Disaster Epidemiology and Surveillance

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REVIEW QUESTIONS, ANSWERS, AND EXPLANATIONS

I. OVERVIEW

Before discussing disaster epidemiology and surveillance, it is important to define what is meant by disaster. A disaster is generally considered to be an event that puts an overwhelming stress on a system such that the resources used on a daily basis are inadequate for dealing with the impact of the event. The resources may be inadequate because of the number of people affected by the event, or because the resources themselves have been damaged or limited as a result of the event. Disasters may be further categorized by intent or cause. Whereas natural disasters are events such as tsunamis, hurricanes, tornadoes, earthquakes, and floods, man-made disasters are related to human-developed technology and may be unintentional, such as a train crash, or intentional, such as a terrorist attack or the intentional distribution of a toxic agent (e.g., 1995 sarin gas release in Tokyo subway, 2011 anthrax letters sent in U.S.). In either case, the epidemiology and surveillance needs in a disaster may be impacted by the type of event that has occurred.

Disaster epidemiology and surveillance are rooted in epidemiologic principles that apply to other diseases, but unique challenges and concerns need to be considered in the context of disaster epidemiology. Investigators use disaster epidemiology to assess the short-term and long-term health effects of disasters. In addition, disaster epidemiology is important in allowing epidemiologists to understand how to prevent deaths, injuries, and disease spread in disaster situations. Despite advances in disaster epidemiology, however, there is still a need to refine the approaches to surveillance and epidemiology in disaster situations, as Noji stated in 1992.

Unlike in other types of events, when we perform epidemiologic studies and surveillance in disasters, we focus on not only the inhabitants of a community affected by the disaster, but also the workers and volunteers who respond to a disaster. These responders are often at risk for injury or disease because of their involvement in the response (e.g., an NYC Fire Department chaplain responding on 9/11 was killed by a falling object). In other situations, workers may be exposed to infectious diseases or injury risks.

A. Burden of Disaster

The World Health Organization (WHO) reports that 385 natural disasters killed more than 297,000 people in 2010. An additional 217 million people were affected by the disasters, at a cost equivalent to $123.9 billion in economic damages. In the United States, there has been a steady increase in the number of official disaster “declarations” from 1990 to 2011, with 100 declarations in 2011 (Fig. 27-1).

II. DEFINITIONS AND OBJECTIVES

To have a basis for understanding the issues associated with disaster epidemiology and surveillance, it is important to understand the definitions commonly used in the study of disasters. First, a disaster could be considered to be an event that places a strain on the health or public health system such that additional resources are needed in order to respond. Disasters may occur within an institution, in a community, or on a broader scale. Disasters can be classified in a number of ways, but are usually described as natural or man-made, as previously noted. Natural disasters encompass a range of situations that put people at risk for significant health effects.

Disaster epidