research during and following disasters have gained attention following such disasters as the World Trade Center attack, Hurricane Sandy, the Deepwater Horizon oil spill, and, more recently, the global Ebola response. Each of these disasters could have benefited from timely responder safety and health research to characterize the unique risks associated with occupational exposure to disaster-related hazards.

In 2014 NIOSH established its Disaster Science Responder Research (DSRR) Program, located within EPRO, with the intent to develop an approach to timely, scalable, scientifically sound responder-based research that can feasibly be implemented before, during, and after a disaster without interfering with the response itself. Specifically, the goals of the DSRR Program are to identify important research gaps for emergency response and recovery workers, to inform approaches for conducting research during a disaster, and to create mechanisms for overcoming the associated logistical, technical, and administrative burdens that researchers will encounter during an emergency response. The program also aims to identify critical topic areas to address research gaps that can be studied outside the scope of an ongoing response.

The DSRR Program's strategic plan will address four major goals: 1) develop a NIOSH disaster research agenda to enhance responder safety and health, 2) address major challenges associated with conducting research during disasters such as rapid IRB protocols, 3) identify already existing data collection capabilities and information resources to be utilized for research purposes, and 4) ensure research findings and lessons learned are translated into practice. The DSRR Program considers *disasters* to include natural disasters, chemical, and radiological emergencies; oil spills; pandemic influenza or other infectious diseases; and other mass casualty events. In addition to large-scale disasters, NIOSH is also focused on small-scale, novel incidents where emerging issues have been identified. NIOSH broadly defines disaster-related workers as anyone involved in the response and recovery effort. Therefore, law enforcement, fire, and emergency medical personnel, as well as other responder groups such as public health personnel, cleanup, and repair/restoration workers, are included. This type of work is carried out by individuals from emergency management, fire service, law enforcement, emergency medical services (EMS), public health, construction and other skilled support, disaster relief and mental health teams, and volunteer organizations. It also includes auxiliary workers involved in the cleanup and recovery phases of an incident or emergency.

In the DSRR Program, "research" is defined broadly and includes both research during a disaster, but may also include studies that can be completed outside the scope of an actual incident. It may be a rapid

assessment of what is already known about a given problem, rapid collection of data from the field to guide ongoing responder safety and health decisions, hypothesis-driven research needed to understand and address the current incident effectively and developing and implementing improved approaches and responses to future incidents. The types of research conducted may include the impact of a novel exposure, unexpected or severe health effects, the effectiveness of a proposed intervention, mental health/resilience issues, and disease outcomes with latency periods. By defining "research" in its broadest sense, the DSRR Program includes etiologic, intervention, applied, laboratory, comparative effectiveness, worker-based participatory, and survey research, and meta-analyses to provide a better understanding of the situations and risks responders face. Using clear, pre-event decision criteria (described below), the DSRR Program recommends that the need for longer-term studies should be assessed early in the course of the event by a committee of subject matter experts.

The decision should also include the considerations that research efforts should not interfere with current response priorities.

Health studies conducted in conjunction with the response to emergency events may be divided into four basic types: (1) *Baseline Activities* that involve routine or baseline health monitoring, health surveillance, industrial hygiene or environmental assessments, responder interviews/focus groups, and roster/registry activities, optimally planned in a generic way prior to an event; (2) *Public Health Investigations* that investigate and respond to immediate health problems and exposures, and are designed to expeditiously provide useful and actionable information that directly affects the health and safety of current responders; (3) *Pilot Investigations* that are exploratory or preliminary in their approach, often to determine the need for or feasibility of a more comprehensive research study; and (4) *Responder Health Research* that entails a systematic and rigorous investigation, typically require peer-reviewed protocols, usually extend well beyond the duration of the emergency, and are designed to develop or contribute to generalizable scientific knowledge (Decker JA, et al. 2013).

The process for determining whether to conduct a research study may be informed by multiple inputs and considerations. Decker et al (2013) describe four "critical gatekeeper factors" that should be satisfied before embarking on a post-disaster research study: 1) the scientific query is clear and testable; 2) exposure is present and measurable; 3) the study design is sound and cost-effective; and 4) the study is feasible with respect to logistics, funding, and rapid regulatory clearances such as Institutional Review Board (IRB) approval.

To enable the most successful and scientifically valid disaster science research, the NIOSH DSRR Program recommends, whenever possible, routine collection of a core set of baseline data, such as exposure data, rosters of exposed individuals, and baseline health status. The ERHMS™ program is an excellent tool for these routine data collections. In addition, the DSRR Program recommends strong interagency communication and cooperation among federal, state, and local governmental agencies (e.g., health departments, labor departments, Federal Emergency Management Agency) in the jurisdiction of the disaster, as well as academic partners. Prior to an event, planning discussions are recommended with relevant umbrella organizations, such as the Council of State and Territorial Epidemiologists (CSTE) and the National Association of County and City Health Officials (NACCHO). Finally, the DSRR Program notes

the important role of the response and recovery workers themselves as an asset in many projects, providing relevant knowledge and skills that can strengthen data collection efforts.

Website: <https://www.cdc.gov/niosh/topics/disasterscience/default.html>

## References

Decker JA, et al. Am J Disaster Med 2013 Jan/Mar; 8(1): 25-33).

## Disclaimers

The findings and conclusions in this chapter are those of the author(s) and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention. In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

## Post-Disaster Surveillance

*Tess Konen, MPH; Melissa Powell, MPH*

---

### Introduction

Certain disasters, such as those related to radiation, cause health effects that may not emerge for many years. Long-term health-related outcomes have a latency period of several months to years and may include cancer, respiratory disease, disabling injuries, mental health, and reproductive outcomes.

Following the 9/11 World Trade Center (WTC) terrorist event, there was public health concern about the long-term health impacts to responders and others exposed to debris from the towers' collapse (Klitzman & Freudenberg, 2003). However, there was no process in place to identify who was at the scene and possibly exposed to the debris. Instead, the WTC registry was established three years after the event using voluntary, rolling enrollment, diminishing the epidemiological rigor of the study (Thorpe et al., 2014). Identifying this gap, the Agency for Toxic Substances and Disease Registry (ATSDR) developed a survey tool, called the Rapid Response Registry (RRR), to quickly collect information on responders and other persons exposed to chemical, biological, or other harmful agents from a disaster to identify affected and displaced people and for possible future health follow-up (Agency for Toxic Substances and Disease Registry, 2014).

Development of a roster can be particularly important to identify and locate subjects and to collect timely event information; this ability for information gathering is crucial to the feasibility of research following a large-scale disaster (Decker et al., 2013). Long-term surveillance is essential for providing effective and continuous public health response to address the public's needs. Monitoring health has a reassuring effect on the public and can be an intervention itself; it can provide closure about long-term health effects for those affected (van den Berg et al., 2008). Long-term surveillance can prevent further issues such as social disorder, mistrust, and suspicion of government (Decker et al., 2013).

However, it is not recommended to collect data just for the sake of collecting data; it is necessary to offer evidence-based interventions or resources in conjunction with implementing the roster (Decker et al., 2013). Deciding to initiate the process of gathering preliminary information from those potentially exposed does not necessarily mean that a registry will be established, and that long-term surveillance will occur. It is, however, an important primary step in identifying the exposed population that is potentially at risk. This approach allows response workers to collect a minimum amount of key information from a large number of people impacted by an event. Rostering includes contact information that enables public health staff to follow-up with people at a more convenient time to gather additional information about their possible exposures and reactions. It also provides a way to reach members of the impacted community with educational information related to the event they experienced.

Establishing a more formal registry and conducting health monitoring requires available funding and dedicated staff time; this can be an expensive and lengthy process that can be a burden for the public

health agency. Before initiating a registry, it is important to review the scientific evidence for a health outcome related to the exposure. ATSDR developed a document with criteria to assist in determining whether a registry should be established (Antao et al., 2015).

The RRR is included as one of the tools in the Assessment of Chemical Exposures (ACE) toolkit developed by ATSDR (Agency for Toxic Substances and Disease Registry, 2016). The ACE Toolkit is a helpful resource to assist local authorities in responding to or preparing for a chemical release. Federal employees must obtain Office of Management and Budget (OMB) approval before any data collections. ATSDR has received generic pre-approval for the ACE investigations, including the RRR; however, the approval is specific to responding to the emergency or recommending improvement to emergency response based on lessons learned and not for using the ACE data to start a follow-up registry. ATSDR has responded to two incidents since they received OMB approval for data collection for the RRR but used longer surveys in place of the RRR for both responses. They are currently working on developing a generic package for starting a registry after a disaster to submit for federal approval.

ATSDR developed the RRR primarily as a resource for state and local health departments to use in manmade or natural disaster response. A couple of states, Oregon, and Minnesota, have developed their own state-specific version of the RRR. They refer to it as a roster instead of a registry since they view it as an initial step in the process. Although states have practiced it in tabletop scenarios, we are not aware of any state or local health departments using the ATSDR RRR, or their state version of the RRR, in a real response situation. The Oregon Health Authority provides perspective on how a state and local health department collaborated to develop active surveillance plans for chemical exposures associated with response planning for communities surrounding a chemical weapons depot. The Minnesota Department of Health (MDH) describes how a state health department collaborated with their emergency preparedness division to develop long-term surveillance planning and education for response staff. These case studies provide insight on how to plan for post-disaster surveillance during the crucial early response phase of an incident, develop a state specific RRR, and practice RRR implementation.

## **Oregon Health Authority Case Study**

State and local public health worked in collaboration with the Chemical Stockpile Emergency Preparedness Program (CSEPP) and the U.S. Army to safeguard the public's health as chemical munitions were stored, transported, and ultimately disposed. The Umatilla Army Depot in northcentral Oregon was formerly the site of a stockpile of sulfur mustard, which was introduced during World War I as a chemical warfare agent. Exposure to sulfur mustard through the air or in water can cause blistering and damage the eyes and respiratory tract. Sulfur mustard can be carried long distances by the wind, and it can persist in the environment.

Early in their planning efforts, Morrow County Public Health and Emergency Management cited the importance of being able to locate, assess, and track individuals in the event of an exposure. Using the ATSDR RRR as a model, Morrow County Public Health and Oregon Public Health devised a roster to be used following a chemical release. Large-scale chemical emergencies are likely to prompt evacuation, so

Oregon's short roster form collected multiple modes of contacting each individual, including several phone numbers and emergency contacts in case follow-up was needed (See roster forms in Appendix A). The exposure information collected included: location at the time of the event, role in the response (e.g., resident, clean-up worker, first responder), and injury status. The information was collected on a one-page paper form facilitated by public health staff, such as at a shelter or triage center, or remotely via the website for displaced people or others wishing to self-report. The entries collected via website populated a database to reduce the need for data entry on the part of public health staff.

Three local and tribal health departments integrated the roster into the Incident Response Action Plan, including an organizational chart and job action sheets, training and exercise plan, and list of required resources for an exposure roster "go kit." State public health staff devised the accompanying database and web form. The roster was also translated into Spanish.

A 2008 full-scale national exercise assessed the roster's utility in a chemical release scenario. Exercise evaluation findings indicated that the roster was easy to understand and implement. Pilot testers found the form easy to use and not time-consuming. In subsequent planning meetings, response partners from non-public health agencies requested clarity on the distinction between a roster and a registry. In response, Oregon Public Health developed additional just-in-time training resources for field staff and simple process diagrams clarifying the purpose of registries and rosters.

The CSEPP program successfully completed the destruction of the sulfur mustard formerly stored at the Umatilla Army Depot, and the exposure roster response plans are now integrated into the Oregon Health Authority's active surveillance plans. The forms, instructions, and database can all be quickly adapted to meet any future needs to stand up and populate an exposure roster to compile a list of individuals who have been exposed to a pathogen, toxin, or other harm in the course of a public health emergency. The list can then be used to populate a registry for long-term monitoring and follow-up. In the future, specific roster and registry questions could be integrated into hazard-specific response plans at the state and local levels.

## **Minnesota Department of Health Case Study**

It is necessary to plan early for long-term surveillance in order to collect critical data that otherwise may become unavailable or lost; timely post-disaster data collection is crucial to the feasibility of surveillance or research following a large-scale disaster.

The Minnesota Department of Health (MDH) identified the need to strengthen Minnesota's emergency response and surveillance capacity of chronic health outcomes. They developed the Long-term Surveillance (LTS) annex as part of the All-Hazard Response and Recovery Plan (AHRRP). AHRRP annexes provide details on the functions that MDH performs in response to an emergency. The LTS function plans and initiates ongoing, systematic collection of data necessary for tracking chronic disease-related outcomes that may be attributed to an emergency event, but which occur months or years following the response and recovery period. This annex consists of a team of chronic disease and injury epidemiologists that consult with subject matter experts.

The MDH Incident Manager will activate the annex if it is determined that a disaster may have long-term health effects. Long-term health-related outcomes include cancer, respiratory disease, disabling injuries, and reproductive outcomes. Examples of events that would be likely to trigger these planning steps are events with recognized population exposure to chemical or physical agents, such as a major chemical spill or radiation release. The annex calls for collecting data on three populations: responders/volunteers, clinic/hospital cases, and the exposed community. A component of this annex is the Minnesota Rapid Response Roster (MN RRR), a survey tool that helps establish a roster of persons exposed, or potentially exposed, to chemicals or other harmful agents during public health emergencies.

MDH developed the electronic, state-specific Rapid Response Roster (MN RRR) based on the ATSDR Rapid Response Registry tool (see Appendix B). MDH met with internal partners in diverse health program areas (including emergency preparedness, environmental health, injury, infectious disease, and behavioral health) for input on the roster content and implementation logistics. The MN RRR collects identification information, contact information, and event-specific questions. This tool would supplement other sources of public health information about the affected population, such as employee/volunteer lists, hospitalization data, and death certificates, in order to identify and monitor the population at-risk for post-disaster long-term health consequences.

The MN RRR was tested using four different disaster scenarios. MDH colleagues were recruited to take the online survey and complete questions on the experience and any difficulties. The MN RRR was revised based on feedback and experience. An implementation guide with criteria to consider before activating the MN RRR was developed to ensure that the MN RRR would only be activated in appropriate situations. The criteria were adapted from MN Tracking's evaluation process for new content and ATSDR's public health assessment guidance document (Agency for Toxic Substances and Disease Registry, 2005). These criteria fit into six categories: 1) causality, 2) actionability, 3) feasibility, 4) physical health impact, 5) social factors, and 6) potential for information building. The MN RRR implementation guide criteria were tested and evaluated in a radiological release tabletop exercise. MDH epidemiologists, trained in public health surveillance, evaluated and consulted with their partners about whether the situation would warrant activating the RRR.

To practice activating the annex and initiating the roster, MDH conducted four functional exercises in the department operations center using a scenario of a train derailment and subsequent release of acrylonitrile – a chemical that can have potential long-term health implication. These exercises helped inform the logistics of working within the Incident Command Structure (ICS) and identified resource needs for implementing the roster.

To better understand how MDH efforts could be coordinated and collaborative, the annex and roster were presented to local city health departments, regional public health preparedness consultants, Red Cross, and the MN Poison Control Center. MDH met with external partners to identify areas of collaboration and information sharing to support an effective response to a hazardous chemical with long-term health implications. MDH hosted a metropolitan train derailment tabletop exercise with invited external partners to solidify these relationships, and to further establish how they would collaborate following a disaster. Partners included: Minnesota Poison Control System, University of Minnesota, local health departments, American Red Cross, and the Minnesota Pollution Control Agency.

The functional exercises elucidated not only how the annex functions within the ICS at the state level, but also how to coordinate with local and regional public health groups and partners. These partners are essential to supporting MDH messages and informing residents of the need to roster. The exercises highlighted the need to improve the plan for communicating with the public about rostering. MDH learned that they need to reach people at disaster reception centers, send out regular messages through social media and official sources, prepare draft messaging now, and translate messages into multiple languages. They also identified their source of volunteers, the need for volunteer training, and how to manage volunteers to effectively roster the affected public.

As a result, Minnesota is better prepared to answer critical public health questions about the long-term health effects originating from disasters. MDH staff and local partners are more aware of the LTS annex and better prepared to respond to disasters with long-term health implications. The exercises made clear how the plan functions at the state level and how to coordinate with local and regional partners. By effectively integrating long-term surveillance into emergency planning at the state level, MDH addressed the need for early planning for long-term surveillance data needs. The next steps are to address gaps identified in the tabletops, to continue to collaborate and practice annually, and to establish memorandums of understandings with external partners.

## Citations

Agency for Toxic Substances and Disease Registry. (2005). *Public Health Assessment Guidance Manual*. Atlanta, Georgia.

Agency for Toxic Substances and Disease Registry. (2014, April 4). Rapid Response Registry. Retrieved from <https://www.atsdr.cdc.gov/rapidresponse/>

Agency for Toxic Substances and Disease Registry. (2016, June 21st). ACE Toolkit. Retrieved from [https://www.atsdr.cdc.gov/ntsip/ace\\_toolkit.html](https://www.atsdr.cdc.gov/ntsip/ace_toolkit.html)

Antao, V. C., Muravov, O. I., Sapp, J., 2nd, Larson, T. C., Pallos, L. L., Sanchez, M. E., . . . Horton, D. K. (2015). Considerations Before Establishing an Environmental Health Registry. *Am J Public Health, 105*(8), 1543-1551. doi:10.2105/ajph.2015.302642

Decker, J. A., Kiefer, M., Reissman, D. B., Funk, R., Halpin, J., Bernard, B., . . . Howard, J. (2013). A decision process for determining whether to conduct responder health research following large disasters. *Am J Disaster Med, 8*(1), 25-33. doi:10.5055/ajdm.2013.0108

Klitzman, S., & Freudenberg, N. (2003). Implications of the World Trade Center Attack for the Public Health and Health Care Infrastructures. *Am J Public Health, 93*(3), 400-406.

Thorpe, L. E., Assari, S., Deppen, S., Glied, S., Lurie, N., Mauer, M. P., . . . Trapido, E. (2014). The role of epidemiology in disaster response policy development. *Ann Epidemiol.* doi:10.1016/j.annepidem.2014.05.016

van den Berg, B., Grievink, L., Gutschmidt, K., Lang, T., Palmer, S., Ruijten, M., . . . Yzermans, J. (2008). The public health dimension of disasters--health outcome assessment of disasters. *Prehosp Disaster Med, 23*(4), s55-59.





## Appendix A

INCIDENT NAME \_\_\_\_\_ INTERVIEW DATE \_\_\_\_\_ INTERVIEWER \_\_\_\_\_ LANGUAGE \_\_\_\_\_  
 Updated 01-21-14 **CHEMICAL EXPOSURE ROSTER – One form per person**

<b>Identification (check one and write in number)</b>			
<input type="checkbox"/> Triage Tag _____		<input type="checkbox"/> Drivers License _____	
<input type="checkbox"/> Rapid Screen Tag _____		<input type="checkbox"/> Other (describe) _____	
<b>PERSONAL INFORMATION</b>			
Name (Last, First, M.I.) _____		Email (Home) _____	
Street Address _____		Email (Work) _____	
City _____ County _____		Phone (Home) _____	
State _____ Zip _____		Phone (Work) _____	
How many people live at this address? _____		Phone (Other) _____	
Date of Birth (mm/dd/yy) _____ Or, Age (years) _____		Sex (circle one) Male Female Unknown	
		If female, (circle one) Pregnant Not Pregnant Unknown	
<b>EMERGENCY CONTACT INFORMATION</b>			
<b>Emergency Contact:</b>		If same as above, write "same" and go to next question.	
Name (Last, First, M.I.) _____		Email (Home) _____	
Street Address _____		Email (Work) _____	
City _____		If same as above, check "same" and go to next question.	
State _____ Zip _____		Phone (Home) _____ <input type="checkbox"/> same	
		Phone (Work) _____ <input type="checkbox"/> same	
		Phone (Other) _____ <input type="checkbox"/> same	
<b>EXPOSURE DETAILS</b>			
Location/Proximity to the event on [DATE] at [TIME] _____		Physical location on [DATE] at [TIME] (check one)	
Address _____		Inside a building      Inside a vehicle	
OR		- Outside                      - Other: _____	
Nearest Intersection _____		<b>Reason for being at the location described</b>	
OR		on [DATE] at [TIME] (check all that apply)	
Nearest Building _____		A resident                      A government official	
OR		A passerby                      A responder or rescue worker	
Nearest Landmark _____		An employee                      A non-governmental organization/site volunteer	
		A clean-up worker              Other: _____	
<b>TO BE COMPLETED BY EVALUATOR</b>			
<b>Exposure location (check one)</b>	<b>Contamination status</b>	<b>Injury status</b>	<b>Specimen Collection: fill out lab specimen collection form, if any specimens collected (check all that apply)</b>
<input type="checkbox"/> Hot Zone	<input type="checkbox"/> None	<input type="checkbox"/> Open wound (non-critical)	<input type="checkbox"/> Blood
<input type="checkbox"/> Warm Zone	External contamination	<input type="checkbox"/> Burn (non-critical)	<input type="checkbox"/> Urine
<input type="checkbox"/> Cold Zone	<input type="checkbox"/> Internal contamination	<input type="checkbox"/> Other (describe) _____	<input type="checkbox"/> None
	<input type="checkbox"/> Y <input type="checkbox"/> N Decontaminated? (if deconned, list in what facility _____)	(if hospitalized, list in what facility _____)	<input type="checkbox"/> Collection form filled in

FAX COMPLETED FORM TO 971-673-XXXX





# Disaster Epidemiology Resource Guide



Form# \_\_\_\_\_ Interviewer \_\_\_\_\_ Date \_\_\_\_\_

First, we will ask some questions about you. This will help us to identify you and to locate you in our system.

Personal information	
<b>First</b> _____ , <b>Middle</b> _____ , <b>Last Name</b> _____ _____ , _____ , _____ _____	<b>Last 4 digits of Social Security Number (XXX-XX-####)</b> _____ - ____ - ____
<b>Street address</b> _____ <b>Apt/unit#</b> _____  <b>City</b> _____ <b>County</b> _____  <b>State</b> ____ <b>Zip code</b> _____	<b>Provide information to contact you and check the preferred phone and email:</b>  <input type="checkbox"/> <b>Phone (Home)</b> (____) - ____ - ____ <input type="checkbox"/> <b>Phone (Cell)</b> (____) - ____ - ____ <input type="checkbox"/> <b>Phone (Work)</b> (____) - ____ - ____ <input type="checkbox"/> <b>Email (Personal)</b> _____ <input type="checkbox"/> <b>Email (Work)</b> _____
<b>Date of Birth (MM/DD/YYYY)</b> __ / __ / ____ <b>Age (years)</b> ____	<b>How would you prefer to be contacted in the future? (select one)</b> <input type="checkbox"/> <b>email</b> <input type="checkbox"/> <b>phone</b> <input type="checkbox"/> <b>mail</b>
<b>Sex (select one)</b> <input type="checkbox"/> <b>Male</b> <input type="checkbox"/> <b>Female</b> <input type="checkbox"/> <b>Other</b>	<b>Close friend/relative who know how to reach you:</b> <b>First,</b> _____ <b>Middle,</b> _____ <b>Last Name</b> _____ _____ , _____ , _____ <b>Home address</b> _____ <b>City</b> _____ <b>State</b> ____ <b>Zip code</b> ____ <b>Phone</b> (____) - ____ - ____ <b>Email</b> _____



Next, we will ask some questions about your experience with the disaster. The disaster will be defined as the event that occurred on \_\_\_\_\_ at \_\_\_\_\_ at this location\_\_\_\_\_. Anyone that was at this location at the time of the event, later came to this location to help, or were affected by the disaster’s byproducts, such as plumes, smoke, etc, should be enrolled.

Event information	
<b>Physical location at start of the event:</b> <input type="checkbox"/> Inside a building <input type="checkbox"/> Inside a vehicle <input type="checkbox"/> Outside <input type="checkbox"/> At another location (specify) _____	<b>Reason for being at the location where event occurred (check all that apply) :</b> <input type="checkbox"/> A resident <input type="checkbox"/> A passerby <input type="checkbox"/> Volunteer not affiliated with any organization <input type="checkbox"/> An employee <input type="checkbox"/> A responder or rescue worker <input type="checkbox"/> A government official <input type="checkbox"/> A clean-up worker <input type="checkbox"/> A non-governmental organization volunteer <input type="checkbox"/> Other _____
<b>Location/Proximity to the event:</b>  Address _____ OR Nearest Intersection _____ OR Nearest Building _____ OR Nearest Landmark _____	<b>Were you seen by a doctor or other medical staff due yes to the event described?</b>  <input type="checkbox"/> yes <input type="checkbox"/> no <input type="checkbox"/> don't know/not sure
<b>Event Specific Question 1</b> <b>Optional questions:</b> Did you leave the area because you were evacuated by yes an official (e.g. police, fireman, government no official)? How long were you at the disaster site? Did you have any children (under 18 years) with you Yes at the time?	<b>Event Specific Question 2</b>

Thank you for completing the survey. We may contact you in the future for further information.

## Disaster Epidemiology Tool: Community Assessment for Public Health Emergency Response (CASPER)

*Tesfaye Bayleyegn, David Zane, Svetlana Smorodinsky, Katie R. Kirsch, Bonnie F. Morehead, Tracy Haywood, Russell Jones, Jennifer A. Horney*

---

### INTRODUCTION

Community Assessment for Public Health Emergency Response (CASPER) is a method and a set of specific tools designed to provide household-based information about an affected community's needs in a disaster quickly, at low cost, and in a simple format to decision-makers (1). CASPER is a form of rapid needs assessment, also called a rapid epidemiologic assessment or a rapid health assessment. CASPER helps public health practitioners and emergency management officials determine community preparedness levels, community health status, and the basic needs of an affected community after a disaster. CASPER is valuable in a disaster preparedness and response because data are collected rapidly and response leadership receives a preliminary report within one week (2). Response leadership during response can use this rapid information on the community needs to target resources and take more effective actions (3).

CASPER uses a two-stage cluster sampling methodology. In the first stage, 30 clusters are selected from the affected area (sampling frame) with the probability of selection proportional to the number of housing units in the cluster. In the second stage, field teams select seven households to interview in each cluster using systematic random sampling (4). The goal is to use a standardized questionnaire and interview a representative sample of 210 (30x7) households.

The primary objectives of CASPER are to

- Assess the emergency or disaster preparedness level of a community.
- Determine the critical health needs and assess the impact of the disaster on a community.
- Produce household-based estimates data or projections for evidence-based public health action.
- Evaluate the effectiveness of actions taken.

CASPER is versatile and has many uses in both disaster and non-emergency settings (5). CASPER has been used in all phases of the disaster cycle: preparedness, response, recovery, and mitigation. This chapter provides three case studies that demonstrate different uses of CASPER.

### References

1. Centers for Disease Control and Prevention. Community Assessment for Public Health Emergency Response (CASPER) Toolkit. 2nd ed. [http://emergency.cdc.gov/disasters/surveillance/pdf/CASPER\\_Toolkit\\_Version\\_2\\_0\\_508\\_Compliant.pdf](http://emergency.cdc.gov/disasters/surveillance/pdf/CASPER_Toolkit_Version_2_0_508_Compliant.pdf). Published 2012. Accessed April 4, 2017.

2. Malilay J, Flanders WD, Brogan D. A modified cluster-sampling method for post-disaster rapid assessment of needs. *Bull World Health Organ.* 1996;74(4):399-405.
3. Malilay J. Public health assessments in disaster settings: recommendations for a multidisciplinary approach. *Prehosp Disaster Med.* 2000;15(4):167-172.
4. Zane DF, Bayleyegm TM, Haywood TL, et al. Community assessment for public health emergency response following Hurricane Ike—Texas, 25-30 September 2008. *Prehosp Disaster Med.* 2010;25(6):503-510.
5. Bayleyegm TM, Schnall AH, Ballou SG, Zane DF, Burrer SL, Noe RS, Wolkin AF. Use of Community Assessments for Public Health Emergency Response (CASPERs) to rapidly assess public health issues — United States, 2003-2012. *Prehosp Disaster Med.* 2015;30(4):1-8.

## CASE STUDIES

### *CASE STUDY 1-PREPAREDNESS: Assessing Preparedness Planning Using CASPER: Oakland, MI, 2012*

#### Background

Michigan is at risk for both natural and human-induced disasters such as floods, tornados, and radiological emergencies. Past incidents in Michigan have highlighted the importance of emergency planning and public health response to disasters (1).

- In June 2008, a tornado and associated severe weather affected several counties in the state (2).
- In July 2010, an oil pipeline ruptured and released an estimated 844,000 gallons of heavy crude oil into surrounding waterways near Marshall, Michigan (3).

In addition to these events, approximately 1.2 million people in Oakland County, Michigan, live less than 50 miles from the Unit 2 of the Fermi Nuclear Power Plant, making them at risk if an emergency occurs at the plant. Michigan is also located near the Great Lakes, making it susceptible to extreme weather events, including ice and snowstorms and tornadoes (4).

In September 2012, the Oakland County Health Division (OCHD) and Michigan Department of Community Health (MDCH) asked CDC for help conducting a CASPER to assess household emergency preparedness in Oakland County. The CASPER provided a valuable opportunity for OCHD and MDCH to receive training and field experience conducting a CASPER. It would also strengthen local and state capacity in preparedness and response and continue to develop disaster epidemiology capabilities in the state.

OCHD and MDCH developed a two-page questionnaire to address five objectives of the CASPER (1):

- 1) Determine the types of emergency preparations in place in Oakland County households.
- 2) Determine the frequency of households with residents who may have special medical needs in an emergency because of their health conditions.
- 3) Identify the most trusted and main sources of information for households during a radiation emergency.

- 4) Assess the likelihood that households in Oakland County would follow public health instructions in a disaster involving radioactive material.
- 5) Identify the frequency of households that would need to care for a pet
- 6) Identify the frequency of households that a dependent not living in the household during an emergency.

CDC staff provided just-in-time training to the field interview teams, which primarily consisted of state and local public health staff. The teams gave all potential respondents an information sheet with contact telephone numbers for OCHD, educational materials from OCHD on emergency preparedness, a bag to store emergency supplies, and other timely local public health information on West Nile virus and flu shots. OCHD alerted the community to the presence of interviewers in Oakland County through a news announcement.

### **Geographic Information System (GIS) tool application**

CDC used the GIS CASPER tool to select the 30 clusters and create maps with census block level-data for each cluster. The Health Studies Section (formerly known as Health Studies Branch) and the CDC Geospatial Research, Analysis and Service Program (GRASP) created the GIS CASPER tool to enhance the cluster sampling and mapping methods used for a CASPER. The tool automatically generates the cumulative number of housing units in each cluster (e.g., census blocks) in the sampling frame and then selects 30 clusters with probability proportional to size. Clusters can be selected more rapidly than through manual methods by using the tool.

With the GIS CASPER tool, users can also incorporate a variety of base maps and data from local and cloud-based sources, including the US Census, street network providers, hydrography, and local landmarks (5). In this example, CDC used data files for Oakland county boundaries, population, and housing units. The GIS CASPER tool also generates a detailed map containing geographic orientation information showing streets, highways, water bodies, and landmarks for each selected cluster. CDC staff printed street maps of clusters showing geographic identifiers in PDF format for OCHD and MDCH. The GIS CASPER tool also automatically creates KMZ files to display the selected cluster maps in Google Earth, allowing for a more detailed aerial view of the selected clusters. If field teams have the capability, KMZ files can also be made available for field interview teams to use on their smart mobile devices with Google Earth or another mapping app to augment the printed PDF maps.

### **Results**

Interview teams completed 192 surveys—a completion rate of 91.4%. Two-thirds of Oakland County households reported having 3 days of basic supplies for an emergency. Over one-third of households had a dependent outside of the home whom they would need to help in an emergency. Almost half of the households had a pet that would need to be accounted for in an emergency. A majority of households (>90%) would follow instructions from officials in the event of a “release of radioactive material” that could affect their community. Respondents were willing to go to a radiation screening center (93%), willing to evacuate (96%), and willing to shelter in place (92%) if officials told them to. More than half of the households said they would rely on the television for updates during a radiation emergency and that their most trusted source of information would be the local public health department (1).

Using the CASPER findings, CDC identified three areas of focus for OCHD and MDCH:

- Establishing community preparedness goals and objectives for Oakland County and Michigan based on baseline data from the CASPER.
- Developing radiation emergency communication plans based on the community's spokesperson and sources of information.
- Developing public health emergency preparedness education materials for areas of focus identified in the CASPER (1).

## Lessons Learned

It is essential to train local and state public health partners to conduct CASPER. During the week of the assessment, CDC staff provided group and one-on-one training to MDCH staff on the process and analysis aspects of administering a CASPER. CDC analyzed data with three MDCH staff for knowledge transfer purposes. The CASPER generated useful information for public health response planning. It also strengthened local- and state-level preparedness and response capability; because OCHD and MDCH participated in the training, development, and implementation of this assessment, they developed disaster epidemiology knowledge and capacity.

Integrating the CASPER methodology with GIS helps facilitate the assessment process. Use of the GIS CASPER tool for sampling and mapping dramatically shortened the time spent on this stage. The tool's capacity to generate detailed maps and KMZ files makes it more useful than manual sampling and mapping methods described elsewhere (6). The combination of paper maps and Google Earth aerial views of the clusters provided detailed information on the assessment area. The GIS CASPER tool is flexible and easy to use. The tool generates quality maps with various ways to display cluster information, which gives teams a better understanding of the selected area and facilitates navigation to and inside the clusters.

However, using GIS software as part of a CASPER is dependent on equipment availability and practical and appropriate methodologies for field use. Staff knowledge of GIS principles and expertise with software is vital. When evaluating GIS technologies and applications for CASPER, agencies should consider whether the selected software requires a licensing fee and whether there are any data source restrictions. Overall, GIS is a valuable tool for planning and implementing a CASPER.

## References

1. Household Emergency Preparedness Oakland County, Michigan September 2012: Available at: [http://www.michigan.gov/documents/mdch/MI\\_CASPER\\_Report\\_FINAL\\_02112013\\_413612\\_7.pdf](http://www.michigan.gov/documents/mdch/MI_CASPER_Report_FINAL_02112013_413612_7.pdf)
2. Fordyce, James. Governor widens storm state of emergency to other counties. *The Michigan Messenger*. [Online] 06 20, 2008. [Cited: 08 29, 2012.] <http://michiganmessenger.com/1445/governor-widens-storm-state-of-emergency-to-other-counties>.



3. Office of Public Health Preparedness. *Public health and medical preparedness: a decade of achievement in Michigan*. Lansing: Michigan Department of Community Health, 2011. Available at [http://www.michigan.gov/documents/mdch/Commemorative\\_Brochure\\_Final2\\_362709\\_7.pdf](http://www.michigan.gov/documents/mdch/Commemorative_Brochure_Final2_362709_7.pdf). Accessed August 29, 2012.
4. Steiger SM, Hamilton R, Keeler J, Orville RE. Lake-effect thunderstorms in the lower Great Lakes. *Journal of Applied Meteorology and Climatology*. 2009;48(5):889-902.
5. American Fact Finder: Census 2010 Oakland, Michigan Summary File. Available at; <https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t#none> Accessed on March 20, 2017
6. Department of Health and Human Services, Centers for Disease Control and Prevention. Community Assessment for Public Health Emergency Response (CASPER) Toolkit. Atlanta, GA: CDC; 2012. Available at: [https://www.cdc.gov/nceh/hsb/disaster/CASPER\\_elearning/CASPER%20Toolkit%20Version%20%2\\_00\\_FINAL%20CLEARED.pdf](https://www.cdc.gov/nceh/hsb/disaster/CASPER_elearning/CASPER%20Toolkit%20Version%20%2_00_FINAL%20CLEARED.pdf). Accessed on October 20, 2018

## **CASE STUDY 2-RESPONSE: Mental Health Needs Assessment after the 2010 Gulf Oil Spill**

### **Background**

On April 20, 2010, the Mobile Offshore Drilling Unit Deepwater Horizon exploded 40 miles south of the Louisiana coast. This event resulted in 11 deaths, 17 injuries, and the worst marine petroleum release in history. Over the next 3 months, the Deepwater Horizon oil spill event released over 4.9 million barrels of oil into the Gulf of Mexico. Although the oil well was capped on July 15, 2010, stopping the flow of oil into the ocean, the released crude oil has prolonged negative effects on marine biota. This released oil has detrimental consequences for the fishing industry; coastal attractions; and estuarine, marsh, and protected ecosystems of the Gulf States of Louisiana, Alabama, and Mississippi (1).

After the oil spill, officials from the Alabama Department Public Health (ADPH) and Mississippi Department of Public Health (MDPH) were concerned that some health effects, particularly mental health outcomes, were not adequately captured by routine surveillance systems. To address these concerns and assess the mental health status of the community, ADPH and MDPH in association with their state departments of mental health, asked CDC to conduct a CASPER in Gulf Coast counties. The CASPER goals were to determine the general and mental health needs of the community after the oil spill and to provide state and local public health officials with information to guide their response and allocate resources.

The sampling frames in Gulf Coast counties of Alabama and Mississippi were divided into three areas for the purpose of this assessment:

- 1) Baldwin County, Alabama (only the coastal portion).
- 2) Mobile County, Alabama (only the coastal portion).

- 3) Coastal Mississippi (all three of its Gulf Coast counties: Hancock County, Harrison County, and Jackson County).

The team developed a two-page data collection instrument in coordination with the Alabama and Mississippi departments of mental health, the state health departments, and CDC's Division of Behavioral Surveillance. The questionnaire included questions on dermatologic and other physical signs and symptoms in the previous 30 days; standardized questions on quality of life, mental health, and social context; and individual and household level exposure questions related to the oil spill. CASPER instruments normally ask questions at the household level. Some questions in this questionnaire were asked at the individual level, so this CASPER included individual- and household-weighted cluster analyses, where the results of each interview question were weighted based on whether the question referred to the individual or to the household.

## Results

The proportion of respondents reporting  $\geq 14$  days of poor physical health, mental health, or limited activity in the past 30 days was greater in all three assessment areas than was reported by state estimates in the 2009 Behavioral Risk Factor Surveillance System. The highest percentage of individuals (22%) reporting  $\geq 14$  days of poor physical health in the previous 30 days were residents of the areas surveyed in Mississippi. More respondents in Mississippi were worried/stressed about money for housing and meals and reported symptoms of anxiety than in the two Alabama assessment areas.

## Lessons Learned

The CASPER leadership team highlighted the major findings and recommendations in a meeting with stakeholders at the end of the assessment. The findings and recommendations were also distributed to emergency managers, state epidemiologists, and state and local health department authorities within 48 hours of assessment completion to support evidence-based public health decision-making. This assessment was unique because it demonstrated, for the first time, the usefulness of the CASPER methodology in mental health response and planning. This CASPER was a successful collaboration of state-, local-, and federal-level health agencies and provided an opportunity to engage with the community and improve mental health outreach programs.

## References

1. Community Assessment for Public Health Emergency Response (CASPER) after the Gulf Coast oil spill: Alabama, 2010: Available at: [http://www.adph.org/CEP/assets/CASPER\\_report.pdf](http://www.adph.org/CEP/assets/CASPER_report.pdf)
2. Buttke D, Vagi S, Bayleyegn T, Sircar K, Strine T, Morrison M, Allen M, Wolkin A. Mental health needs assessment after the Gulf Coast oil spill—Alabama and Mississippi, 2010. *Prehosp Disaster Med.* 2012;27 (5):1-8.

## ***CASE STUDY 3-RECOVERY: Longitudinal Community Assessment for Public Health Emergency Response to Wildfire, Bastrop County, TX, 2011 and 2015***

### **Background**

On September 4, 2011, a wildfire ignited in Bastrop County, Texas. The wildfire was the most destructive wildland-urban interface wildfire in Texas history; it burned 34,068 acres of land, destroyed 1,669 residential structures, and caused 2 deaths.<sup>1</sup> To assess public health impacts from the fire, Health Services Region 7 of the Texas Department of State Health Services conducted a CASPER on September 24-25, 2011, with the Bastrop County Office of Emergency Management.<sup>2</sup>

The objectives of the 2011 CASPER were to

- Determine the immediate public and mental health needs of the community.
- Provide an overview of key public health issues to assist local officials with response and resource allocation issues as recovery operations commenced.
- Assess sources of information and communication preferences during the immediate disaster response and ongoing recovery.

Nearly three and a half years later, in 2015, a follow-up CASPER was conducted to

- Measure progress in recovery and preparedness,
- Assess long-term health and mental health status,
- Identify useful means of communication, and
- Ascertain new concerns or unmet needs to be shared with Bastrop County officials.

CASPER can be effectively used in both disaster and non-disaster settings; therefore, it could be applied to both the 2011 assessment immediately after the wildfire and the 2015 assessment focusing on recovery and preparedness.

The survey instruments used in both CASPERs consisted of questions addressing several areas of concern for local emergency management and public health officials involved in the disaster response and recovery efforts. Longitudinal data were collected on several topics in the 2015 CASPER (see Table 1) to learn more about the long-term effects of the 2011 wildfire and the trajectory of disaster recovery in Bastrop. The survey instrument used in the 2015 CASPER included 33 questions addressing several areas of interest for local emergency management and public health officials, including preparedness, physical and mental health status, communication, and recovery. It included questions about residence at the time of the 2011 wildfire, home damage as a result of the wildfire, preparedness, physical and mental health status, preferred communication methods, and concerns related to the continued recovery of the Bastrop community.

Table 1. Domains of Knowledge Assessed during 2011 and 2015, Texas Wildfire CASPER

	2011	2015
Number of questions	34	33
<b>Domains of knowledge</b>		
Structural damage to the residence	x	x
Access to basic services, e.g. utilities	x	
Access to medical care	x	x
Physical and mental health status among adults and children	x	x
Evacuation behaviors	x	
Wildfire-related communications	x	x
Pet and livestock issues	x	
Preparedness		x
Recovery	x	x
Residence at the time of the 2011 wildfire	x	x
Intention to rebuild	x	
Rebuilding		x
Evacuation locations*	x (actual)	x (intended)
Inclusion of 5 important elements in a household emergency plan	x	x
Awareness of available mental health services	x	x

\* "Actual" is the location respondents evacuated to during the 2011 wildfires. "Intended" is the preferred location the respondents would go to if they had to evacuate during future wildfires.

The GIS CASPER tool referenced in the 2012 Oakland, Michigan, CASPER was used for the cluster sampling and mapping activities. Assessments were conducted in census blocks within, overlapping, or touching the perimeter of the Bastrop County Complex Wildfire. In both assessments, 35 census blocks were selected, for a target of 245 surveys. Detailed maps of selected blocks were generated. The clusters chosen for the 2015 CASPER were selected using the 2011 fire perimeter to allow for comparison of some responses.

## Results

In 2011, survey teams completed 135 household interviews, with a cooperation rate of 91.2% and a contact rate of 43.5%. In the follow-up CASPER conducted in 2015, survey teams completed 185 household interviews, with a cooperation rate of 78.1% and a contact rate of 53.9%.<sup>3</sup>

The vast majority (91%) of households living in wildfire-affected structures surveyed in 2015 indicated that residential structures had been repaired or rebuilt.

The reported lodging types used during the 2011 evacuation were consistent with the stated preferences in the 2015 assessment. The majority of households ranked neighbors, friends, and family first as the preferred lodging type during evacuation. In 2015, households exposed to the 2011 wildfires were significantly more likely to

- Have established a family meeting place and evacuation route,
- Have confidence in the local government's ability to respond to disaster, and
- Report symptoms of depression and higher stress.

## Lessons Learned

The Bastrop CASPERs demonstrated the utility of rapid needs assessments for developing effective strategies for recovery in communities affected by a major wildfire. The opportunity to conduct a longitudinal assessment of the long-term effects of a major wildfire disaster using the CASPER method is unique.<sup>3</sup> Having an established partnership between emergency management and public health officials, who recognized the value of CASPER and wanted to see how post-fire recovery was progressing, was essential to the success. The assessment provided actionable information for improved planning, preparedness, and recovery to public health and emergency management agencies and community residents. Findings were widely shared with and used by local public health and emergency management officials. The results lead to changes in planning, notification, health education, resource allocation, and implementing additional recovery activities.

## References

<sup>1</sup> National Climatic Data Center (NCDC). (2011). Storm events database: event details. NOAA website. 2011. <http://www.ncdc.noaa.gov/stormevents/eventdetails.jsp?id=349876>. Accessed March 3, 2016.

<sup>2</sup> Zane D, Jones R, Huss J, Sanches K, Hoogheem J, Clements B. Public Health Emergency Response to a Massive Wildfire in Texas (2011), *Texas Public Health Journal* 2012; 64(4): 6-10.

<sup>3</sup> Kirsch KR, Feldt BA, Zane DF, Haywood T, Jones RW, Horney JA. Longitudinal Community Assessment for Public Health Emergency Response to Wildfire, Bastrop County, Texas. *Health Security*. 2016 Mar-Apr;14(2):93-104.

## *CASE STUDY 4-INCIDENT COMMAND SYSTEM (ICS) IN CASPER IMPLEMENTATION: Assessing the Public Health Impacts of Drought in Mariposa and Tulare Counties, CA, 2015*

### Background

California's unprecedented drought began in 2012. Since then, thousands of private wells have gone dry, reducing access to potable water; and millions of trees have died or succumbed to bark beetle infestation in drought-stricken forests, resulting in an increased risk of wildfires, landslides, and costs to property owners. Governor Edmund G. Brown Jr. proclaimed a State of Emergency in January 2014 (<https://www.gov.ca.gov/news.php?id=18368>) and, by the end of 2015, California recorded 63

Emergency Proclamations from city, county, tribal governments, and special districts ([http://drought.ca.gov/pdf/archive/WeeklyDroughtUpdate\(11-25-15\).pdf](http://drought.ca.gov/pdf/archive/WeeklyDroughtUpdate(11-25-15).pdf)).

A severe drought is a slow-onset disaster with far-reaching impacts on the economy, environment, and communities. Drought-associated adverse outcomes might be the result of long exposures, leading to both direct and indirect health consequences. Drought-impacted households may lack running or potable water, experience physical and mental health effects, and face financial losses related to the drought. However, little has been reported on the public health impacts of drought.

The California Department of Public Health (CDPH) collaborated with two severely impacted counties in 2015 to conduct CASPERs to better quantify drought-related population impacts and to inform public health decisions and action. Tulare County, a largely agricultural county in the heart of California's Central Valley, has had the majority of reported private well failures in the state. Mariposa County, located at the foothills of the Sierra Nevada Mountains, had the most affected forests, with an estimated 30%–50% mortality of pine, fir, and oak. These CASPERs assessed

- Knowledge, attitudes, and practices regarding the drought,
- Access to and use of water,
- Water conservation practices,
- Perceived impacts of the drought on health, mental health, and finances,
- Preferred emergency communication methods, and
- Household demographics.

Tulare County conducted two simultaneous CASPERs, one in the northern part of the county and one in the southern part. The two sampling frames were designed to augment the sample with households on private wells. Mariposa County chose a single countywide sampling frame. The complete results of the assessments are available at CDPH website

(<https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/Pages/Emergency-Preparedness-Team.aspx>).

Both Tulare and Mariposa counties implemented Incident Command System (ICS) to conduct the drought CASPERs. Additionally, Tulare used its Emergency Operations Center (EOC) location as the Incident Command Post, and Mariposa exercised its Public Health Emergency Preparedness (PHEP) capabilities.

In this case study example, we discuss how CASPER fits with the ICS infrastructure, how ICS can benefit CASPER implementation, and how local jurisdictions can leverage both to fulfill their PHEP requirements.

### **Incident Command System and CASPER**

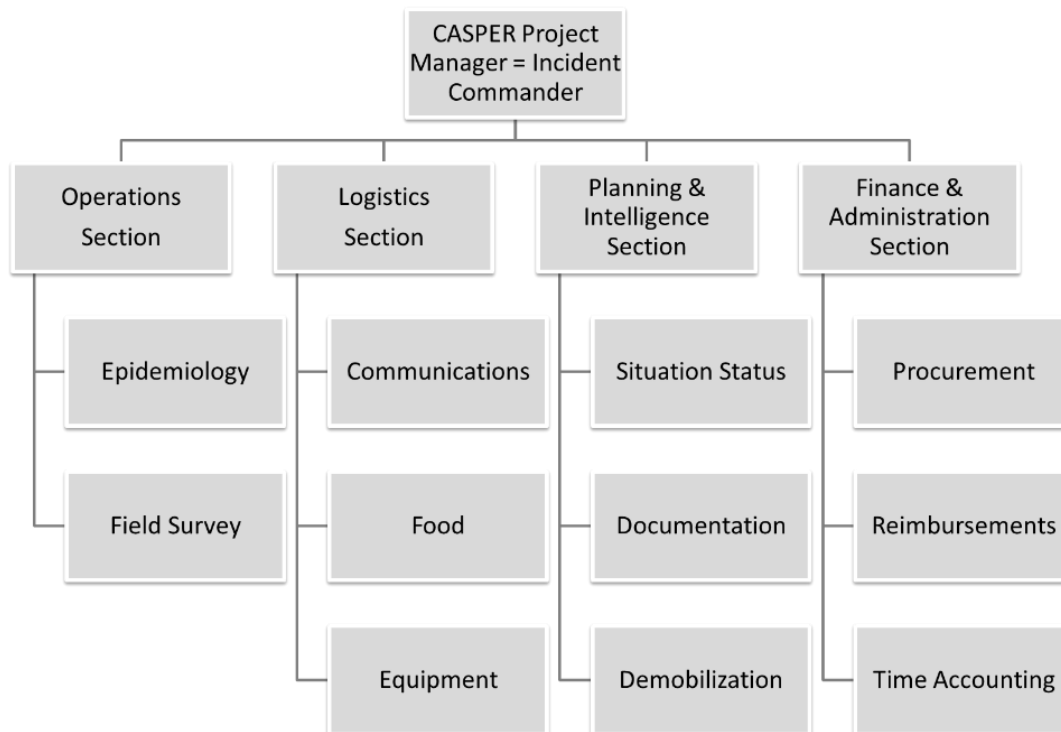
ICS enables effective and efficient incident management by integrating personnel, equipment, procedures, and communications in a common organizational structure. The common structure has five major functional areas: Command, Operations, Planning & Intelligence, Logistics, and Finance & Administration (for more information: <https://www.fema.gov/incident-command-system-resources>).

While CASPER itself is a specific epidemiological method, the overall process necessary for its implementation—from selecting a sampling frame to designing a questionnaire to managing field

interview teams to data entry and analysis—largely fits with the ICS structure (Figures 1-3). Potential benefits of conducting a CASPER using an ICS structure include

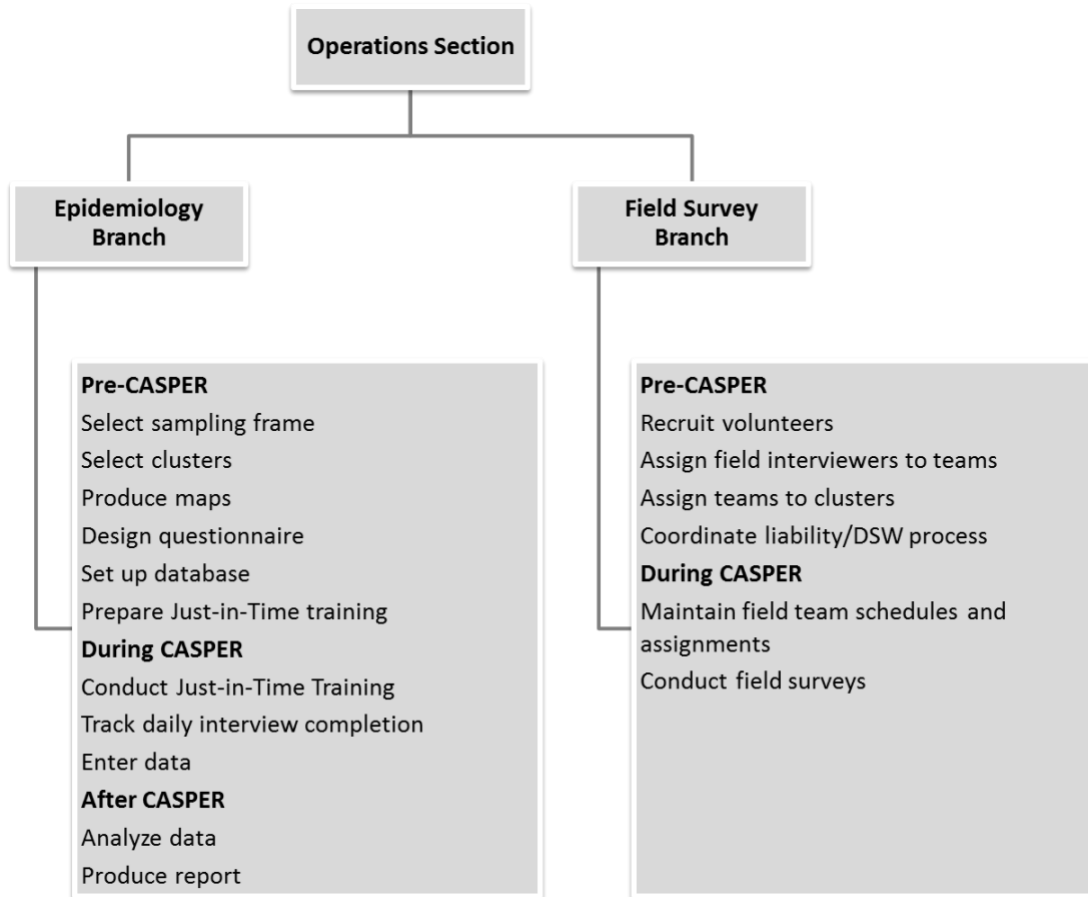
- Partnering with emergency management and other agencies to reduce costs and increase efficiency
- Having an opportunity to conduct PHEP-mandated training and exercise in a real public health application.
- Assigning roles and responsibilities in a standardized manner.
- Creating a clear chain of command and communication flow among all the partners and volunteers.
- Keeping interview teams safe in the field.
- Having standard templates and forms for keeping track of activities, expenditures, and equipment.

Figure 1. Example of CASPER ICS Structure\*



\*Example created by the CDPH Environmental and Occupational Emergency Preparedness Team.

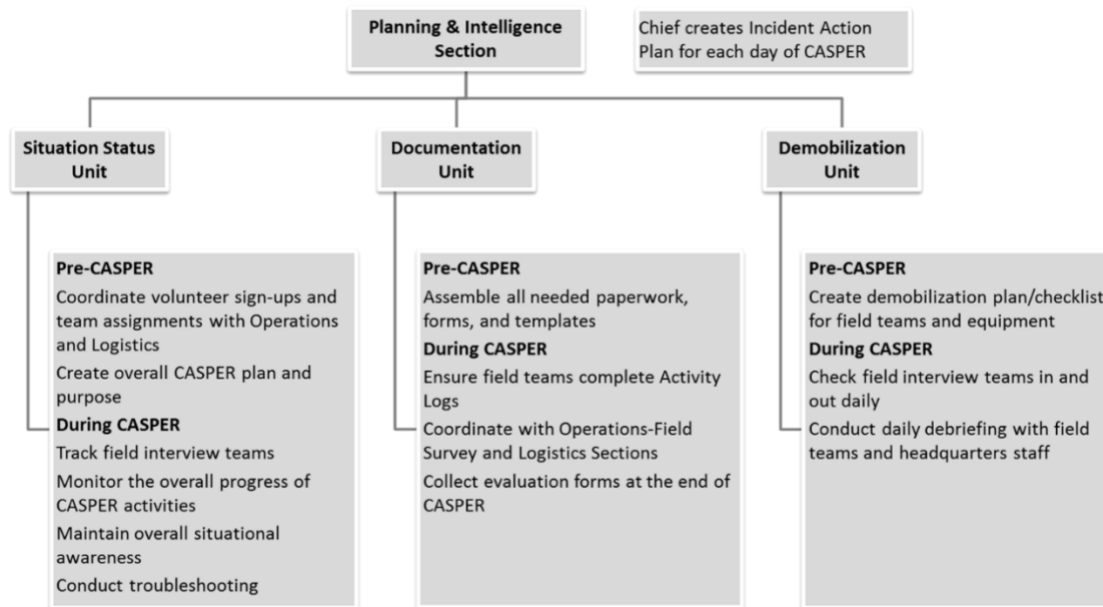
Figure 2. Example of an Operations Section's CASPER Activities\*



\*Example created by the CDPH Environmental and Occupational Emergency Preparedness Team.



Figure 3. Example of a Planning & Intelligence Section's CASPER activities\*



\*Example created by the CDPH Environmental and Occupational Emergency Preparedness Team.

## Public Health Emergency Preparedness (PHEP) and CASPER

CDC developed 15 capabilities to serve as national public health preparedness standards (<https://www.cdc.gov/phpr/capabilities/>) to guide state and local health departments in preparing for and responding to public health emergencies and incidents. PHEP capabilities are at the intersection of public health essential services and emergency management, and they include CDC requirements for training and exercises ([https://www.cdc.gov/phpr/capabilities/dslr\\_capabilities\\_july.pdf](https://www.cdc.gov/phpr/capabilities/dslr_capabilities_july.pdf)).

In 2015, the Council of State and Territorial Epidemiologists published a crosswalk document illustrating how disaster epidemiology tools, such as CASPER, can be used to meet PHEP capabilities ([http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/PDFs/Crosswalk\\_5.28.15.pdf](http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/PDFs/Crosswalk_5.28.15.pdf)). Conducting a CASPER allows a jurisdiction to collect valuable data. It also provides an opportunity to train and exercise various PHEP capabilities by engaging multiple partners, directly interacting with the affected communities, implementing an organizational management system (i.e., ICS), evaluating specific plans and processes, and formulating and executing improvement strategies.

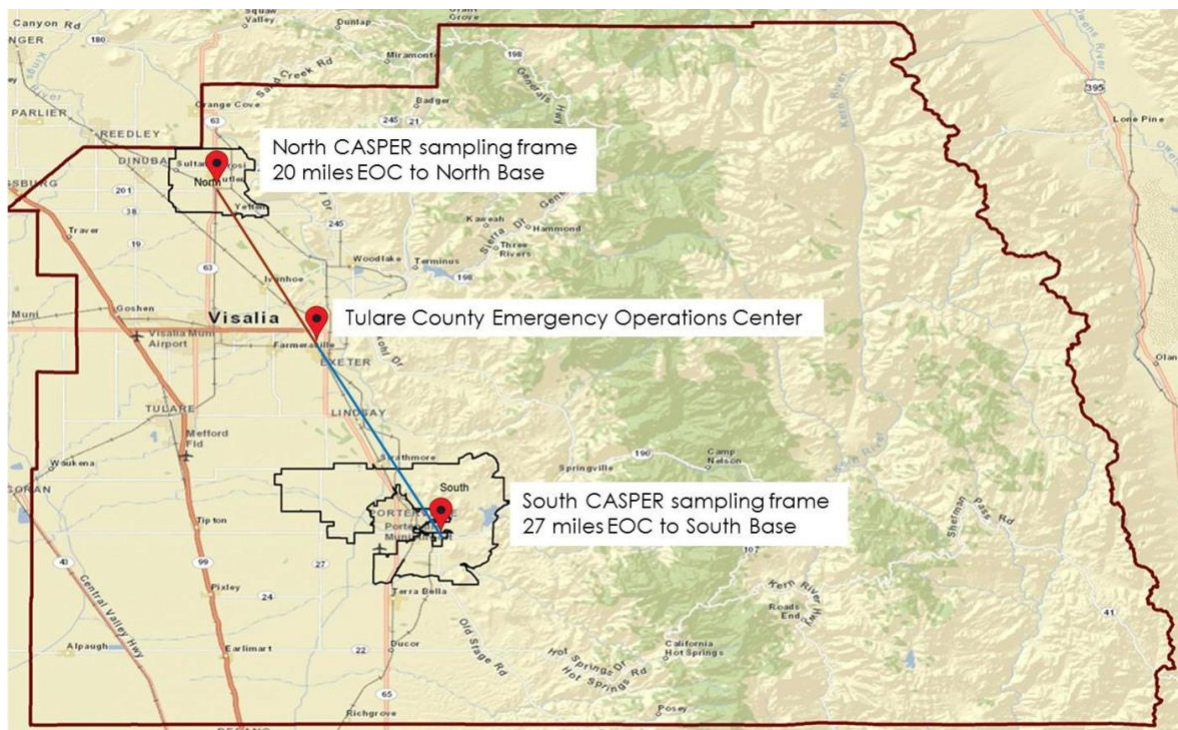
## Tulare County CASPER

The Tulare County Health and Human Services Agency partnered with the Tulare County Office of Emergency Services (OES) and the Tulare County Fire Department. The Tulare County PHEP Manager served as Incident Commander; the county Health Officer served as a Deputy Incident Commander. The vast majority of field teams were volunteers from local community organizations or county departments. The County's EOC facility was used as the Incident Command Post and call center to manage all aspects of the two simultaneous CASPERs. The EOC facility was the just-in-time training site on the first day, then became the hub for logistics and communications. To maintain the ICS concept of span of control over the geographically large operating area, the Operations section was split into Northern and Southern branches that corresponded to the sampling frames. In each sampling frame, a fire station was designated as a forward operating base (Figure 4). Field supervisors from Tulare OES and scientific staff from CDPH staffed the fire station bases to handle field team check-in, check-out, meal breaks, and end-of-day debriefs. All teams checked in at their respective fire station base to collect their materials and receive instructions at the beginning of the day, returned to the base to eat lunch and turn in questionnaires completed in the morning round, and checked out at the end of the day after a daily debrief. At the end of the 3-day CASPER period, forward operating base staff demobilized the interview teams.

Every field team received a UHF radio that operated on one of the Sheriff's channels as a backup to cell phones. Teams either radioed or called in their whereabouts as they progressed through their CASPER clusters and reported each completed questionnaire. Using Google Fusion Tables\* (<https://support.google.com/fusiontables/answer/2571232?hl=en>), command staff monitored teams through the call center, allowing for universal awareness of team whereabouts at the Incident Command Post and forward operating bases. Incident Command Post staff watched for teams with long out-of-contact times. To help teams that had gotten lost and to ensure the safety of all teams in the field, Command Post or forward operating base staff called teams with long out-of-contact times to determine status. Forward operating base staff had county vehicles to respond to unreachable teams or those in need of assistance.

*\*Use of trade names is for identification only and does not imply endorsement by the Centers for Disease Control and Prevention, the Public Health Service, or the U.S. Department of Health and Human Services.*

Figure 4. Tulare County CASPER Sampling Frame, Emergency Operations Center Headquarters, and Forward Operating Bases Locations



## Mariposa County CASPER

The Mariposa County Health Department (MCHD) partnered with the Mariposa Amateur HAM Radio Group and Mariposa County OES. The Mariposa County PHEP Coordinator served as the Incident Commander; the acting county Health Officer participated as a field interviewer. Field team membership included county agency staff, local volunteers, and a small number of out-of-the-area volunteers. Mariposa County did not use its EOC for the CASPER; a fire station was designated as the headquarters. Various county personnel and scientific staff from CDPH staffed the headquarters to handle field team check-in, check-out, meal breaks, and end-of-day debriefs. Operations Section included Divisions based on geographical areas within the county; each field interview team was assigned to a Division. All teams checked in at the fire station to collect their materials and receive instructions at the beginning of the day, returned to headquarters to eat lunch and turn in questionnaires completed in the morning round, and checked out at the end of the day after a daily debrief. At the end of the 3-day initial CASPER period, headquarters staff demobilized interview teams. However, because of the small number of field interview teams, the CASPER had to be extended, and several teams operated out of the MCHD office for another 2 weeks to complete the necessary number of interviews.



Mariposa County has poor cellular phone coverage and a robust local Amateur HAM Radio Group, which chose CASPER as an opportunity to exercise its procedures and equipment. The radio operators integrated into the ICS structure, developed the communications plan, and managed the Communications Unit within the Logistics Section. Roving radio operator teams were assigned to CASPER field teams in various regions of the county; they were essential to relay radio transmissions from survey areas to the Communications Unit to keep track of team status and assure safety. Every field team received a radio as the primary communication method. Teams radioed (called or texted in areas with cell coverage) their whereabouts as they progressed through their CASPER clusters. Roving radio operators were dispatched to locate teams with long out-of-contact times in their assigned areas.

## ICS Forms

FEMA offers templates for all ICS forms, such as the Incident Action Plan (ICS 201) and Activity Log (ICS 214), that can be used to document CASPER operations. This information is especially critical for reimbursements after a declared emergency (<https://training.fema.gov/emiweb/is/icsresource/jobaids.htm>).

Both Tulare and Mariposa counties took advantage of existing ICS form templates to create drought CASPER implementation plans and to document their activities. The incident commanders generated an Incident Action Plan (ICS form 201) for each day and compiled incident objectives (ICS form 202, Figure 5). Command staff in both counties used an Assignment List (ICS form 204) to manage field teams. Recognizing the rural and remote nature of the sampling frame, Mariposa's Safety Plan (ICS Form 208, Figure 6) listed important safety messages to share with the field teams during the just-in-time training. The Finance Section in Mariposa County required all field interview teams to fill out Activity Logs (ICS form 214) for mileage and other reimbursement calculations. Tulare County used a sophisticated Excel spreadsheet to manage all of its ICS forms in a centralized document.

Figure 5. Example of ICS 202 Incident Objectives Forms from Tulare and Mariposa Drought CASPERs

INCIDENT OBJECTIVES (ICS 202)		
1. Incident Name: <b><i>Tulare Drought CASPER</i></b>	2. Operational Period: Date From: _____ Date To: _____ Time From: <b>9:00</b> Time To: <b>17:30</b>	
3. Objective(s): 1. <i>Ensure the safety of all survey team members and support staff</i> 2. <i>Complete training, orientation, and briefing of all survey team members by 1400 hours</i> 3. <i>Begin conduct of household surveys in East Porterville and Cutler-Orosi areas</i>		
INCIDENT OBJECTIVES (ICS 202)		
1. Incident Name: <b><i>Mariposa Drought CASPER</i></b>	2. Operational Period: Date From: _____ Date To: _____ Time From: <b>8:00</b> Time To: <b>20:00</b>	
3. Objective(s): 1. <i>Ensure the safety of all survey team participants and incident staff</i> 2. <i>Complete an in-person survey of 210 designated households in specifically defined census blocks</i> 3. <i>Exercise Public health Emergency Response Capabilities: Volunteer Management, and REsponse Safety and ealth, Emergency Public Information and Warning, Information Sharing, Community Recovery, and Public Health Surveillance and Epidemiological Investigation</i>		

Figure 6. Example of ICS 208 safety plan form from Mariposa drought CASPER.

SAFETY MESSAGE/PLAN (ICS 208)			
1. Incident Name: <b>Mariposa Drought Impact Survey</b>	2. Operational Period:	Date From: <b>11/12/15</b>	Date To: <b>11/14/15</b>
		Time From: <b>8:00</b>	Time To: <b>20:00</b>
3. Safety Message/Expanded Safety Message, Safety Plan, Site Safety Plan:			
1. Driving is biggest hazard - drive safely, wear seatbelts, and maintain awareness of your surroundings 2. Approaching Residences - Any concerns about personal safety, do not enter; pause and wait before getting out of the car. Listen for dogs approaching and listen for homeowner warnings. 3. Identify yourself 4. Ask for permission to enter the property 5. Keep method of communications available at all times 6. Contact / Request help as soon as possible if situation becomes unsafe 7. Practice how you will ask for help with a radio BEFORE you need it.			

## Exercise of PHEP Capabilities

As part of PHEP funding, all local health jurisdictions in California are required to participate in an annual statewide health and medical exercise. In lieu of the exercise, Mariposa County used the drought CASPER to test the following PHEP capabilities and their functions (1): Community Preparedness (Capability 1); Community Recovery (Capability 2); Emergency Operations Coordination (Capability 3); Emergency Public Information and Warning (Capability 4); Responder Safety and Health (Capability 14); and Volunteer Management (Capability 15). At the conclusion of all CASPER activities, the county developed an After Action Report (AAR) and Improvement Plan (IP).

Following is a detailed example of how CASPER and use of ICS tested Capability 3 in Mariposa County:

- For Function 1 (Conduct a preliminary assessment to determine the need for public activation), CDPH and MCHD defined knowledge gaps and priority topics for assessing the public health impact of the drought, gathered appropriate stakeholders (e.g., radio operators) for the incident command operations, and established lead and supporting roles.
- For Function 2 (Activate public health emergency operations), the county engaged its resources (human, technical, physical space, and physical assets) to address CASPER in accordance with the National Incident Management System and consistent with jurisdictional standards and practices (e.g., MCHD opened its Department Operations Center; the county PHEP Coordinator assumed the Incident Commander role; county staff were pulled from their daily jobs to assume ICS roles at CASPER headquarters or as field interviewers).
- For Function 3 (Develop incident response strategy), the Mariposa PHEP Coordinator in the role of the Incident Commander produced an Incident Action Plan (IAP) for each operational period, disseminated the plan to all staff, and revised the plan as necessary based on CASPER interview progress.

- For Function 4 (Manage and sustain the public health response), Mariposa County and CDPH had to extend field interview activities past the planned 3 days because of the county's large geographic area and the small number of volunteers able to dedicate 3 full days to the CASPER. IAP and other activities were adjusted accordingly.
- For Function 5 (Demobilize and evaluate public health emergency operations), all field interview teams were debriefed and demobilized at the end of the CASPER, all deployed equipment (e.g., radios, safety kits, map atlases) was collected and inventoried, Activity Logs were turned over to Finance, and the AAR and IP were produced. The AAR and IP addressed every exercised capability and provided recommendations for improving county procedures. For example, as discovered during the field team debrief, the check-in process on the first day was unclear and chaotic. Therefore, the IP included specific recommendations for developing a smoother check-in process, which was successfully implemented during the 2016 follow up drought CASPER in Mariposa.

Administration of any CASPER directly fulfills two functions of Capability 14, Responder Safety and Health (identify responder safety and health risks; identify safety and personal protective needs) and the four functions of Capability 15, Volunteer Management (coordinate volunteers; notify volunteers; organize, assemble, and dispatch volunteers; demobilize volunteers). Therefore, jurisdictions conducting CASPERs could account for those activities in their PHEP deliverables as well.

## Conclusion

Following an ICS while preparing for and conducting drought CASPERs in Tulare and Mariposa counties worked very well. The major advantages included clear roles, responsibilities, and accountability among all partners, awareness of where field interview teams were at all times, and more efficient use of the resources (staff, equipment, questionnaires, and expenditures). Use of the EOC facility as an Incident Command Post in Tulare allowed for centralization of resources and communications in a single command center; operation of the bases in each of the sampling frames benefitted field teams that otherwise would have very long drives to headquarters. Mariposa exercised its PHEP capabilities and successfully partnered with the local Amateur HAM Radio Group, whose members provided critical communications for the CASPER field teams and filled in as interviewers when necessary. In addition to providing important public health impact data, the drought CASPERs in both counties stressed that maintaining a close working relationship among public health, emergency management, and community organizations is crucial for overall community preparedness and building of local resilience.

## Reference

1. Center for Disease Control and Prevention (CDC). Public Health Preparedness Capability: National Standard for State and Local Planning. March 2011. Available at [https://www.cdc.gov/phpr/readiness/00\\_docs/DSLRC\\_capabilities\\_July.pdf](https://www.cdc.gov/phpr/readiness/00_docs/DSLRC_capabilities_July.pdf)

## Disclaimer

The findings and conclusions in this chapter are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

## Additional Resources

The following CASPER resources can provide details of the assessment procedures and help state, tribal, local, and territorial health departments and public health professionals develop local capacity for disaster response:

- **Center for Disease Control and Prevention (CDC)**  
The National Center for Environmental Health's Health Studies Section (HSS) at the Centers for Disease Control and Prevention (CDC), Emergency Management, Radiation and Chemical Branch (EMRCB) is the response section for the Center (<https://www.cdc.gov/nceh/ehsp/default.html>) HSS helps state, tribal, local, and territorial health departments conduct CASPERs in the field or provides remote technical assistance on topics such as sampling and mapping or reviewing a questionnaire and analysis method. The CASPER toolkit and the web-based training resources are available at (<https://www.cdc.gov/nceh/hsb/disaster/casper/default.htm>)
- **Council of State and Territorial Epidemiologists (CSTE)**  
The CSTE Disaster Epidemiology (DE) subcommittee identified the need to share information among state, local, and federal epidemiologists on disaster-related methods, tools, and lessons learned. To meet this need, the DE subcommittee created a repository of DE tools including CASPER and related guidance on their uses. Subcommittee members created a crosswalk of disaster epidemiology and public health preparedness to provide resources to health departments on disaster epidemiology tools to help meet the capabilities. <https://www.cste.org/group/disasterepi>
- **National Institute of Health (NIH)**  
The **NIH Disaster Research Response Program (DR2)** is the national framework for research on the medical and public health aspects of disasters and public health emergencies. The DR2 website, provided by the National Institute of Environmental Health Sciences and the National Library of Medicine, supports disaster science investigators by offering data collection tools, research protocols, and disaster research news and events. <https://dr2.nlm.nih.gov/>
- **North Carolina Health and Human Services (NCHHS)**  
North Carolina's disaster epidemiology program created advanced CASPER tools to conduct community-based surveys. NCHHS provides disaster epidemiology consultation, technical assistance and training to the state's public health agencies and largest hospital systems to ensure preparedness and response capabilities that meet community needs, national standards, and state health department accreditation requirements. <https://epi.publichealth.nc.gov/phpr/>

- **Texas Department of State Health Services (TXDSHS)**  
TXDSHS at Austin has established a CASPER Team to **assist** and **partner** with local and regional health departments in responding to public health emergencies in their communities.  
<https://www.dshs.texas.gov/commprep/disasterepi/casper.aspx>
- **California Department of Public Health (CDPH)**  
The CDPH, Division of Environmental and Occupational Disease Control (DEODC) Emergency Preparedness (EP) Team conducted several investigation using the CASPER methodology and has developed a California-specific CASPER toolkit. The EP Team also provides disaster epidemiology consultations and technical assistance to local jurisdictions.  
<https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/Pages/Emergency-Preparedness-Team.aspx>

## CASPER learning resources

- CDC course (60-120 min, CEU available)  
[http://www.cdc.gov/nceh/hsb/disaster/CASPER\\_elearning/](http://www.cdc.gov/nceh/hsb/disaster/CASPER_elearning/)
- UNC course (25min, CEU available)  
[https://nciph.sph.unc.edu/tws/HEP\\_CASPER/certificate.php](https://nciph.sph.unc.edu/tws/HEP_CASPER/certificate.php)

## CASPER videos

- Lake County, California, 2012  
9 minutes, <https://www.youtube.com/watch?v=vf12bE-pdu0>
- Fort Bend, Texas, 2015  
5 minutes, <https://www.youtube.com/watch?v=37mWBZ83aQE>
- Ysleta Del Sur Pueblo Indian Nation (El Paso), Texas, 2015  
7 minutes, [https://www.youtube.com/watch?v=pQtpKoAaV\\_w](https://www.youtube.com/watch?v=pQtpKoAaV_w)
- Harris County, Texas, 2015  
3 minutes, <https://www.youtube.com/watch?v=IDgna5xyG4c> 10 minutes, <https://www.youtube.com/watch?v=GwB9jtTbrKU>
- Harris County, Texas, 2017
  - 21 minutes, Just-in-time-training, CASPER overview  
<https://www.youtube.com/watch?v=d4VK4VeER0k>
  - 18 minutes, Just-in-time-training, Clusters and systematic random sampling  
[https://www.youtube.com/watch?v=nGh9SIVnuuM&index=2&list=PLOBJgqWGHBjg\\_rYakEIVZovcgjOGW9Rxm](https://www.youtube.com/watch?v=nGh9SIVnuuM&index=2&list=PLOBJgqWGHBjg_rYakEIVZovcgjOGW9Rxm)
  - Nine 1-minute videos on different CASPER aspects  
<https://www.youtube.com/playlist?list=PLOBJgqWGHBjgEcdrJhS22AL3cvumFxtVWz>





- CDC Response to Hurricanes using CASPER, 2018  
5 minutes, <https://www.youtube.com/watch?v=bTc91V1Xexg>

**Note:** This section was written based on the second edition of the CASPER Toolkit. At the time of publication, CSTE is aware that the third edition of the CASPER toolkit is available on the CDC website. <https://www.cdc.gov/nceh/hsb/disaster/casper/default.htm>

## Assessment of Chemical Exposures

*Svetlana Smorodinsky, Jason Wilken, Tracy Barreau, Mary Anne Duncan, Alice Shumate, Kimberly Brinker, Erica Thomasson, Joy Hsu*

---

**Dedicated to Mary Anne Duncan (1963–2017), who was instrumental in developing and implementing the ACE program at ATSDR.**

### **INTRODUCTION** *[contributed by Mary Anne Duncan]*

Chemical releases can cause injuries, and possibly death, to large numbers of workers and local residents. When this occurs, public health officials may need epidemiologic data to best direct the public health response. Often, the responding local or state health agencies lack experience in chemical spill epidemiologic investigations and do not have sufficient staff to conduct one in a timely manner. In addition, the literature often lacks health outcomes from chemical releases in communities, so it can be difficult to communicate health information to the public.

In 2010, the Agency for Toxic Substances and Disease Registry (ATSDR) developed the Assessment of Chemical Exposures (ACE) program to assist local and state health agencies in responding to acute chemical incidents. The program developed the ACE toolkit ([https://www.atsdr.cdc.gov/ntsip/ace\\_toolkit.html](https://www.atsdr.cdc.gov/ntsip/ace_toolkit.html)) that contains surveys, consent forms, medical chart abstraction forms, and databases, so new materials do not need to be developed for each response. Instead, appropriate sections of the existing materials can quickly be adapted to the situation. The ACE toolkit includes consent forms; a contact collection form; surveys for hospitals, households, adults, children, and pets; and hospital and veterinary medical record abstraction forms. ACE teams are available to deploy to the field to assist in an investigation, or the program can provide technical assistance over the phone or through email. Reports are published after each ACE investigation describing the health effects identified after the chemical exposures. ACE investigations may include key informant interviews, exposed person surveys, and medical chart reviews. Data can also be collected about household pets to supplement the human data.

#### **Data collected from ACE investigations has been used to:**

- Provide individual-level assistance to exposed persons
- Report accurate descriptions of health impacts to reassure community members
- Make recommendations to prevent a similar chemical release from occurring in the future
- Make recommendations to improve response to future mass-casualty incidents
- Make recommendations to protect the health of emergency responders
- Change state-level policy for reporting chemical incidents to the health department
- Identify exposed persons to be followed for long-term health effects of the acute exposure

The ACE program has also developed training materials, an on-line introductory course in performing assessments after acute chemical releases ([link](#)), and a daylong, in-person ACE course.

## CASE STUDIES

**CALIFORNIA** [contributed by Svetlana Smorodinsky, Jason Wilken, Tracy Barreau]

### Background

In June 2010, chlorine gas, which can cause severe respiratory symptoms with long-term consequences, was unintentionally released from a ruptured 1-ton, low-pressure tank at a recycling facility in Tulare County, CA. The tank was unlabeled, reportedly empty, and sold to the facility as scrap metal.

Following the incident, ATSDR and Centers for Disease Control and Prevention (CDC) collaborated with the California Department of Public Health (CDPH) and Tulare County agencies to determine the causes and extent of chlorine gas exposures and their associated health effects, and to develop recommendations for preventing similar incidents in the future. This investigation was a pilot implementation of the newly developed ACE toolkit.

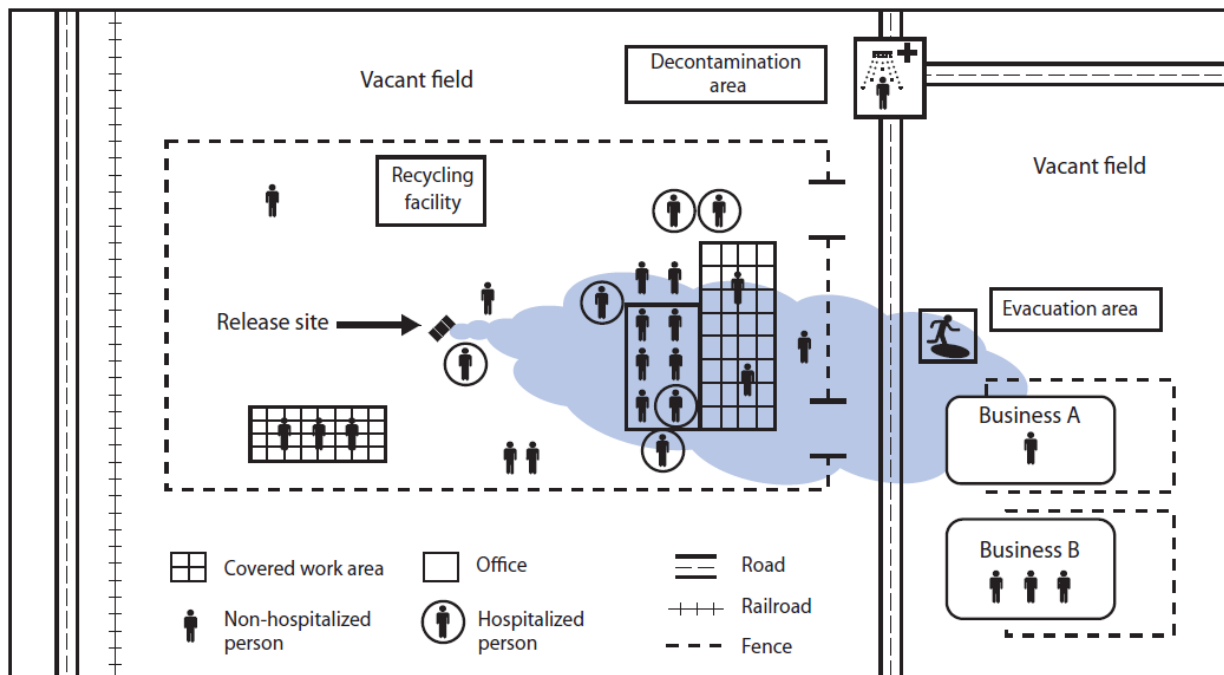
### ACE implementation

The ACE team conducted key informant interviews with various parties, including local health and environmental health officials, fire and hazmat responders, and facility owners. Using the ACE exposure and health effects questionnaire, the team interviewed the affected individuals; with the help of county public health nurses, most interviews were completed in one day. In addition, CDPH created a supplementary assessment form for employees to evaluate safety practices at the recycling facility. An ATSDR industrial hygienist conducted a facility walkthrough and assessment and provided a comprehensive report with recommendations to the facility. Finally, medical records of the exposed individuals were abstracted. The results are available in an MMWR publication, <https://stacks.cdc.gov/view/cdc/29040>.

The release occurred outdoors in an open work area when the chlorine tank was torn open by heavy equipment. The chlorine gas plume traveled at least a mile from the explosion site in the direction of the facility exit gate, reaching a field across the street. That field was designated in the facility's plan as the emergency evacuation area (see Figure 1; information obtained from the surveillance video and employee interviews). Most workers followed the designated route, inadvertently evacuating into the plume. One worker described holding his breath until he was across the street, therefore unwittingly inhaling chlorine gas in the evacuation area. Three hours after the incident, a hazmat team measured the tank off-gassing at 328 ppm (life-threatening effects such as pulmonary edema and respiratory failure can occur within 2-4 hours from chlorine exposure at 40-60 ppm; exposure to 430 ppm lasting over 30 minutes is lethal). (ATSDR, 2010)

The incident affected 29 people, of whom 23 (including employees, customers, and workers at nearby businesses) reported respiratory symptoms within 24 hours of exposure; six were hospitalized for 1– 11 days; one required mechanical ventilation for two days. Those hospitalized were not necessarily the closest to the release (Figure 1).

Figure 1. Schematic of chlorine gas release at a metal recycling facility (from Kelsey et al., 2011).



At the conclusion of the investigation, CDPH created and distributed a Chemical Release Alert to >1,200 recycling facilities in California to educate them on how to prevent future releases of chlorine gas and other hazardous materials (<https://www.cdph.ca.gov/Programs/CCDC/DEOD/CDPH%20Document%20Library/Chlorine%20Release%20Scrap%20Metal%20Alert.pdf>). The alert encouraged facilities to only accept containers that are cut open, dry, and without a valve or plug; to treat closed containers as potentially hazardous waste, and to develop and practice an evacuation plan and train workers to stay upwind when evacuating for a chemical release.

CDPH conducted further follow up interviews with the affected individuals six months after the event, assessing continuing symptoms (including a post-traumatic stress disorder checklist) and the quality of received medical care. The purpose of the follow up was to understand the long-term consequences of the exposure, facilitate access to adequate healthcare, and evaluate feasibility and utility of such follow up after other incidents. The follow up showed that several individuals continued to have ongoing symptoms (e.g., respiratory) not present before the incident; many were not satisfied with the medical

care they received, and several screened positive for post-traumatic stress disorder. CDPH attempted to connect these individuals with the necessary providers.

## Lessons learned

The ACE team was initially not aware that multiple fire departments were involved in the immediate response, and therefore did not conduct interviews with the correct personnel at the beginning. Thus, quickly obtaining information about all responding agencies, understanding the complexity of the local response, and forming partnerships with key players is of utmost importance.

Developing prevention materials following an ACE is valuable. CDPH developed the content of the Chemical Release Alert in collaboration with ATSDR and CDC staff. CDPH also sent a draft of the alert to the affected employer and to the safety director of a scrap recycling trade association for their input. The Alert was widely distributed and well-received.

The six-month follow up illustrated that a hazardous material incident like this could result in lasting physical and mental health effects. It may be helpful to plan for a follow up at the outset of an ACE. For instance, it might be useful to obtain patient consent for further contact at the initial interview or to adapt a registry or a contact collection form for a smaller scale event.

Conducting further follow up on chemical exposure incidents which result in mass casualties, such as this one, offer multiple public health and healthcare opportunities, such as the following:

- Bringing attention to long-term consequences of such exposures
- Educating and training healthcare providers
- Improving standards of care for chemical exposures
- Creating more robust literature on the topic
- Improving workplace health and safety
- Improving emergency planning at the facilities and among first responders

This ACE investigation was a successful collaboration of federal, state, and local agencies and allowed CDPH to understand the circumstances of the incident and health effects associated with exposures, and to make recommendations for preventing recurrences.

## References

- Agency for Toxic Substances and Disease Registry. Toxicological profile for chlorine. Atlanta: U.S. Department of Health and Human Services; 2010 Nov. Accessible online at: <https://www.atsdr.cdc.gov/toxprofiles/tp172.pdf>
- Kelsey K et al., Chlorine gas at a metal recycling facility — California, 2010. MMWR Morb Mortal Wkly Rep. 2011, 60(28): 951–4

**NEW JERSEY** [contributed by Kimberly Brinker, Alice Shumate, Jason Wilken]

## Background

On November 30, 2012, a freight train derailed while crossing a railroad bridge over a creek on the outskirts of a town of ~6,000 residents in New Jersey. Four tanker cars fell into the creek, and one tanker car was ruptured, releasing ~20,000 gallons of pressurized vinyl chloride. Vinyl chloride is a colorless, sweet-smelling gas, the inhalation of which can cause respiratory and neurological symptoms, and, at high concentrations, can cause cardiac dysrhythmia, loss of consciousness, and death.

Authorities issued a shelter-in-place (SIP) order, the street adjacent to the creek was evacuated, and later in the day, the evacuation order was extended. Over the next four days, SIP orders were issued and lifted as ambient vinyl chloride concentrations fluctuated. Four days after the derailment, more residents were evacuated when ambient vinyl chloride concentrations rose.

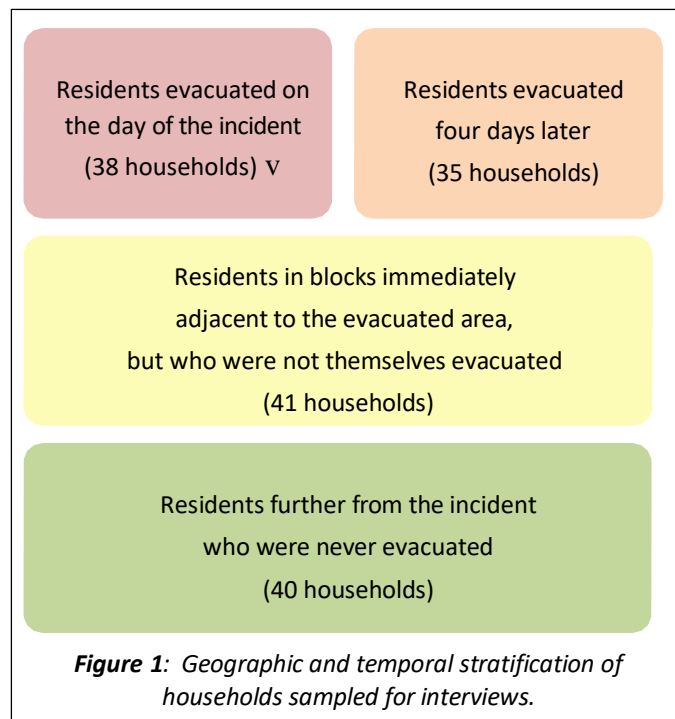
The New Jersey Department of Health (NJDOH) collaborated with ATSDR and CDC to characterize exposure and health effects of the community affected by the vinyl chloride release, examine the medical response to the release, evaluate the occupational safety and health of emergency personnel who responded to the incident, and to describe the response to the incident and develop recommendations for public health preparedness and response to mass-casualty chemical releases.

These separate components of the investigation were conducted using various modules of the ATSDR ACE toolkit.

## ACE implementation – Community survey

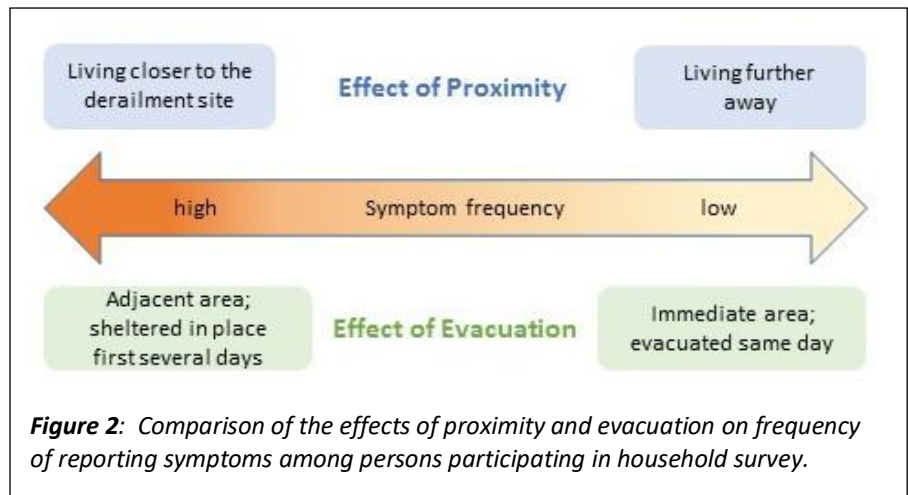
In response to widespread public concern about the health impact on the local community, the NJDOH initiated an ACE household survey of affected residents stratified into four areas by proximity, time, and evacuation status (Figure 1). Household surveys were designed to capture information on exposure, health effects, communication during the incident, and preferred methods of communication.

Two survey types were used, in-person administered surveys and self-administered mail-in surveys. In-person household surveys were conducted at 154 households during a one-week period beginning 14 days after the incident, after evacuated residents had been allowed to return. The team used a two-stage sampling approach for the



in-person survey<sup>1</sup>: the interviews were conducted door-to-door in randomly selected census blocks from within each of the four designated areas, and employed a household member information sheet, the ACE General (Adult) Survey, and the ACE Child Survey, as well as ACE Consent Forms. Surveys captured information on all household members who were at home for any amount of time in the seven days immediately following the incident and who were willing to participate. Surveyors were trained using the ACE Interviewer Training Manual, and included employees of NJDOH, ATSDR, CDC, and volunteers from the local Medical Reserve Corps as well as US Public Health Service officers stationed nearby. To ensure that all residents had an opportunity to participate, a self-administered mail-in questionnaire was sent to all postal addresses in the town 28 days after the incident, and 580 households returned a completed survey; this mailed survey was a simplified version of the in-person survey.

Fifty-eight percent of 459 town residents surveyed in-person experienced at least one new or worsened symptom consistent with exposure to vinyl chloride. In general, those living closer to the derailment site reported symptoms at higher frequencies than those living further away; however, residents evacuated the same day reported lower frequencies of symptoms than did those in the adjacent area who sheltered in place during the first several days before being evacuated (Figure 2).



An average of 9% of 459 individuals surveyed in-person sought medical care; this frequency was higher closer to the derailment site and lower further away. Mail-in questionnaire results were consistent with those obtained through in-person surveys, though with slightly higher rates of symptoms and medical care.

The community survey was extremely informative regarding communication during this incident, and both in-person and mail-in surveys identified the same trends. Most area residents first learned of the chemical leak, and about what actions they should take, from a relative, friend, neighbor, co-worker, or from television, rather than from a person in a position of authority. Residents who learned that they were supposed to shelter in place often didn't understand what actions were needed in order to do so

<sup>1</sup> An ACE can employ various statistical sampling techniques. While this ACE used a two-stage sampling approach, it is not related to the Community Assessment for Public Health Emergency Response (CASPER) method. For more information, please see the CASPER chapter in this document.

safely. Survey participants expressed a preference to receive more information directly from a person in authority.

### **ACE implementation – Hospital study**

Every incident is unique, requiring a different type and scale of medical response, and making medical response planning challenging. The ACE toolkit includes a Hospital Survey designed to help capture the medical response and lessons learned. Approximately two weeks after the incident, key informant interviews at area hospitals were used to better understand available resources and their usage, communication during the response, the number of patients treated and types of care required, and lessons learned. In addition, at the request of the State Epidemiologist, follow-up medical chart reviews were conducted for patients who sought care at area hospitals in the month following the chemical release, using the ACE Medical Chart Abstraction Form.

Hospital approaches to the response varied across facilities, but all reported effective internal communication and functioning. All hospital key informants expressed a desire for more complete and timely information regarding the incident, including initial notification of the event and the imminent arrival of individuals needing emergency care, the chemical released, and whether or not patient decontamination would be necessary upon patient arrival. Resources available through the poison center and a designated medical coordination center, including information about patient decontamination as well as chemical plume modeling, were underutilized. Finally, nearly all patient visits were concentrated at the single closest facility, and better response communication might facilitate a more even distribution of the patient surge.

No fatalities were associated with the vinyl chloride release, and 98% of patients were treated in the emergency department and then released. Most patients self-identified as having been exposed to the released chemical, and hospitals used different wording, but consistently identified the chemical exposure in the chief complaint field. While signs and symptoms were rarely severe enough to warrant hospital admission, they were often persistent; patients continued to seek care for signs and symptoms related to vinyl chloride exposure for four weeks after the incident. Five of six admitted patients had preexisting medical conditions, and 93% of asymptomatic emergency department patients were children.

### **ACE implementation – First responder survey**

To understand the emergency response, exposures, occupational health factors, and symptoms of responders who worked at the incident site at any time between November 30 and December 7, 2012, approximately 100 responders representing fire, police, emergency medical services, and hazardous materials disciplines were surveyed. The ACE General Survey was adapted to create a self-administered survey for first responders, including some questions from the community survey as well as additional relevant questions for responders. This survey assessed health effects, the use of personal protective equipment (PPE), and preparedness training among emergency responders. The investigation team met



with Unified Command, emergency response leaders, and local responders during the period December 11–21, 2012. Respondents completed surveys during the meetings, and those who did not attend any meetings had the option of mailing in the survey.

The survey included questions addressing demographics, emergency response roles, activities, and experiences. Because a typical work shift lasted 12 hours, participants were categorized by the duration of exposure: those who worked a total of <12 hours and those who worked >12 hours in the evacuation zone throughout the entire eight-day period. The utilization of medical care and PPE, including respiratory protection, was assessed. In addition, respondents were asked questions to evaluate preparedness training and their perceptions of the response. Questions pertaining to medical history prior to the event and mental health status after the response were examined as well. Finally, the emergency responders' perceptions of the response and interagency communication were assessed.

Acute symptoms of vinyl chloride exposure were common, but only 23% of respondents sought medical care. The majority of respondents did not use respiratory protection, but most reported receiving some emergency responder training that included the use of respiratory protection and felt they had sufficient instruction, indicating a possible gap in perception of risk.

While the first responder survey captured invaluable information about experiences and exposures of first responders, coordinating the investigation among the large number of involved agencies and identifying core questions applicable to each responding agency was challenging. The vast majority of surveys were completed in-person, and only a handful were returned by mail, underscoring the importance of direct contact between investigators and survey respondents. Scheduling meetings with responders (and providing opportunities to complete the survey) at different times of the day improved capture across work shifts.

### **ACE implementation – Refinery survey**

While conducting the First Responder Surveys described above, the investigation team was approached by a responder who was concerned about vinyl chloride exposures at a refinery near the derailment site. The investigation team arranged a meeting with ~20 refinery workers, the refinery health and safety officer, and the environmental officer, and learned that the train derailment occurred near the time of shift change and had blocked the only access road to the refinery. Workers unable to exit the refinery and workers trying to reach the refinery were potentially exposed. Workers on the refinery grounds identified elevated levels of an unknown volatile organic compound shortly after the derailment. The refinery environmental officer learned of the residential SIP order near the derailment site, and the refinery ordered a SIP for its workers. Approximately 4 hours after the derailment, the train was cleared from the access road, and the refinery released all non-essential workers. The refinery safety officer raised concerns about difficulties in obtaining timely information about the incident from incident command at the derailment site.

The team partnered with the refinery health and safety officer, environmental officer, and an employee union representative to develop and distribute a voluntary survey for the refinery workers and contractors. This refinery worker survey was adapted from the community survey and included questions specific to refinery workers (e.g., worker experiences during the incident including if/where they sheltered and how they received communications about the incident). Most workers completing the survey reported experiencing at least one symptom, but none sought medical evaluation after the incident. Some reported moving from one shelter to another during the incident, either in response to rising volatile organic compound concentrations or to reach shelters designated by existing emergency plans. Workers who moved from one shelter to another were more likely to have been symptomatic, possibly because of increased vinyl chloride exposure while outdoors, although also possibly because of greater concentrations inside a shelter than outside. Workers completing the survey echoed concerns of the refinery environmental officer about a lack of effective communication with outside agencies.

## **Lessons learned**

### *Community Survey*

Risk communication was a clear need, including direct communication from authorities about the incident and steps for the residents to take in order to protect themselves and their families. Public concern and frustration were high at the time of the community survey. Residents were concerned about exposure and potential health effects, confused about decisions that were made regarding evacuation, and frustrated regarding what they perceived as a lack of communication and guidance from responders as well as local health agencies. Interviewers often spent a great deal of time capturing respondents' thoughts, and the community survey provided an important opportunity to distribute key health information and answer community questions and concerns. Residents were thankful that their views were being captured.

Community survey results led to several recommendations. First, it is important that jurisdictions develop, test, and follow emergency communication plans so that residents efficiently receive instructions from persons in authority during emergency events. Second, local officials should prepare community-specific emergency planning educational materials tailored to the relevant hazards in their area and make those available to the residents. Finally, public health agencies should be engaged within the incident command system to provide guidance to and address the health concerns of the affected population. After this incident, the local jurisdiction began working to implement these recommendations, starting with improvements to the reverse 911 system and emergency communication plans.

### *Hospital Study*

Communication in emergency responses is always a challenge, and this vinyl chloride release was no different. While hospital key informants reported effective communication within their facility, they reported a need for better external communication, including notification about the release, the identity

of the chemical, the need for patient decontamination upon arrival, and the number and acuity of patients en route.

Continuous emergency response planning on a regional level can better familiarize all partners with the available resources as well as with important counterparts at other organizations and can establish important communication channels in advance. Emergency response planning might incorporate strategies to distribute the patient surge among area hospitals based on symptom acuity and resource availability. For emergencies in which many patients transport themselves to the hospital, public communication strategies could be used to help distribute the patient surge. Additionally, risk communication might target individuals with existing medical conditions and caretakers of children, to offer pediatric-specific guidance on signs and symptoms.

### *First Responder Survey*

Having an accurate account of emergency responders who worked at the scene and the periods over which work shifts occurred is imperative. Because complete rosters of emergency responders who worked in the evacuation zone were unavailable, it is possible that a number of first responders never completed the survey. As a result of the first responder survey, the investigation team recommended that various agencies implement the Emergency Responder Health Monitoring and Surveillance (ERHMS; <http://www.cdc.gov/niosh/topics/erhms>) framework in order to roster and monitor responders in incidents like this one.

Despite the limitation that not all responders were captured, the first responder survey allowed the investigation team: 1) to describe those who arrived at the evacuation zone and assess their acute health effects, medical evaluations, and use of PPE; and 2) to capture respondents' perceptions, attitudes, and beliefs about training and safety prior to, during, and after the response. On the basis of those findings, the team recommended that response organizations within the region evaluate training needs for all emergency response roles and promote proper PPE and other work practices to reduce first responder exposures.

### *Refinery Survey*

Though the investigation team was not aware of the events at the refinery when developing their initial goals and priorities for the ACE implementation, the refinery assessment offered an opportunity to capture experiences of a unique population impacted by the vinyl chloride release and highlights the importance of flexibility and capacity to add new components during an ACE investigation. Interviews with key refinery staff allowed the interview team to refine and develop questions specific to the refinery workers, thereby capturing data pertinent to the refinery's emergency response. Based on these findings, the team was able to develop guidelines for responses to chemical releases at similar facilities, including both internal and external communication strategies, emergency egress plans, and the judicious use of sheltering in place and air handlers to minimize exposure to a chemical plume.

## Conclusion

This investigation highlights the multiple populations that can be exposed as a result of a chemical release and underscores the scalable and modular design of the ACE toolkit. The ACE toolkit includes hospital as well as general and household survey modules. As shown in this investigation, surveys can be rapidly tailored based on the specific exposures and characteristics of each population, e.g., surveys informed by interviews with representatives of response agencies were tailored to capture the exposures and experiences of first responders and refinery workers.

The investigation team used the ACE toolkit general, household, and hospital surveys, tailored as described above, as part of a holistic approach to describing the exposures of multiple populations impacted by a large chemical release. Existing templates enabled the development of these different survey instruments on the fly, allowing the investigation team to rapidly capture a large amount of data from different populations. A common theme amongst these population survey results was a perceived lack of adequate risk communication, and by documenting these communication gaps, an ACE investigation can strengthen inter-agency and community emergency planning and response, thereby reducing the morbidity and mortality associated with chemical releases.

## References

The results are available in the following publications:

- Shumate AM et al., Medical response to a vinyl chloride release from a train derailment: New Jersey, 2012. *Disaster Med Public Health Prep.* 2017, 11(5): 538-544. (<https://doi.org/10.1017/dmp.2016.191>)
- Brinker K et al., Assessment of emergency responders after a vinyl chloride release from a train derailment — New Jersey, 2012. *MMWR Morb Mortal Wkly Rep.* 2015, 63(53): 1233–7. (<https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6353a1.htm>)
- Wilken JA et al., Exposures and symptoms among workers after an offsite train derailment and vinyl chloride release. *Am J Disaster Med,* 2015, 10(2): 153–65. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4705857/pdf/nihms748362.pdf>

**WEST VIRGINIA** [contributed by Erica Thomasson and Joy Hsu]

## Background

On January 9, 2014, approximately 10,000 gallons of 4-methylcyclohexanemethanol (MCHM) and propylene glycol ethers (PPH) (~7% by weight) spilled from an above-ground chemical storage tank into the Elk River in Charleston, West Virginia, contaminating the potable water supply of approximately 300,000 residents. The West Virginia Governor declared a State of Emergency, and the local water company issued a “Do Not Use” water order, except for flushing toilets, for nine counties. The West Virginia Poison Center (WVPC) received calls about symptoms that callers attributed to exposure to the

contaminated water, such as vomiting and nausea, and hospital emergency departments reported hundreds of visits by persons reporting exposure to contaminated water.

### **ACE implementation - Emergency department medical record investigation**

The West Virginia Bureau for Public Health (WVBPH) requested assistance from ATSDR's Assessment of Chemical Exposures (ACE) Program. The ACE team deployed within two days of receiving the request for assistance and collaborated with epidemiologists at the WVBPH on an ACE investigation. The objectives of the investigation were to understand what symptoms persons were seeking care for at the emergency department following reported exposure to the contaminated water and to determine the extent of the symptoms.

Ten hospital emergency departments in the affected area were required to report daily to the WVBPH numbers of persons who visited their emergency departments reporting MCHM exposure. At the time of the chemical spill, toxicologic data on MCHM and PPH were limited, and the human health effects of exposure were unknown. Therefore, there was no standard clinical case definition for exposure to either chemical. While all 10 emergency departments used case definitions that included patients reporting MCHM exposure, four emergency departments included alternative criteria. Among these four emergency departments, three case definitions included patients who reported certain symptoms but did not mention MCHM exposure, and one case definition included any patient who was in the affected area on the day of the chemical spill.

Medical records of persons reporting exposure were obtained and each record was reviewed. Exclusion criteria were created to eliminate medical records not related to the chemical spill. Records were excluded when 1) a patient left without being seen by a physician, 2) no exposure was recorded in the record, 3) an alternate diagnosis was more likely to have caused a patient's symptoms (e.g. patient reported flu-like symptoms (cough, abdominal pain, fever, body aches, congestion) and had a positive rapid flu test), 4) no symptoms were reported by the patient (i.e., emergency department visit was because of concern), and 5) when a patient had been previously seen in the emergency department for this same event.

The medical records abstraction form found in the ACE toolkit was customized to create a standardized data abstraction form that would be appropriate for a large-scale water contamination incident. The following information was abstracted from the medical records: patient demographics, prior medical history, routes of exposure, chief complaint/reported symptoms, test outcomes, diagnoses, and treatment. Data were managed in Microsoft Excel, and a descriptive analysis was conducted using Epi Info 7.

The medical chart analysis showed that the majority of patients presented to the emergency department with mild symptoms that required minimal or no treatment. The most common symptoms were nausea, rash, vomiting, abdominal pain, and diarrhea. The complete results of this investigation were published in Public Health Reports (<http://dx.doi.org/10.1177/0033354917691257>).

## ACE Implementation - Hospital survey

Environmental health emergencies involving contaminated water supplies can present unique challenges for hospital emergency preparedness. For example, decisions about resource allocation can affect hospitals' provision of health care. This part of the investigation sought to understand the chemical spill's impact on hospital operations.

The survey used questions from the ACE toolkit's Hospital Survey to assess how the spill affected hospital operations. The survey was conducted approximately two weeks after the chemical spill. It included all ten hospitals providing daily updates to WVBPH (as described above). At each hospital, the infection control specialist participated in the survey and sometimes volunteered additional survey respondents from the same hospital (e.g., hospital quality improvement or disaster response staff).

Because of winter weather, surveys were administered either in person or by phone, depending on the road conditions for each day. Survey data were analyzed using Microsoft Excel.

Results revealed that the spill-related loss of potable water affected many aspects of hospital operations, including hemodialysis, sterilization of surgical or endoscopic equipment, hospital cleaning, and infection control for *Clostridium difficile*, a health care-associated infection (because alcohol does not kill *Clostridium difficile* spores, the use of soap and water is more efficacious than alcohol-based hand sanitizer [REF [https://www.cdc.gov/hai/organisms/cdiff/cdiff\\_faqs\\_hcp.html](https://www.cdc.gov/hai/organisms/cdiff/cdiff_faqs_hcp.html)]). The complete results of this investigation were published in *Disaster Medicine and Public Health Preparedness* (<https://doi.org/10.1017/dmp.2016.193>).

## Lessons learned

### *Emergency department medical record investigation*

Prior to this incident, ACE investigations involved direct releases of common hazardous materials, including chlorine, ammonia, and vinyl chloride, for which chemical-specific data on toxicity and exposure limits is readily available. This large-scale contamination of a municipal water supply by a mixture of chemicals with limited toxicity data presented many unique challenges, including the lack of a standard clinical case definition as described above. The use of varying case definitions by hospital emergency departments exaggerated the number of medical records; over one-third (215 of 584) of the medical records were eliminated after exclusion criteria were applied. Medical chart reviews are time and labor-intensive, and a clear case definition helps to narrow the scope of the review and to enable the investigation to be conducted in a timelier manner, especially in cases of acute chemical exposures. Moreover, frequently reported symptoms such as nausea and vomiting were nonspecific, making it difficult to distinguish health effects attributable to MCHM exposure from symptoms attributable to other causes. In situations where toxicological data for a chemical are available, a standardized clinical case definition should be used to identify exposed persons.

Jurisdictions should consider utilizing multiple data collection methods, such as key informant interviews and exposed person surveys. Incident responders and hospital staff can be interviewed to gain a better understanding of what happened, who was exposed, steps taken to protect health, and communication during the response. More detailed information on exposure history, symptoms experienced, medical history, health services used, how people received information about the chemical spill/release and resulting needs can be collected by interviewing exposed persons. Because this ACE investigation did not include key informant interviews and interviews of exposed persons, findings were limited to information documented in the medical records.

### *Hospital survey*

This ACE investigation found that hospitals could enhance emergency preparedness plans for a compromise in water supply by specifying alternative sources of potable water sufficient for hemodialysis, sterilization of surgical or endoscopic equipment, hospital cleaning, infection control of *Clostridium difficile*, and other relevant hospital operations. These results complement existing guidance on emergency water supply planning for hospitals [REF <https://www.cdc.gov/healthywater/pdf/emergency/emergency-water-supply-planning-guide.pdf>].

### *Additional data sources*

Jurisdictions should consider utilizing additional sources of data and disaster epidemiology methods to complement ACE investigations during a disaster response. Since the medical record review provided information only for those who sought medical care at emergency departments, we analyzed two additional data sources to provide a multifaceted picture of the acute health effects associated with this chemical spill. First, we reviewed poison center call records to capture data on acute health effects in people who contacted the poison center but did not visit the emergency department. Second, to identify acute health effects among members of households in the affected communities, we included household questions on health effects in the Community Assessment for Public Health Emergency Response (CASPER) conducted three months after the spill (Results are available in Public Health Reports, <http://dx.doi.org/10.1177/0033354916689606>).

ACE investigations are descriptive in nature, and oftentimes cannot quantify exposure to a chemical. Although this method may be inexact and unable to ascertain causality, it was useful for describing the acute health effects associated with the chemical spill. Results were used to formulate risk communications in an effort to help alleviate the public's concerns about spill-related health effects and to determine whether long-term health monitoring was warranted.

### *Collaboration infrastructure*

At the time of this incident, there was limited infrastructure in place to conduct investigations such as ACE and minimal awareness of disaster epidemiology utility in emergency response at the WVBPH. Establishing collaboration across multiple disciplines and across multiple levels of government and

securing buy-in from stakeholder leadership (first response organizations, healthcare, public health, etc.) is crucial for an effective response to emergencies such as the MCHM spill.

State or local jurisdictions should consider conducting training in disaster epidemiology methods to build capacity and raise awareness and utilization of these tools among epidemiologists and personnel involved in emergency response, including hospital emergency response coordinators. Since the investigation, the WVBPB coordinated with CDC/ATSDR and the National Institute for Occupational Safety and Health to host a 3-day disaster epidemiology training, with the participation of about 70 responder, healthcare, and public health staff from across the state.

## References

Acute Health Effects After the Elk River Chemical Spill, West Virginia, January 2014  
(<http://dx.doi.org/10.1177/0033354917691257>)

Assessment of Impact and Recovery Needs in Communities Affected by the Elk River Chemical Spill, West Virginia, April 2014 (<http://dx.doi.org/10.1177/0033354916689606>)

Hospital Impact After a Chemical Spill That Compromised the Potable Water Supply: West Virginia, January 2014 (<https://doi.org/10.1017/dmp.2016.193>)

## SUMMARY

In addition to human-related causes, natural disasters can be important mechanisms of direct and indirect hazardous material releases; therefore, integrating public health investigations of environmental and occupational emergencies into all-hazards plans is of utmost importance.

ACE is a scalable and modular set of tools for large-scale chemical release incidents. Jurisdictions can use a variety of approaches and epidemiological sampling techniques to achieve incident-specific ACE objectives. An ACE investigation may fit into either the response or recovery phases of an emergency cycle. A trained team (whether local/state or from ATSDR) can deploy to the affected area within just a few days and seamlessly integrate within the Incident Command System (ICS; for more discussion on ICS, please see the CASPER chapter). Finally, receiving an ACE training or conducting an ACE fulfills all four functions of CDC's Public Health Emergency Preparedness Capability 13 (Public Health Surveillance and Epidemiological Investigation).

Overall, an ACE may have many potential benefits for agencies, community members, and other stakeholders, including the following:

- Describe acute health effects of chemical exposures and understand the impact on the community
- Assess shelter-in-place or evacuation efficacy



- Identify population cohorts that may need to be followed for persistent health effects of acute exposures
- Better direct aid to the affected community
- Identify issues to address in emergency and mass casualty plans, such as training or communication gaps
- Identify issues to address with established stakeholder partnerships
- Identify occupational safety and health issues
- Identify best methods of communication with the public

## Resources

ACE Website

<https://www.atsdr.cdc.gov/ntsip/ace.html>

ATSDR ACE workbook

[https://www.atsdr.cdc.gov/ntsip/ACE\\_ToolKit/docs/ACE%20Workbook.pdf](https://www.atsdr.cdc.gov/ntsip/ACE_ToolKit/docs/ACE%20Workbook.pdf)

ATSDR Rapid Response Registry tool

<https://www.atsdr.cdc.gov/rapidresponse/>

Natural and technologic hazardous material releases during and after natural disasters: a review. S. Young et al. *Science of the Total Environment* 322 (2004) 3–20, available from Digital Commons @ University of Nebraska – Lincoln at

<http://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1089&context=publichealthresources>

## Disclaimer

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the official position of the Centers for Disease Control and Prevention/the Agency for Toxic Substances and Disease Registry.

## Shelter-based Surveillance Systems in Post-Disaster Settings

*Ashley Conley, Miguel A. Cruz, Doug Thoroughman, Mary Casey-Lockyer, Josephine Malilay*

---

**Topic:** Overview of disaster-based shelter surveillance systems in the context of disaster epidemiology and its applications to post-disaster settings

**Objective:** Conduct a literature review and describe field experiences of disaster-based shelter surveillance

### **Purpose of Disaster Shelter-based Health Surveillance in Post-disaster Settings**

The public health effects of catastrophic disasters are well known. They can include the disruption of basic services and utilities and damage to medical systems and preventative services. The austere and unsanitary environmental conditions created by disasters leave affected communities more vulnerable to injury, disease, and worsened chronic health conditions.<sup>1-3</sup> Disasters can force people to seek temporary shelter away from their homes. Disaster shelters often are established in response to voluntary or mandatory evacuations or the direct result of damages that leave homes uninhabitable and force residents to seek protection elsewhere.<sup>4</sup> Disaster epidemiology uses epidemiological and risk assessment tools and methods to help collect public health data and information to monitor and describe the health and status of the affected populations throughout the phases of a disaster cycle.

These may include surveillance activities during the pre-event or preparedness phase, post-event or during the immediate response, and post-event also known as the recovery phase. These methods might include the use of enhanced surveillance techniques and beyond the jurisdiction passive system syndromic surveillance activities. Disaster shelter surveillance is one of those methods and includes establishing systems for capturing and reporting associated illnesses in these facilities. These systems may be complemented by other sources of data that may be available from other sources. That includes information such as the use of syndromic surveillance systems such as BioSense platforms, hyperbaric chamber reports, poison control centers, electronic medical records from disaster medical teams, and medical examiner reports or fatalities. This information is then further analyzed by the disaster team or developing interventions or preventive activities specific to the event.<sup>5</sup>

Disaster shelters often bring people together under less than ideal conditions that create a need for shelter-based disease surveillance systems for monitoring and identifying emerging health issues and threats.<sup>6</sup> As such, public health surveillance remains a primary focus of the activities of disaster epidemiologists during a public health disaster response that lasts through to the recovery phase. The information gathered can be used for several purposes: (1) monitoring the health status and risks of survivors and responders, (2) identifying unmet needs, (3) evaluating programs and interventions that are meant to protect residents, and (4) prioritizing limited resources available to assist during the response.<sup>7</sup> Most routine methods for gathering information include needs assessments, community surveys, monitoring and sampling, and health surveillance.<sup>8,9</sup> Summaries of this information are shared

with emergency managers and other agencies that need this information to respond to the disaster or to better understand the effects of the disaster. This paper will discuss the types of information that could be useful to collect in a disaster shelter, the challenges associated with setting up a shelter-based health surveillance system, and partnerships that are vital to a successful surveillance system.

## Types and Complexities of Disaster Shelters

To understand how a health surveillance system is set up and used in a disaster shelter, we need to become familiar with the various types of shelters established in response to a disaster. Local emergency management authorities usually pre-identify and pre-select disaster shelter locations. When disaster shelters are pre-identified, emergency managers can work with organizations to create plans for how and when to use the shelters and identify staffing, usually from volunteer organizations. These facilities often provide a safe place for all residents, including those with functional needs and disabilities, to sleep, bathe, eat, and access basic health-care and social services.<sup>10,11</sup> The American Red Cross is a co-lead for supporting disaster shelter services along with the Federal Emergency Management Agency (FEMA). The sheltering function in a disaster is part of “mass care activities.”<sup>12</sup>

The size of a shelter varies according to the characteristics of the population and the location. Shelters are either congregate or non-congregate facilities. Congregate shelters are typically public facilities that provide contingency congregate refuge to evacuees, but that day-to-day serve a non-refuge function such as schools, stadiums and churches. Non-congregate shelters are private or public facilities that, by design, provide a short-term lodging function and an increased degree of privacy over congregate shelters. These include dormitories, hotels, cruise ships, the use of recreational vehicles or campers, or individual tents for families. Facilities can accommodate anywhere from a few persons and families to thousands of displaced persons and disaster workers.

The structure and organization of each type of shelter vary. Most shelters provide food, areas for children to play and sleep, and basic health services. Many also provide case management and social services. Other shelters include the use of modular units, such as low acuity medical shelters known as federal medical stations and those run by local or municipal government agencies and faith-based groups. Other non-conventional or transitional shelters include facilities used for mass feeding, respite, warming, or cooling. “Electrical shelters” give people a place to plug in personal-use equipment such as oxygen concentrators and recharge devices such as cell phones.<sup>10,13,14</sup> Disaster shelters today not only house and protect humans but also service animals and other pets. Many evacuees prefer to stay home with their pets if a shelter does not permit animals.<sup>15-18</sup> Historically, service animals were the only animals allowed in disaster shelters. After complaints of pets being neglected and abandoned during Hurricane Katrina, the US Congress enacted the FEMA Pets Act of 2006. Now, other types of animals, including therapy and support animals and household pets, are allowed to visit or stay near shelter occupants.<sup>23</sup> Disaster shelter based-surveillance monitors infectious diseases in these animals and helps prevent the spread of infection from animals to humans. It also monitors for injuries to occupants who

might be scratched or bitten.<sup>19,20</sup> For the purposes of this paper we will address only congregate settings where people seek refuge for at least one overnight stay.

## Disaster Shelter-based Health Surveillance

Health needs assessments conducted in disaster shelter settings have documented the need for shelter-based disease surveillance activities to protect all occupants. For example, the results of assessments among Gulf Coast hurricane survivors showed that almost half of the shelter occupants suffered from a chronic illness, had a physical disability, or suffered from post-traumatic stress disorders. The assessments also found socio-economic disparities among many of the residents seeking shelter. They were underemployed or unemployed, relied on benefits or assistance, lacked health insurance, and were mostly single, widowed, or divorced.<sup>21-26</sup>

Disaster shelter surveillance monitors the health status of persons at risk and health conditions by identifying increases in morbidity and mortality. Documenting risk factors among shelter occupants allows shelter workers to take steps to maintain or address health conditions and reduce risks.<sup>27</sup>

Outbreaks of communicable diseases and conditions have occurred in disaster shelters. Outbreaks of scabies, lice, influenza, respiratory illnesses, gastrointestinal illnesses, and skin conditions have been reported among evacuees and disaster workers (Table 1).<sup>28-35</sup> Anecdotal information suggests that these outbreaks are more common than actually reported. Such outbreaks might be under-reported because of limited use or lack of health surveillance systems. Public health organizations also need reliable and standardized systems to be able to evaluate and describe those effects from one event to another. For this reason, proactive vigilance of the environment in which occupants are living makes sense under these austere conditions.

**Table 1. Reported Outbreaks of Communicable Diseases and Other Conditions in Disaster Shelters during Selected Events in the United States**

Event	Year	Location	Illness	Source
Hurricane Florence	2018	NC	Gastrointestinal illnesses (GI)	NCDOH
Hurricane Maria	2017	PR	GI, skin	Media
Hurricane Harvey	2017	TX	Norovirus, flu	TXDOH
Hurricane Sandy	2012	NJ	GI	Gaither et al <i>Prehosp Disaster Med</i> 2015. <sup>32</sup>

NCDOH=North Carolina Department of Health; TXDOH, Texas Department of Health, NEJM=New England Journal of Medicine; MMWR=Centers for Disease Control and Prevention Morbidity and Mortality Weekly Report

Joplin tornado	2011	MO	Skin, fungal infections	NEJM
Hurricanes Ike and Gustav	2008	Multi-state	Upper respiratory illnesses (URI), GI	Noe et al. <i>South Med J</i> 2013. <sup>31</sup>
Hurricanes Katrina and Rita	2005	Multi-state	Norovirus, GI, skin (scabies, methicillin-resistant <i>Staphylococcus aureus</i> )	CDC/MMWR
Hurricane Floyd	1999	NC	URI, GI	CDC/MMWR
Hurricane Hugo	1989	PR	Skin (head lice), URI, GI	CDC/MMWR

Public health practitioners and academic scholars continue to debate whether disasters increase or decrease the likelihood of outbreaks of communicable diseases and conditions in shelters. Until these arguments are resolved, public health disaster surveillance and sound environmental health management practices remain useful tools to prevent disease and help monitor potential health threats to shelter occupants.<sup>36-39</sup> Organizations such as the Centers for Disease Control and Prevention, have worked with state and local partners to develop disaster surveillance tools and methods to help establish disaster shelter-based surveillance systems.<sup>40,41</sup> These peer-reviewed tools have been used in numerous events, especially natural disasters such as hurricanes, floods, and tornadoes. Although, during small and localized events, local jurisdictions might choose to use their own tools and methods, which might be more appropriate. However, for larger events, including those causing wide scope destructions across state lines and require outside assistance, the adoption of a standard surveillance tool could more operationally feasible. Since the adoption of one regional or multi-state data collection system may provide a common operational view that could aid in the distribution of resources amongst impacted states

Information about geographical locations, census, and other variables of interest are also available on the Internet. One site that captures disaster shelters is the National Shelter System (NSS), which includes information about American Red Cross-owned and affiliated facilities. The NSS, a joint collaborative effort with FEMA, can provide helpful information about the facilities that are included in the system but might lack data from unaffiliated shelters. Although the system provides census figures, the information has limited use for public health purposes, such as monitoring the health status of evacuees.<sup>42</sup> To be inclusive, any system designed to track people should be scalable and flexible to follow these populations that move across various shelter systems, settings, and state lines. Special consideration and coordination should be given during the preparedness phase for expanding the health surveillance system across state lines and aligning under a single coordinating body, if possible. Although participating jurisdictions might have their own protocols and systems in place, they might need the situational awareness available through information sharing.

**Challenges to implementing communicable disease surveillance in New York City evacuation shelters after Hurricane Sandy, November 2012. *Public Health Rep.* 2015; 130(1):48–53.**

*“Effective communication and information sharing among agencies running shelters and collecting data are essential. Tools to document patient encounters and collect data for shelter surveillance, along with plans for decisions regarding what data to collect and collection logistics, should be developed pre-event so that they can be implemented quickly when needed.”*

## Facets of Establishing Shelter-based Surveillance System

### *Pre-disaster considerations for a shelter-based surveillance system*

During the various pre-disaster phases, planners have opportunities to conceptualize the type of surveillance systems and the resources needed to support those activities during an actual event. For example, during the planning phase, they can pre-identify and select tools, systems, resources, and data collection methods. They can carefully consider differing effects according to the type and intensity of a disaster. In addition, planners can talk with disaster shelter operators and emergency managers to explain the benefits of having an extra layer of protection in the facilities. Having more formal approaches, written procedures and policies, training for teams, and signed agreements with disaster shelter partners could result in better integration of services. It might also help avoid the chaos that often follows in the initial response immediately after a major event or disaster.<sup>43</sup>

During the response phase, emergency managers will try to determine the number and types of shelter facilities in operation (e.g., general population or medical) and denominator information (e.g., daily census) for each facility. This would allow the surveillance team to pick the facilities to serve as surveillance sentinel sites, while increasing the sensitivity of the surveillance system. Other considerations should include establishing agreements for sharing epidemiologists, data analysts, shelter teams, and specialized staff that might be requested.<sup>44</sup> Cross-border sharing of information and resources might require additional funding and capabilities beyond those available from the affected states, including assistance from the federal government. These assumptions make intra-state and inter-state coordination agreements more relevant to the success of the health surveillance operation.

**Morbidity surveillance after Hurricane Katrina — Arkansas, Louisiana, Mississippi, and Texas, September 2005. *MMWR Morb Mortal Wkly Rep.* 2006;55:727–31.**

*“During large-scale disasters with widespread effects, coordination of multijurisdictional surveillance and implementation of standardized methods can promote the integration of surveillance data. To meet the information needs of all partners, a process for collecting and exchanging information among participating agencies is being planned and will be supported by data-sharing agreements that allow surveillance data to flow rapidly and securely.”*

After emergency officials decide to open disaster shelters, the next decision focuses on the type of surveillance to conduct in the shelters. Usually, a snapshot of information is gleaned from a variety of local sources, such as social media, traditional media reports, responder reports, or community concerns about pre-disaster health or socioeconomic issues (e.g., influenza season, prevalence of Zika virus, and high numbers of homeless people). For example, in Kentucky, regional epidemiologists in the affected community seek locations of pre-identified shelters and informal shelters and use a “3-day” rule to conducting surveillance. Surveillance begins when a shelter has an overnight population for 3 days or more, or when it is clear that it will, in which case surveillance can start any time after opening. Environmental health assessment of the shelter often begins during pre-occupancy. The local jurisdictions determine criteria about when and how often facilities are re-assessed, often until the last occupants are relocated to other shelters or lodging or are allowed to return home.

**Disaster-related injuries and illnesses treated by American Red Cross disaster health services during Hurricanes Gustav and Ike. *South Med J.* 2013;106(1):102–8.**

*“We characterized the disaster-associated injuries and illnesses using the aggregated data and examined whether this new reporting format would allow the Red Cross to identify immediate public health concerns and determine healthcare delivery needs during a disaster relief operation.”*

## ***Implementing a shelter-based surveillance system***

After resource allocation and access to shelters are addressed, attention turns to implementing the surveillance system. At this phase, the determination of who, what, when, and where data collection sites will be selected becomes the main focus. Staff members are selected for various teams with the responsibility of visiting the shelters, collecting and entering the data, analyzing, and preparing the daily surveillance reports and dashboards. Shelter health surveillance teams might include members who are familiar with how shelters operate and how they are staffed. Shelter staff might include personnel responsible for health issues, including nurses, physicians, and other health-care volunteers. Shelters might also keep logs or registries in which they document illnesses among occupants. They might already use some of the forms available from other agencies, including CDC and the American Red Cross.<sup>40,41</sup>

During past events, local or state epidemiologists have used their ingenuity and creativity and a wide array of methods and tools to capture health surveillance information, with great success. For example, during the Gulf Coast hurricanes of 2015, approximately 1200 shelters operated in 23 states to track displaced residents from the Gulf States.<sup>45</sup> During this response, health surveillance systems were established in mega-shelters and evacuation centers, with remote monitoring that used both Internet and paper tools.<sup>46</sup> During Hurricane Sandy, response teams used cell phones to help collect and share data.<sup>47</sup> During the shelter intake or screening process, the shelter surveillance team might work with the facility caseworkers, medical staff, and managers to identify persons susceptible to or at greater risk for threats to physical and mental well-being and to institute better monitoring and response to unique health needs. Intake information is self-reported by persons when they arrive at a disaster shelter. Although comprehensive intake assessments are ideal, determining the appropriate information to collect will be influenced by available time and personnel.<sup>48</sup> During slow-moving natural disasters, such as floods and hurricanes, shelters might have more time to collect the information and complete the required assessments. Acute disaster events, such as tornadoes, flashfloods, earthquakes, or even industrial, transportation, or terror events, might not allow enough time and would require a shorter intake interview process. Rushed intake processes can affect the quality or amount of critical health information obtained, or result in incomplete information. This situation is especially true in large shelters when personnel might have other pressing priorities for shelter operations, and people constantly move in and out or within facilities.

After shelter occupants are settled at the facility, decisions are made by shelter managers about practical and realistic expectations and the frequency of collecting additional information during their stay to identify changes in health status or risk. Combining information from other systems might strengthen the sensitivity of the health surveillance system. That might include medical information from sentinel sites, such as disaster medical assistance team sites and clinics, other provider field clinics, poison control centers, and existing syndromic surveillance systems.<sup>49,50</sup> For example, syndromic data could be obtained daily from health providers to monitor gastrointestinal illness, acute respiratory



illness, fevers, behavioral issues, and other health conditions.<sup>51-53</sup> Information from poison control centers could be used to monitor cases of carbon monoxide poisoning and other types of intoxications.<sup>54,55</sup> Table 2 lists key elements of information that could be acquired through the shelter-based surveillance system by partners and situation reports.

**Table 2. Key Elements and Sub-Categories of Information to Evaluate Potential Issues of Public Health Concern and Needs for Establishing or Prioritizing a Health Surveillance System in a Disaster Shelter**

Areas of Concern	Sub-categories
Communicable Diseases and Conditions	<ul style="list-style-type: none"> <li>Potential risk for infectious diseases or conditions and outbreaks of acute illness</li> <li>Drug-resistant diseases (e.g., tuberculosis)</li> <li>Pre-existing health conditions and emerging diseases</li> <li>Infection control issues</li> <li>Epizootic</li> </ul>
Chronic health and Medical Vulnerable	<ul style="list-style-type: none"> <li>Limitations and damage to medical and health-care services</li> <li>Preexisting health conditions</li> <li>Medication replacement needs</li> <li>Medical equipment dependency</li> <li>Mental and behavioral health</li> <li>Persons with disabilities and functional needs</li> </ul>
Socially Vulnerability and Special Groups	<ul style="list-style-type: none"> <li>Number and type of occupants per facility</li> <li>Unaccompanied children</li> <li>People with service animals</li> <li>Pregnant and lactating women</li> <li>Seniors, especially if unaccompanied</li> <li>Elderly, especially with preexisting medical and health issues</li> <li>Chronically ill and susceptible individuals</li> <li>Homeless prior to disaster event</li> <li>Undocumented persons</li> <li>Out of state displaced families or persons due to the unavailability of safe shelter either at the local state level</li> </ul>
Environmental Health, Hygiene, and Safety Conditions	<ul style="list-style-type: none"> <li>Food preparation safety and potential for foodborne illness</li> <li>Drinking water and ice safety and potential for waterborne illness</li> <li>General sanitation and hygiene</li> <li>Adequate number of toilets and handwashing and shower Facilities</li> <li>Local site security and accessibility</li> <li>Indoor air quality and pollutants (e.g., CO<sub>2</sub>)</li> <li>Vector-borne disease risks</li> <li>Access to potable water</li> <li>Loss of electricity</li> <li>Loss of or damage to sewage systems</li> </ul>

	<ul style="list-style-type: none"> <li>Carbon monoxide and gasoline poisoning</li> <li>Child care or children’s respite areas</li> <li>Overcrowding and spacing</li> <li>Chemical and toxicological substances</li> <li>Pets and animal issues</li> <li>Waste management and disposal</li> </ul>
Workforce and Occupational Health	<ul style="list-style-type: none"> <li>Response workers and volunteers</li> <li>Pet shelters, stray animals</li> <li>Potential for injuries and injury prevention and control</li> </ul>
Other	<ul style="list-style-type: none"> <li>Training in public health among staff</li> <li>Attrition and workforce issues</li> </ul>

Establishing and conducting disaster shelter-based surveillance can be challenging. Issues to address can include the types of facilities used, worker safety issues, staff training needs, competition for resources, lack of coordination, denial of access to facilities or data, availability of facility information, and perception related to other post-disaster priorities. Other issues, particularly when designing systems for multi-state or jurisdiction-based health surveillance, include a lack of consensus on systems to be used or variables to collect. Some shelters might not be suitable sites for surveillance. Those might include facilities that only provide limited services or whose activities span just a few hours of operations. Examples include shelters that provide cooling or food and respite areas for children.

Fluctuations in shelter numbers also affect the denominators. Some facilities are empty during the day and fully occupied at night as disaster-affected people return to the shelter to sleep after spending most of the day dealing with house repairs or procuring disaster assistance and services. Children of school age might be bused every day to school or to childcare centers, also resulting in fluctuations in the number of occupants. Shelter occupants might be relocated to new shelters, return home, move to hotels, or be consolidated into mega-shelter facilities. Another shortfall is the inability to provide health surveillance information about the number of disaster survivors who left the affected areas or were relocated across state lines by authorities.

Disasters can create unsafe conditions for field workers. Because of that, shelter surveillance staff might face involuntary delays in reaching out to and visiting shelter facilities. Concerns for personal health and safety, issues with mental attitude and coping with the event, limited access to roads and cell reception, fuel shortages, local curfews, or timeliness are a few of these variables that might affect when to conduct shelter surveillance activities.

The safety of all public health workers, and occupants is always the number one priority of any public health agency supporting the response. Concerns regarding disaster shelter worker occupational issues have been described in disaster worker surveys and occupational health reports.<sup>56-60</sup> Creating and maintaining a culture of safety first in the shelter surveillance team might help in recruiting adequate numbers of staff and sustaining the effort through all the phases of the event.

Working with shelter health-care providers to conduct surveillance also has challenges. These staff, key partners in any surveillance system, often are assigned to support other areas of the shelter operation, including direct care, emotional support, and case management. Some of these staff, mostly volunteers, might not be adequately trained or aware of how to use public health surveillance tools. They also might lack training in understanding general public health concerns such as sanitation, health surveillance, prevention of outbreaks, and infection control.<sup>61-65</sup> These same workers might be in high demand to help in other areas of the public health response that might be a higher priority and when skilled staff are scarce.

Determining how the information or surveillance reports will be distributed and shared can challenge jurisdictions in the middle of a major disaster.<sup>66</sup> Although most disasters are considered local, this information is often used to establish event priorities that cross regional boundaries and interest multiple agencies. Concerns about the number and types of illnesses might reach beyond the local jurisdiction to other agencies. For example, if shelter occupants relocate across regional or state lines, the receiving entities might like to have the data to be able to better prepare for these persons in the receiving disaster shelter or evacuation centers.<sup>67</sup> Federal or state jurisdictions providing support with disaster shelters during evacuations or with augmentation of shelter staff in the response might want to know more about any emergency issues in those facilities that might require additional support or technical expertise.

Although surveillance information should be exchanged at all levels, data systems, local policies, and laws might preclude full sharing of data elements.<sup>68,69</sup> Disaster medical teams might use electronic medical records with remote feeds of information directly into the local or state passive syndromic surveillance system. Others might not be able to share information from their systems for shelter surveillance purposes. For example, military medical units and federal health facilities might have their own medical records and surveillance systems. They gather data from field medical units, medical support hospitals, and even some of the large hospital vessels available and deployed during large events to care for military personnel and civilians under disaster conditions.<sup>70,71</sup> Access to those systems might be difficult because of privacy and security concerns. Having those partners as liaisons at surveillance team meetings might help build collaborations and strengthen the coverage area of some groups that otherwise might not be included in the analysis.

In anticipation of such events, well-established information and data sharing agreements should be in place as a best practice. Jurisdictions should review their local regulations and policies governing the exchange of information during disasters or other public health emergencies. They should address concerns about sharing information for situational awareness. Misinformation or incomplete health surveillance information about public health issues in a disaster shelter would only add more uncertainty in an already complex event.<sup>72,73</sup> Showing a unity of command across all jurisdictional levels, agencies, community agencies, and coalitions will reassure persons affected by major disasters that public health authorities are addressing the situation and working to share disaster information.<sup>74,75</sup>

Everyone working in disaster recovery operations hopes for a prompt return to normal. Careful consideration should be given as to when to start the demobilization or disassembly of the disaster shelter based-surveillance system. One obvious trigger is the closure of all disaster shelters. The decision to end or continue surveillance is critical because often public health systems, including those responsible for monitoring, testing, and preventing diseases, might not all be back to operational mode.<sup>76</sup> Currently, no reliable or evidence-based indicators define the appropriate time or steps to transition from an active surveillance systems approach to a passive one. Each phase of a disaster brings new sets of challenges and concerns.<sup>9</sup> Even as other agencies or sectors of the response begin rotating and standing down emergency response resources, the need for public health vigilance continues. As recovery begins, fewer disaster shelters might be needed. At the same time, the area might see increased numbers of worker camps, tents, and bases housing thousands or new arrivals brought in for recovery work.

Contrary to previous thinking, disaster surveillance continues even when all shelters are closed. Instead, surveillance transforms into a new phase, with the arrival of thousands of volunteers or recovery workers creating new challenges for the surveillance team. Ending or modifying shelter surveillance activities requires a great deal of discussion between the appropriate teams and entities involved in health surveillance. Perhaps active surveillance will shift back to using passive systems, but with an increased focus on monitoring living conditions and occupational health on the arriving disaster workers. The decision to stop shelter surveillance activities altogether should not be based on convenience or a rush to return to normal operations. The decision should be based on an evaluation of all potential risks to avoid missing the signals about new or emerging health problems later in the recovery.

### ***Partnerships for implementing a shelter-based surveillance system***

During small-scale events and disasters, local and state resources are usually able to handle the situation without the need for external help. Public health entities have jurisdictional authority to enter shelter facilities to conduct health surveillance and work with shelter operators to report communicable diseases and conditions. Most states coordinate shelter activities with their local and state non-governmental partners, social service agencies, and organizations that assist with setting up shelters.

Shelters are a snapshot of the community and microcosm of community interests, culture, diversity, trust, and organizations. Working with partners, shelter operators, regulators, emergency managers, faith-based organizations, and other community groups is a year-round task that requires planning, training, agreements, and other coordination activities before a disaster strikes.

The disaster shelter surveillance team must include epidemiologists who understand potential health issues that might arise from local living conditions and loss of preventive services. Team selection might include people familiar with the area, preferably staff that work in the county or state where the event takes place. However, those same staff members might be overwhelmed by excess work or might also suffer from the disaster and be unable to assist with operations. As a result, staff from other areas of the state that are less affected might be needed to augment teams. External support also might be obtained

through inter-state agreements, such as emergency management assistance compacts, or by requesting federal support.<sup>77,78</sup>

The team's ability to get out to the field to collect information could be hampered by a lack of or shortages of logistical resources and equipment. Disaster effects tend to spread over large jurisdictional areas, across states, or overlap with other disaster events occurring in other parts of the nation. As a result, available resources, including personnel, might be limited or unavailable. Having a flexible data collection plan is crucial. It also might need to conform to the challenges posed by the inability to acquire needed resources. As other affected jurisdictions compete for the same resources, the expectations of a large and robust surveillance system might diminish with the size of the affected area or type of disasters. For example, a hurricane is a slow-moving event that might directly affect only coastal states. Neighboring states might be able to assist, provide resources, and even coordinate cross-state surveillance activities before impact. In a major acute onset event, such as a catastrophic earthquake where the local jurisdiction is severely affected, safe harbors and facilities that serve as shelters might be destroyed or condemned, resulting in an unprecedented number of destroyed or damaged facilities that can quickly overwhelm local state response.

Another challenge when requesting technical assistance and support from partners outside the affected area is the lack of familiarity with the arriving public health teams with local processes, tools, and reporting mechanisms.<sup>79</sup> Arriving teams might have received just-in-time training and must be introduced to the local agencies and shelter operators before the beginning of field work. Teams can become frustrated and confused if they arrive at a shelter and have no access because a shelter operator does not recognize the role of an external jurisdiction or entity. This might happen even if the entity is providing direct support to the local public health agency. The best approach to avoid such situations is to work collaboratively with other regions or states to select methods and tools in advance, not in the middle of a major disaster response.<sup>29</sup>

An ideal field team would include at least an epidemiologist, a nurse, and environmental health specialists or sanitarians. In facilities that have medical care provided by a clinic or disaster medical team, the shelter teams might be augmented with an infection prevention and control specialist that has epidemiological training and can advise on how to best monitor for infections and prevent outbreaks. The public health and medical skills of shelter staff vary. Staff might include community or outside area volunteers such as retired persons, medical workers, counselors and caseworkers, and faith-based organization groups, among others.<sup>62</sup> In situations where pets, therapy animals, or service animals are present or near the shelter, veterinary support could be sought to better assess risks for illness and injury from those animals.<sup>19</sup> Table 3 describes the contribution of various local and state partners to the shelter-based surveillance system.

**Table 3. State and Local Partnerships and Contributions to Shelter-based Surveillance Systems**

State or Local Partner*	Contribution to Shelter-based Surveillance System
State or local health department epidemiologists	Epidemiologists can help analyze data from local shelters and monitor for trends and unusual occurrences
Environmental services/sanitarians	Environmental health specialists and sanitarians can help local staff assess the living environment for potential hazards such as food, crowding, improper hygiene, and sanitation practices.
Physicians and public health nurses	If an outbreak or unusual occurrence is identified, physicians and public health nurses can help with the outbreak investigation and mitigation to control the spread of infectious diseases in the local shelter.
Infection prevention and control specialist	Infection prevention and control specialists can monitor for the transmission of infectious diseases and outbreaks, evaluate infection control practices where shelter residents are receiving health care, and ensure adequate protocols and supplies (e.g., hand washing) are available and being followed.
Veterinary officer/epidemiologist	Shelters allow animals and pets; epizootic disease must be monitored.
Medical examiners and coroners	Provide information about unusual deaths reported among shelter occupants or the community and provide help with post-mortem specimen collection for testing and determining cause of death.
Media and health communications staff	These teams specialize in monitoring rumors and response to issues in the area affected by the disaster and might provide early clues to the health surveillance team about emerging issues in some facilities.

\*These resources might need to be augmented using partner support.

## Summary

The preparations for conducting shelter-based surveillance are preferably done before a disaster occurs. Flexible and adaptable systems can be used by local, state, and federal agencies during and after a disaster to monitor the health status of the population in shelters. More information on establishing and conducting surveillance in shelters is available from the Council of State and Territorial Epidemiologists Disaster Epidemiology Subcommittee. For additional references, tools, and information on surveillance in shelters, visit the Centers for Disease Control and Prevention Emergency Health Services website on shelters (<https://www.cdc.gov/nceh/ehs/etp/shelter.htm>).

## References

1. World Health Organization. Communicable diseases following natural disasters. Risk assessment and priority interventions. <http://www.who.int/diseasecontrol/emergencies/guidelines/cd-disasters-26-06.pdf>. Accessed April 2012.
2. Noji EK. The public health consequences of disasters. *Prehosp Disaster Med.* 2000;15(4):147-157.
3. Ivers LC, Ryan ET. Infectious disease of severe weather-related and flood-related natural disasters. *Curr Opin Infect Dis.* 2006;19(5):408-414.
4. The Sphere Project. Humanitarian charter and minimum standards in disaster response. <http://www.sphereproject.org/handbook>. Published 2011. Accessed March 20, 2013.
5. Malilay J. Public health assessments in disaster settings: recommendations for a multidisciplinary approach. *Prehosp Disaster Med.* 2005;15(4):167-172.
6. Infection prevention and control in disaster shelters. Association for Professionals in Infection Control and Epidemiology. [http://www.apic.org/Resource/TinyMceFileManager/Practice\\_Guidance/Emergency\\_Preparedness/Shelters\\_Disasters.pdf](http://www.apic.org/Resource/TinyMceFileManager/Practice_Guidance/Emergency_Preparedness/Shelters_Disasters.pdf). Published 2012. Accessed September 2013.
7. Malilay J, Henderson A, McGeehin M, Flanders D. Estimating health risks from natural hazards using risk assessment and epidemiology. *Risk Anal.* 1997;17(3):353-358.
8. Cruz MA, Garcia S, Chowdhury MA, Malilay J, Perea N, Williams OD. Assessing the congregate disaster shelter: using shelter facility assessment data for evaluating potential hazards to occupants during disasters. *J Public Health Manag Pract.* 2017;23(1):54-58.
9. Malilay J, Hermann M, Perrott D, et al. The role of applied epidemiology methods in the disaster management cycle. *Am J Public Health* 2014;104(11):2092-2102.
10. Federal Emergency Management Agency. Shelter field guide. [http://www.nationalmasscarestrategy.org/wp-content/uploads/2015/10/Shelter-Field-Guide-508\\_f3.pdf](http://www.nationalmasscarestrategy.org/wp-content/uploads/2015/10/Shelter-Field-Guide-508_f3.pdf). Accessed August 2018.
11. Federal Emergency Management Agency. Guidance on planning for integration of functional needs support services in general population shelters. November 2010. Available at: [http://www.fema.gov/pdf/about/odc/fnss\\_guidance.pdf](http://www.fema.gov/pdf/about/odc/fnss_guidance.pdf). Accessed April 14, 2014.
12. US Department of Homeland Security. National Response Framework. [https://s3-us-gov-west-1.amazonaws.com/dam-production/uploads/20130726-1914-25045-1246/final\\_national\\_response\\_framework\\_20130501.pdf](https://s3-us-gov-west-1.amazonaws.com/dam-production/uploads/20130726-1914-25045-1246/final_national_response_framework_20130501.pdf). Accessed July 2014.
13. International Association of Assembly Managers. Mega shelters: planning and activation. <http://www.cdphe.state.co.us/hf/emergencyplanning/masscare/Mega-ShelterPlanningActivation.pdf>. Accessed March 2014.
14. Centers for Disease Control and Prevention. Federal medical station. <https://www.cdc.gov/phpr/stockpile/fedmedstation.htm>. Accessed, September 2018.
15. Douglas R, Kocatepe A, Barrett AE, Ozguven EE, Gumber C. Evacuating people and their pets: older Floridians' need for and proximity to pet-friendly shelters. *J Gerontol B Psychol Sci Soc Sci.* 2017 October 4. <https://doi.org/10.1093/geronb/gbx152>.
16. Edmonds AS, Cutter SL. Planning for pet evacuations during disasters. *J Homel Secur Emerg Manag.* 2008;5(1):1-18.

17. Heath SE, Kass PH, Beck AM, Glickman LT. Human and pet-related risk factors for household evacuation failure during a natural disaster. *Am J Epidemiol*. 2001;153(7):659-665.
18. Public Law. Pets Evacuation and Transportation Standards Act of 2006. <https://www.congress.gov/109/plaws/publ308/PLAW-109publ308.pdf>. Accessed August 2018.
19. US Department of Agriculture. Animal Health Hazards of Concern During Natural Disasters. [https://www.aphis.usda.gov/animal\\_health/emergingissues/downloads/hazards.PDF](https://www.aphis.usda.gov/animal_health/emergingissues/downloads/hazards.PDF). Published February 2002. Accessed August 2018.
20. Warner GS. Increased incidence of domestic animal bites following disaster due to natural hazards. *Prehosp Disaster Med*. 2010;25:188-90.
21. Centers for Disease Control and Prevention. Morbidity surveillance after Hurricane Katrina — Arkansas, Louisiana, Mississippi, and Texas, September 2005. *MMWR Morb Mortal Wkly Rep*. 2006;55:727-731.
22. Greenough PG, Karsh TD. Public health response—assessing needs. *N Engl J Med*. 2005;353(15):1544-1546.
23. Ridpath AD, Bregman B, Jones L, Reddy V, Waechter H, Balter S. Challenges to implementing communicable disease surveillance in New York City evacuation shelters after Hurricane Sandy, November 2012. *Public Health Rep*. 2015;130:48-53.
24. Rodriguez SR, Tocco JS, Mallonee S, Smithee L, Cathey T, Bradley K. Rapid needs assessment of Hurricane Katrina evacuees—Oklahoma, September 2005. *Prehosp Disast Med*. 2006;21:390-395.
25. Ghosh TS, Patnaik JL, Vogt RL. Rapid needs assessment among Hurricane Katrina evacuees in metro- Denver. *J Health Care Poor Underserved* 2007;18(2):362-368.
26. Brodie M, Weltzien E, Altman D, Blendon RJ, Benson JM. Experiences if Hurricane Katrina evacuees in Houston shelters: implications for future planning. *Am J Public Health*. 2006;96:1402–1408.
27. Springer J, Casey-Lockyer M. Evolution of a nursing model for identifying client needs in a disaster shelter: a case study with the American Red Cross. *Nurs Clin North Am*. 2016;51:647-662.
28. Centers for Disease Control and Prevention. Epidemiologic notes and reports surveillance of shelters after Hurricane Hugo—Puerto Rico. *MMWR Morb Mortal Wkly Rep*. 1990;39:41-47.
29. Centers for Disease Control and Prevention. Infectious disease and dermatologic conditions in evacuees and rescue workers after Hurricane Katrina—multiple states, August—September 2015. *MMWR Morb Mortal Wkly Rep*. 2005;54:961-964.
30. Yee EL, Palacio H, Atmar RL, et al. Widespread outbreak of norovirus gastroenteritis among evacuees of Hurricane Katrina residing in a large “megashelter” in Houston, Texas: lessons learned for prevention. *Clin Infect Dis*. 2007;44(8):1032-1039.
31. Noe RS, Schnall AH, Wolkin AF, et al. Disaster-related injuries and illnesses treated by American Red Cross disaster health services during Hurricanes Gustav and Ike. *South Med J*. 2013;106(1):102-108.
32. Gaither JB, Page R, Prather C, Paavola F, Garrett AL. Impact of a hurricane shelter viral gastroenteritis outbreak on a responding medical team. *Prehosp Disaster Med*. 2015;30:355-358.
33. Neblett Fanfair R, Benedict K, Bos J, et al. Necrotizing cutaneous mucormycosis after a tornado in Joplin, Missouri, in 2011. *N Engl J Med*. 2012;367:2214-2225.
34. Centers for Disease Control and Prevention. Public Health Assessment and Surveillance After a Disaster. <https://www.cdc.gov/disasters/surveillance/index.html>. Published November 6, 2016. Accessed August 2018.



35. Centers for Disease Control and Prevention. Morbidity surveillance after Hurricane Katrina — Arkansas, Louisiana, Mississippi, and Texas, September 2005. *MMWR Morb Mortal Wkly Rep.* 2006;55:727-731.
36. Watson JT, Gayer M, Connolly MA. Epidemics after natural disasters. *Emerg Infect Dis.* 2007;13:1-5.
37. Morgan O, deVilleville de Goyet C. Dispelling disaster myths about dead bodies and disease: the role of scientific evidence and the media. *Rev Panam Salud Publica.* 2005;18:33-6.
38. Pan American Health Organization. Environmental Health Management After Natural Disasters. [https://www.paho.org/disasters/index.php?option=com\\_content&view=article&id=677:environmental-health-management-after-natural-disasters&Itemid=924&lang=en](https://www.paho.org/disasters/index.php?option=com_content&view=article&id=677:environmental-health-management-after-natural-disasters&Itemid=924&lang=en). Accessed October 2018.
39. Harvey PA, Reed RA. Planning environmental sanitation programmes in emergencies. *Disasters* 2005;29:129-151.
40. Council of State and Territorial Epidemiologists. Disaster Epidemiology Tool Repository. <https://www.cste.org/page/DisasterEPIToolRes/Disaster-Epidemiology-Tool-Repository.htm>. Accessed September 2018.
41. Centers for Disease Control and Prevention. Public Health Surveillance after a Disaster. <https://www.cdc.gov/nceh/hsb/disaster/surveillance.htm>. Published 2018. Accessed September 2018.
42. Federal Emergency Management Agency. National Shelter System. [https://www.fema.gov/pdf/media/factsheets/2011/fema\\_national\\_shelter\\_system.pdf](https://www.fema.gov/pdf/media/factsheets/2011/fema_national_shelter_system.pdf). Published May 2011. Accessed August 2018.
43. Mintz A, Gonzalez W. National mass care strategy: a national integrated approach. *J Bus Contin Emer Plan.* 2013;7(1):33-43.
44. Binder S, Sanderson LM. The role of epidemiologists in natural disasters. *Ann Emerg Med.* 1987;16(9):1081-1084.
45. Government Accountability Office. FEMA should more fully assess organizations mass care capabilities and update the Red Cross role in catastrophic events. <http://www.gao.gov/products/GAO-08-823>. Published September 18, 2008. Accessed October 2013.
46. Cookson ST, Soetebier K, Murray EL, Fajardo GC, Hanzlick R, Cowell A, Drenzek C. Internet-based morbidity and mortality surveillance among hurricane Katrina evacuees in Georgia. *Prev Chronic Dis.* 2008;5(4):A133.
47. Shumate AM, Yard EE, Casey-Lockyer M, et al. Effectiveness of using cellular phones to transmit real-time shelter morbidity surveillance data after Hurricane Sandy, New Jersey, October to November, 2012. *Disaster Med Public Health Prep.* 2016;10(3):525-528.
48. Springer J, Casey-Lockyer M. Evolution of a Nursing Model for Identifying Client Needs in a Disaster Shelter: A Case Study with the American Red Cross. *Nurs Clin North Am.* 2016;51:647-662.
49. Perritt KR, Boal WL; Helix Group Inc. Injuries and illnesses treated at the World Trade Center, 14 September-20 November 2001. *Prehosp Disaster Med.* 2005;20:177-183.
50. Wolkin A, Schnall AH, Law R, Schier J. Using poison center data for postdisaster surveillance. *Prehosp Disaster Med.* 2014;29:521-524
51. Buehler JW, Whitney EA, Smith D, Prietula MJ, Stanton SH, Isakov AP. Situational uses of syndromic surveillance. *Biosecur Bioterror.* 2009;7:165-177.

52. Gould DW, Walker D, Yoon PW. The Evolution of BioSense: Lessons Learned and Future Directions. *Public Health Rep.* 2017;132:7S-11S.
53. Cordes KM, Cookson ST, Boyd AT, et al. Real-time surveillance in emergencies using the Early Warning Alert and Response Network. *Emerg Infect Dis.* 2017 Nov;23(13). doi: 10.3201/eid2313.170446.
54. Van Sickle D, Chertow DS, Schulte JM, et al. Carbon monoxide poisoning in Florida during the 2004 hurricane season. *Am J Prev Med.* 2007;32:340-346.
55. Carbon monoxide poisoning from hurricane-associated use of portable generators—Florida, 2004. *MMWR Morb Mortal Wkly Rep.* 2005;54:697-700.
56. Errett NA, Egan S, Garrity S, et al. Attitudinal determinants of local public health workers' participation in Hurricane Sandy recovery activities. *Health Secur.* 2015;13:267-273.
57. Mäkinen TH, Miettinen SM, Kernohan WG. Mental well-being considerations in preparation for disaster health care: learning from deployment. *Prehosp Disaster Med.* 2015;30:327-336.
58. Brinker K, Head CA, Johnson CY, Funk RH. Injuries and illnesses among American Red Cross responders-United States, 2008-2012. *Disaster Med Public Health Prep.* 2014;8:404-410.
59. Newman DM. Protecting worker and public health during responses to catastrophic disasters-learning from the World Trade Center experience. *Am J Ind Med.* 2014;57:1285-1298.
60. Cowden J, Crane L, Lezotte D, Glover J, Nyquist AC. Pre-pandemic planning survey of healthcare workers at a tertiary care children's hospital: ethical and workforce issues. *Influenza Other Respir Viruses.* 2010;4(4):213-222.
61. Kwon J, Zottarelli L, Kwon S, Lee YM, Ryu D. Food safety training needs at evacuation shelters operated by faith-based organizations. *J Environ Health.* 2013;76:14-21.
62. Brahmabhatt D, Chan JL, Hsu EB, et al. Public health preparedness of post-Katrina and Rita shelter health staff. *Prehosp Disaster Med.* 2009;24:500-505.
63. Reischl TM, Sarigiannis AN, Tilden J. Assessing emergency response training needs of local environmental health professionals. *J Environ Health* 2008;14-19.
64. Burkle FM. Sheltering the sheltered: protecting the public health and educating the workforce. *Prehosp Disaster Med.* 2009;24:506-507.
65. Patton-Levine JK, Vest JR, Valadez AM. Caregivers and families in medical special needs shelters: an experience during Hurricane Rita. *Am J Disaster Med.* 2007;2:81-86.
66. Morton M, Levy JL. Challenges in disaster data collection during recent disasters. *Prehosp Disaster Med.* 2011;26:196-201.
67. Grier NL, Homish GG, Rowe DW, Barrick C. Promoting information sharing for multijurisdictional public health emergency preparedness. *J Public Health Manag Pract.* 2011;17:84-89.
68. Tomczyk S, Arriola CS, Beall B, et al. Multistate outbreak of respiratory infections among unaccompanied children, June 2014-July 2014. *Clin Infect Dis.* 2016;63:48-56.
69. Vest JR, Issel LM. Factors related to public health data sharing between local and state health departments. *Health Serv Res.* 2014;49:373-391.
70. Rusiecki JA, Thomas DL, Chen L, Funk R, McKibben J, Dayton MR. Disaster-related exposures and health effects among US Coast Guard responders to Hurricanes Katrina and Rita: a cross-sectional study. *J Occup Environ Med.* 2014;56:820-833.

71. Lombardo J, Burkom H, Elbert E, et al. A systems overview of the Electronic Surveillance System for the Early Notification of Community-Based Epidemics (ESSENCE II). *J Urban Health*. 2003;80:i32-42.
72. Burger J, Gochfeld M. Health concerns and perceptions of central and coastal New Jersey residents in the 100 days following Superstorm Sandy. *Sci Total Environ*. 2014;481:611-618.
73. Bernstein RS, Baxter PJ, Falk H, Ing R, Foster L, Frost F. Immediate public health concerns and actions in volcanic eruptions: lessons from the Mount St. Helens eruptions, May 18-October 18, 1980. *Am J Public Health*. 1986;76:25-37.
74. Shipp Hilts A, Mack S, Eidson M, Nguyen T, Birkhead GS. New York State public health system response to Hurricane Sandy: lessons from the field. *Disaster Med Public Health Prep*. 2016;10:443-453.
75. Walsh L, Craddock H, Gulley K, Strauss-Riggs K, Schor KW. Building health care system capacity to respond to disasters: successes and challenges of disaster preparedness health care coalitions. *Prehosp Disaster Med*. 2015;30:112-122.
76. Abbott D. Disaster public health considerations. *Prehosp Disaster Med*. 2000;15:158-166.
77. Jones M, O'Carroll P, Thompson J, D'Ambrosio L. Assessing regional public health preparedness: a new tool for considering cross-border issues. *J Public Health Manag Pract*. 2008;14:E15-22.
78. Stier DD, Goodman RA. Mutual aid agreements: essential legal tools for public health preparedness and response. *Am J Public Health*. 2007;97:S62-68.
79. Horney JA, Markiewicz M, Meyer AM, Macdonald PD. Support and services provided by public health regional surveillance teams to local health departments in North Carolina. *J Public Health Manag Pract*. 2011;17(1):E7-13.

## Epidemiology of Behavioral and Mental Health Response to Disasters

Jennifer Beggs<sup>1</sup>, Akiko Saito<sup>2</sup>, David Dickinson<sup>3</sup>, Michael Heumann<sup>4</sup>

<sup>1</sup>Michigan Department of Health and Human Services

<sup>2</sup>Oregon Health Authority

<sup>3</sup>United States Department of Health and Human Services

<sup>4</sup>HeumannHealth Consulting LLC

---

### Introduction

The World Health Organization states, “Emergencies, despite their tragic nature and adverse effects on mental health, are also unparalleled opportunities to improve the lives of larger numbers of people. This is important because mental health is crucial to the overall wellbeing, functioning, and resilience of individuals, societies, and countries recovering from natural disasters.” (20) Disaster behavioral and mental health is a necessary component of response and recovery due to increased recognition from responders and media and greater need overall. Individual and community health and resilience and the successes of response and recovery are directly linked to the level of attention that is brought to solving behavioral and mental health issues. During response and recovery efforts, disaster epidemiology techniques can be utilized to assess needs, progresses, and gaps for behavioral health programs.

Defining behavioral and mental health is important so that an appropriate surveillance or assessment program can be implemented. The Centers for Disease Control and Prevention (CDC) and the Council of State and Territorial Epidemiologists (CSTE) performed an assessment regarding disaster mental health surveillance at state agencies. Mental health was defined as “a range of psychological (e.g., depression, anxiety, PTSD, suicide etc.), emotional (e.g., grief, fear, anger, loss of sleep, inability to concentrate, etc.) and behavioral (e.g., substance abuse, misuse, domestic violence, gambling, or other addictions, etc.) responses that may be experienced by people affected by a disaster.” (2)

An assessment performed by the Disaster Epidemiology Subcommittee of the Council of State and Territorial Epidemiologists (CSTE) discovered that 26% of 53 jurisdictions surveyed reported: “...tracking behavioral and mental health outcomes post-disaster.” (12). This statistic highlights the need for increased emphasis on disaster behavioral health planning and response.

### Rules and Regulations

The National Incident Management System (NIMS) has two support functions that address behavioral health issues. Disaster behavioral health support falls under the NIMS Emergency Support Function (ESF) #8 (Public Health and Medical Services). ESF-8 mandates the ability to mobilize disaster behavioral health teams to an emergency. These teams can consider “the interconnected psychological, emotional, cognitive, developmental, and social influences on behavior, mental health, and substance abuse, and the effect of these influences on preparedness, response, and recovery from disasters or traumatic events.” (19) (20) The NIMS ESF #6; Mass Care, Emergency Assistance, Housing, and Human Services;

coordinates with the tasks associated with ESF #8. Reducing psychological risks and stressors, such as loss of housing during a disaster, can be mitigated through the programs affiliated with ESF #8 and #6. (19)

Additional legal authorities addressing disaster behavioral health include presidential directives and acts. The Homeland Security Presidential Directive (HSPD) 21 mandates the establishment of a “federal disaster mental health advisory committee” that focuses on the relevance of larger public health emergencies needing psychological support. (18) The Stafford Act establishes the Crisis Counseling Assistance and Training Program (CCP). This program is to function in conjunction with the federal agency, Health and Human Services (HHS). CCP has been transitioned under the Substance Abuse and Mental Health Services Administration (SAMHSA). All of these programs work collaboratively to assess the needs and appropriate responses of communities and individuals during a disaster.

## Disaster Behavioral and Mental Health Key Concepts

The *Field Manual for Mental Health and Human Service Workers in Major Disasters* provides several key concepts for disaster behavioral health planning and response. (3) These are:

- No one is untouched by a disaster.
- Two types of trauma exist- individual and community.
- Effectiveness of functioning together is decreased after a disaster.
- Stress and grief are normal outcomes after a disaster strikes.
- Survivors are reluctant to seek out mental services and support.
- Disaster mental health services must meet the needs of a specific community.
- Mental health workers may need to forego traditional methods to assist their client, such as, going to the client rather than waiting for the client to approach them.
- The phase of the disaster will direct appropriate interventions.
- Social support is necessary for recovery.

Acknowledging these key concepts will improve the behavioral health response to individuals and the community by quickly identifying needs and concerns. Once needs and concerns are identified, strategies can be developed to improve behavioral health. Typical emotions that emerge after a disaster include, fear, anxiety, depression, and grief. Behavioral health programs must recognize the need to address these emotions in order to promote well-being.

Psychological first aid must be offered to the survivors of a disaster immediately. The functions of psychological first aid “addresses emotional distress, builds coping skills, connects people with support services, and promotes a return to normal routine”. All of these steps are key concepts to improving the health of a community and individual. (21)

## Disaster Behavioral Health: Planning

Planning for the behavioral health needs of an individual and community before a disaster will provide for quicker and more efficient responses once an incident or event occurs. Mental health services are often overlooked in the disaster planning phase. Lessons learned from previous incidents can be used to build a foundation for behavioral health programs (21). The following components gleaned from previous incidents should be used when planning the behavioral health effects of a disaster:

- Awareness of the community's baseline behavioral health needs
- Awareness of existing behavioral health resources
- Demographics of the community
- Evaluation of the community at potential risk for impact

Comprehension of these principles can be used to build a disaster behavioral health plan. Collaboration amongst governments, academic, clinical, and non-profit entities will ensure that appropriate planning will occur. All of these entities can provide background information of the behavioral health needs of a community for the planning process.

A focus on individuals is also necessary to ensure robust planning. Resilient individuals are persons that embody behaviors, thoughts, and actions that promote rebuilding (17). The following concepts promote individual resiliency:

- Focusing on one's own needs
- Identifying and maintaining a peer support group
- Limiting exposure to negative media coverage of the disaster
- Accepting a new, attainable life
- Setting clear actions to achieve goals
- Developing a positive perspective (17)

Recovery is a long, ongoing process during and following a disaster; however, planning and promoting positive actions will encourage individual resiliency.

## Disaster Behavioral Health: Response

Once a disaster occurs, behavioral health consequences on individuals and communities occur immediately. Consequences include post-traumatic stress disorder, depression, anxiety, loneliness, fear, grief, and exacerbation of pre-existing mental health conditions, amongst other symptoms. Symptoms can range from short-term to long-term. Therefore, measurements of consequences need to occur periodically to determine if intervention measures are successful.

### *Community Assessment for Public Health Emergency Response (CASPER)*

It is critical to assess the situation as promptly and efficiently as possible, using epidemiologic models and trusted methods to ensure accurate data is collected. This includes performing assessments within impacted communities. The Centers for Disease Control and Prevention has developed a modified

cluster sampling methodology called *Community Assessment for Public Health Emergency Response (CASPER)*. CASPER is a low-cost method to rapidly assess "...health status, basic needs, or knowledge, attitudes, and practices of a community..." (10). CASPERs can be performed by anyone at the local, state, or federal level and has been tested numerous times after disasters have occurred. For more information on CASPER see chapter 5 of this guide.

### *Behavioral Risk Factor Surveillance System (BRFSS)*

The Centers for Disease Control and Prevention (CDC) Division of Behavioral Surveillance has designed the *Behavioral Risk Factor Surveillance System (BRFSS)*. BRFSS is a telephone-based survey method that can be used to determine the needs and behaviors of a community (4). The BRFSS survey method may provide some baseline information about mental or behavioral health in communities. This method may also serve to measure changes following a disaster or emergency in a community over time. Surveys can be developed after a disaster to collect data that is specific to behavioral health. This surveillance data can be used by federal, state, and local entities to target and prioritize behavioral health interventions.

### *Additional Sources of Surveillance Data*

Multiple entities collect behavioral health surveillance data. The data analyzed from other entities can assist with prioritization and targeting of interventions in conjunction with information identified from CASPER and BRFSS (2) (9) (14) (16). These entities include:

- Substance Abuse and Mental Health Services Administration (SAMHSA) ([www.samhsa.gov](http://www.samhsa.gov))
  - Maintains standardized data collection system for Crisis Counseling Assistance and Training Program (CCP) (14)
- American Association of Poison Control Centers (AAPCC) ([www.aapcc.org](http://www.aapcc.org))
  - Tracks poisonings; reported from citizens and medical professionals
- Researched Abuse, Diversion and Addiction-related Surveillance (RADARS) System ([www.radars.org](http://www.radars.org))
  - Surveillance system for drug abuse, misuse, and diversion; includes timely geographic data
- RADARS Web Monitoring ([www.radars.org/home2/programs/web-monitoring](http://www.radars.org/home2/programs/web-monitoring))
  - Tracks themes posted to social media, blogs, and forums related to drug abuse, misuse, and associated consequences
- RADARS Street RX ([www.radars.org/home2/programs/streetrx](http://www.radars.org/home2/programs/streetrx))
  - Tracks user-submitted information on street prices of drugs
- Real-time Outbreak and Disease Surveillance (RODS) System ([www.rods.pitt.edu/site/](http://www.rods.pitt.edu/site/)) or syndromic surveillance
  - Surveillance system for detection of disease outbreaks; can occur via chief complaint in emergency departments
- FirstWatch Real-time Situational Awareness System ([www.firstwatch.net/](http://www.firstwatch.net/))
  - Detects information into dispatch systems related to symptoms and trends (16) (9)
- Crisis counseling hotlines
  - Self-reported behavioral health issues and symptoms reported via hotline
- Specific shelter and receptions area surveillance

- Self-reported behavioral health issues and symptoms reported to staff and volunteers For more information on shelter surveillance see chapter 7 of this guide.
- Private mental health experts
  - Self-reported behavioral health issues admitted during sessions
- FEMA specific counseling programs
  - Data dependent on citizen reporting
- Telephone and web surveys
  - Drafted prior or during disaster; reporting based on citizens reporting (2)

It is critical to identify which surveillance systems and assessments are available for analysis during disasters. Dedicated, knowledgeable staff are important for being available to analyze data and train others in surveillance methods. Regular communication and organization of the overall disaster behavioral health response will promote effective interventions.

### *First Responder Considerations*

First responders include such persons as police, firefighters, emergency medical services, and recovery personnel that are first on the scene of a disaster. They are expected to adhere to core competencies (4) that are provided during their training and experiences. Typically, responders are the first people victims encounter after a disaster occurs. Special considerations should be taken for first responders due to the extent of exposure that they endure during a response. (18)

Surprisingly, one study estimated that ~10-20% of rescue workers develop post-traumatic stress disorder (PTSD) in comparison to direct victims of disasters who experience ~30-40% PTSD. (6) However, another study demonstrated that many first responders (44.5%) develop significant clinical symptoms of depression, anxiety, and PTSD amongst other conditions in comparison to the general population (~10.1%). (1) Additional epidemiological studies are needed to assess the impact of disasters on first responder behavioral health.

The National Institute of Occupational Safety and Health (NIOSH) of CDC has developed the Emergency Responder Health Monitoring and Surveillance (ERHMS) framework. The ERHMS framework is broken into pre-deployment, deployment, and post-deployment phases. ERHMS has sections that can be used for credentialing and rostering emergency response workers, track health screening, training, exposure events, track in- and out- processing, and provide a method for post-event health tracking ([www.cdc.gov/niosh/topics/erhms](http://www.cdc.gov/niosh/topics/erhms)). This framework allows for specific, thorough tracking of responders both short- and long- term. For more information on ERHMS see chapter 3 of this guide.

### *Considerations for High-Risk Populations*

Communities all have high-risk groups that may mentally experience disasters more deeply than the general population. This includes age groups (i.e., children, elderly), cultural and ethnic groups, people with disabilities, low economic status, people with chronic illness, immigrants, and people with serious and persistent mental health illnesses. For example, “cognitive and emotional maturity” in children is not comparable to adults. (8) Therefore, newly presenting behavioral symptoms, such as fear of the dark or bed wetting should be evaluated for disaster related causation. People of low economic status may be



“less resilient” for a disaster due to the inability to afford life-sustaining materials or have the means to relocate to a safer environment. This results in a greater, long-term need for assistance and resources. (13) All of these groups will have the challenge of obtaining behavioral health care. Epidemiology can assist in identifying the needs of these populations by identifying the factors most important to those at high-risk, which can lead to quicker response and recovery.

## Disaster Behavioral Health: Recovery

Being resilient “...is the process of adapting well in the face of adversity, trauma, tragedy, threats, or even significant sources of stress...” (17) Recovery from a disaster does not occur immediately and behavioral health support will be necessary throughout the process to regain normalcy. Communities and individuals must have the behavioral health support to be able to return an optimal level of function. Much of the community may experience homelessness and/or unemployment. (11) Additional recovery planning for behavioral health includes:

- Assessment of availabilities of behavioral health facilities and programs
- Responding to psychological surge needs
- Engagement of additional behavioral health partners and stakeholders
- Development of behavioral health messaging and guidance

To assess how well recovery is occurring and how resilient an entity is, epidemiology can assist with measures of this process. Traditionally, mental health personnel review behavioral health data. However, public health has become more involved in assessing behavioral health needs. In addition, there is an increase in trained professionals of both public health and disaster behavioral health, which allows for the opportunity to increase response activities. An after-action meeting and summary should occur to assess the effectiveness of behavioral health interventions. (2) Frequent behavioral health training of responders and volunteers will only benefit disaster planning, response, and recovery initiatives.

## Disaster Behavioral Health Challenges

Several challenges impair individuals and communities from receiving appropriate behavioral health care. A lack of providers or lack of access to providers is the foremost problem with receiving adequate care. (21) Limited funding, silos for public health versus behavioral health programs, and lack of coordination amongst programs contribute to barriers to performing behavioral health surveillance. In addition, the availability of epidemiologists with behavioral health training is minimal at best. (2) All of these factors contribute to the lack of achieving optimal behavioral health care and appropriate analytical analysis of the situation. This leads to an underestimation of exactly how dire the circumstances causing the need for behavioral health support is. The type and duration of exposure to the results of a disaster determine the risk factors leading to negative outcomes. (9) Mitigation of the duration and type of exposure (i.e., homelessness) will lessen the negative consequences of a disaster. Therefore,

optimal disaster response requires active planning and preparation for the challenges involved in providing successful behavioral health care to individuals and the community. (15)

## Future Recommendations

Disasters are unpredictable; however, it can be assumed that there will be a tremendous need for behavioral health care after an incident occurs. (6) Funding must be dedicated to building a stable, robust public health response that incorporates disaster behavioral health into the services provided to individuals and the community. Developing behavioral health infrastructure into response planning is critical to the implementation of a program. This includes the integration of epidemiology practices. (15) Surveillance systems need to be strengthened and improved to collect actionable data. (21) Epidemiology can provide concrete evidence of when a behavioral health program is successful, and it can be used to assess how best to execute a program and where it is needed most.

## References

1. Carleton R, Afifi T, Turner S, Taillieu T, Duranceau S, LeBouthillier D, et. al. Mental disorder symptoms among public safety personnel in Canada. *Canadian Journal of Psychiatry*. 2017;August:1-11.
2. Council of State and Territorial Epidemiologists (CSTE). (2013). Disaster mental health surveillance at state health agencies: results from a 2013 CSTE assessment. Atlanta, GA: [www.cste.org/resource/resmgr/environmentalhealth/dmhsfinalreport.pdf](http://www.cste.org/resource/resmgr/environmentalhealth/dmhsfinalreport.pdf). Accessed August 20, 2017.
3. DeWolfe D. Substance Abuse and Mental Health Services Administration (SAMHSA). (2000). Field manual for mental health and human service workers in major disasters. Rockville, MD: <https://store.samhsa.gov/product/Field-Manual-for-Mental-Health-and-Human-Service-Workers-in-Major-Disasters/ADM90-0537>. Accessed August 20, 2017.
4. Division of Behavioral Surveillance, Public Health Surveillance and Informatics Program Office, Centers for Disease Control and Prevention. Monitoring behavioral and mental health to improve public health. Atlanta, GA: [https://www.cdc.gov/surveillancepractice/documents/dbs\\_overview\\_12\\_232372\\_n\\_rem\\_5\\_25\\_2012.pdf](https://www.cdc.gov/surveillancepractice/documents/dbs_overview_12_232372_n_rem_5_25_2012.pdf). Accessed August 20, 2017.
5. Everly G, Beaton R, Pfefferbaum B, Parker C. Training for disaster response personnel: the development of proposed core competencies in disaster mental health. *Public Health Reports*. 2008;123:539-542.
6. Galea S, Nandi A, Vlahov D. The epidemiology of post-traumatic stress disorder after disasters. *Epidemiol Rev*. 2005;27:78-91.
7. Goldmann E, Galea S. Mental health consequences of disasters. *Annu. Rev. Public Health*. 2014;35:169-83.
8. Kar N. Psychological impact of disasters on children: review of assessment and intervention. *World J Pediatr*. 2009;5(1):5-11.
9. Lauper U, Chen J-H, Lin S. Window of opportunity for new disease surveillance: developing keyword lists for monitoring mental health and injury through syndromic surveillance. *Disaster Med Public Health Preparedness*. 2017; 11:173-178.

10. National Center for Environmental Health, Centers for Disease Control and Prevention. (2016). Community Assessment for Public Health Emergency Response (CASPER). Atlanta, GA: <https://www.cdc.gov/nceh/hsb/disaster/casper/>. Accessed August 20, 2017.
11. Shultz J, Galea S. Mitigating the mental and physical health consequences of hurricane Harvey. JAMA. Published online September 11, 2017.
12. Simms E, Miller K, Stanbury M, Heumann M, Miller T. Disaster surveillance capacity in the United States: results from a 2012 CSTE assessment. Council of State and Territorial Epidemiologists. Available at [http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/EnvironmentalHealth/Disaster\\_Epi\\_Baseline731KM.pdf](http://c.ymcdn.com/sites/www.cste.org/resource/resmgr/EnvironmentalHealth/Disaster_Epi_Baseline731KM.pdf). Accessed August 20, 2017.
13. Substance Abuse and Mental Health Services Administration (SAMHSA). (2017). Disaster technical assistance center supplement research bulletin greater impact: how disasters affect people of low socioeconomic status. Rockville, MD: [https://www.samhsa.gov/sites/default/files/programs\\_campaigns/dtac/srb-low-ses.pdf](https://www.samhsa.gov/sites/default/files/programs_campaigns/dtac/srb-low-ses.pdf). Accessed August 20, 2017.
14. Substance Abuse and Mental Health Services Administration (SAMHSA). (2016). Disaster technical assistance center supplement research bulletin stronger together: an in-depth look at selected community-level approaches to disaster behavioral health. Rockville, MD: [https://www.samhsa.gov/sites/default/files/programs\\_campaigns/dtac/srb-community-approaches.pdf](https://www.samhsa.gov/sites/default/files/programs_campaigns/dtac/srb-community-approaches.pdf). Accessed August 20, 2017.
15. Substance Abuse and Mental Health Services Administration (SAMHSA). (2003). Mental health all-hazards disaster planning guidance. Rockville, MD: <https://store.samhsa.gov/product/Mental-Health-All-Hazards-Disaster-Planning-Guidance/SMA03-3829>. Accessed August 20, 2017.
16. Substance Abuse and Mental Health Services Administration (SAMHSA). Public Health Surveillance Systems. Rockville, MD: [https://www.samhsa.gov/capt/sites/default/files/capt\\_resource/public-health-surveillance-systems.pdf](https://www.samhsa.gov/capt/sites/default/files/capt_resource/public-health-surveillance-systems.pdf). Accessed August 20, 2017.
17. University of San Francisco Human Resources. A personal strategy for engaging and building your resilience. San Francisco, CA. Available at <https://hr.ucsf.edu/hr.php?A=1055&AT=&org=we>. Accessed August 20, 2017.
18. U.S. Department of Health and Human Services (DHHS). (2008). Summary of HHS disaster behavioral health assets and capabilities. Rockville, MD. Available at <https://www.phe.gov/Preparedness/planning/abc/Documents/sum-hhs-disasterbehavioralhealth.pdf>. Accessed August 20, 2017.
19. U.S. Department of Health and Human Services (DHHS). (2016). Disaster behavioral health concept of operations. Washington D.C. Available at <https://www.phe.gov/preparedness/planning/abc/documents/dbh-conops-2016.pdf>. Accessed August 20, 2017.
20. World Health Organization (WHO). Building back better: sustainable mental health care after emergencies. WHO: Geneva, 2013.
21. Yun K, Lurie N, Hyde P. Moving mental health into the disaster-preparedness spotlight. N Engl J Med. 2010;363:1193-1195.

## Disaster Epidemiology Organizations and Tool Repositories

This chapter describes disaster epidemiology organizations and tool repositories made available by CDC, CSTE, and the National Institutes of Health (NIH). It also describes an inventory of tools developed by the Preparedness and Emergency Response Research Centers (PERRCs). These freely-available repositories house many of the disaster epidemiology tools that are available for local, state, and federal epidemiologists to use throughout the disaster lifecycle. The tools can be modified or used “off the shelf.” The repositories and disaster organizations discussed below provide a mechanism for local, state, and federal epidemiologists to share disaster epidemiology methods, tools, evaluations, and lessons learned.

### **CDC Disaster Epidemiology Community of Practice (DECoP)**

The Disaster Epidemiology Community of Practice (DECoP) is housed in the CDC’s National Center for Environmental Health (NCEH). Formally known as the Disaster Surveillance Workgroup (DSWG), this collaborative group is made up of CDC employees and other federal, state, tribal, local, territorial, and academic partners. The DECoP’s purpose is to provide technical resources to members, to expand the use of disaster public health surveillance tools, and to evaluate tools and guidelines to improve situational awareness and response activities. During a major disaster, it is critical for public health practitioners to have the capacity to conduct disaster epidemiology activities (e.g., surveillance, assessments) – the DECoP provides tools and resources to support these activities. Since the inception of this group in 2005, members have provided technical assistance for every natural disaster to which CDC has responded, whether in the field or at CDC’s headquarters in Atlanta in the Emergency Operations Center. The DECoP hosts quarterly conference calls for members to present and share information about activities they are conducting, tools they have developed, and their areas of expertise.

#### ***CDC DECoP SharePoint®***

As part of the DECoP, members have access to an online SharePoint® website, which serves as a one-stop-shop for a variety of disaster epidemiology tools and resources. Members are encouraged to share tools and resources and participate in discussions concerning disaster epidemiology-related information. This fosters collaboration among the partners between the dates of the quarterly calls. Some tools and guidance documents currently available for download on the site include the Community Assessment for Public Health Emergency Response (CASPER), Emergency Responder Health Monitoring and Surveillance (ERHMS), morbidity/ and mortality surveillance forms, and the Assessment for Chemical Exposure (ACE). Members also have access to foundational disaster epidemiology information to increase their knowledge about the field.

If interested in joining the DECoP and its SharePoint® site, please request access by emailing your **full name, and preferred email address** to [DECoP@cdc.gov](mailto:DECoP@cdc.gov).

## **CSTE Disaster Epidemiology Subcommittee**

The CSTE Disaster Epidemiology Subcommittee brings together epidemiologists from across subject disciplines to share best practices and collaborate on the use of epidemiologic approaches to improve all-hazard preparedness and response capacities.

### ***CSTE Disaster Epidemiology Resource Repository***

In 2015, the CSTE Disaster Epidemiology Subcommittee identified the need to share resources and information among federal, state, and local partners, and subsequently, members of the subcommittee developed a repository of disaster epidemiology resources and tools. The repository compiles member-shared forms, surveys, and other tools developed by state and federal partner agencies. Tools currently available address topics including shelter surveillance, syndromic surveillance, mortality surveillance, morbidity surveillance, and community health impacts rapid needs assessments (e.g., CASPER methodology guidance). The sharing of methods and tools via this interactive process benefits everyone who applies epidemiologic methods to disaster planning, response, and recovery. The repository is accessible [here](#).

CSTE anticipates these resources and tools will be downloaded and modified for situations specific to jurisdictions. If you or your state modify a tool, CSTE is interested in hearing how well it worked for the specific need and how it was modified for the situation.

The CSTE Disaster Epidemiology Subcommittee convenes monthly conference calls to continue its efforts. To stay up-to-date on subcommittee calls, activities, and workshops, become a CSTE member and join the Disaster Epidemiology Subcommittee – by doing so, you will receive all CSTE Disaster Epidemiology Subcommittee communications. If you would like more information about being a CSTE member, visit the [CSTE Member Website Page](#).

If you or your state would like to share disaster epidemiology-related tools and activities or have questions on how to become involved with CSTE, please email the CSTE staff lead listed on the [Disaster Epidemiology page](#).

## **Disaster Research Response (DR2) Repository**

The National Institutes of Health (NIH) Disaster Research Response program (DR2) began in 2013 as a pilot project sponsored by the National Institute of Environmental Health Sciences (NIEHS) and the National Library of Medicine (NLM). The DR2 Program provides data collection tools, research protocols, IRB guidance, and training materials to advance timely research in response to disasters and public health emergencies. The DR2 Program is helping to respond to critical needs identified by senior officials, agencies, and NGO's to support disaster science through readily available tools and resources, trained investigators, funding, trans-disciplinary coordination, and integration with national disaster frameworks to further response, recovery, and future preparedness.

One of the main goals of the DR2 program is to create an environmental health disaster research system that will provide a suite of ready-to-go data collection tools, surveys, forms and research tools to empower state and local responders to conduct and sustain research efforts within their jurisdiction, especially in those disasters that do not require federal involvement.

As part of this system, the DR2 Program has developed a Data Collection Tools & Resources repository, which hosts over 300 tools intended for use in disaster-related research. These tools include surveys, surveillance forms, research protocols, and biospecimen collection methods, and environmental sampling tools. An extensive literature search of over 10,000 peer-reviewed articles was used to create the repository. Metadata on each of the data collection tools (e.g., mode of administration, population of interest, languages, reading level) were collected to help standardize and improve the selection of an appropriate tool by the research community. The website features newly-developed filters to facilitate the rapid identification of disaster research tools. The NIH DR2 website hosts data collection instruments used to measure pre- and post-disaster impacts in eight research categories, including environmental exposure, lifestyle and quality of life, mental health and cognitive function, occupational health, preparedness, social support and resiliency, specific body systems and specific disasters. Since the disaster research landscape is dynamic, new tools are periodically added to the repository as they become available. The DR2 program also developed and highlighted curated sets of research tools for just-in-time use in response to specific disaster events, such as Hurricanes Harvey, Irma and Maria in 2017.

The publicly accessible DR2 Program information and repository of disaster research tools (see Data Collection Tools & Resources tab) are available at <http://dr2.nlm.nih.gov>.

## Preparedness and Emergency Response Research Centers' Tools

[The Preparedness and Emergency Response Research Centers \(PERRCs\)](#) were established through the Pandemic and All-Hazards Preparedness Act of 2006, which called for research to improve federal, state, local, and tribal public health preparedness and response systems. These academic centers conducted research to focus on the most critical elements needed to enhance preparedness for all hazards and close gaps in public health preparedness and response services. An integral part of this research focused on translating the results to public health practice. Although the PERRC program is no longer supported, much of the PERRC research was translated into tools designed to assist state and local health agencies in preparedness efforts. The Emergency Preparedness, Research, Evaluation & Practice Program at the Harvard T.H. Chan School of Public Health developed an inventory of these tools with the aim of disseminating the research findings and promising practices to enhance preparedness efforts and strengthen the competence of the public health workforce. Some of these tools are stand-alone disaster epidemiology tools and others may be used in conjunction with disaster epidemiology tools to facilitate planning, disseminate messaging, conduct evaluations, and support exercises. The tools are provided in an inventory and include the following topics:

- Tools to Support Mental Preparedness Efforts
- Tools to Support Legal Preparedness Efforts

- Tools to Enhance Leadership
- Tools to Support Communications to the Public
- Tools to Support Educational Activities Directed to the Public
- Tools to Support Planning Efforts
- Tools to Support Evaluation Efforts
- Tools to Support the Implementation of Emergency Preparedness Exercises

The tools listed in the inventory are freely available for use and can be implemented with limited support from the toolkit developers. The inventory includes a brief description of each of the toolkits, toolkit source, contact information, and links to the toolkits. The inventory can be found at:

<https://cdn1.sph.harvard.edu/wp-content/uploads/sites/1609/2017/03/PERRC-Toolkit-Inventory.pdf>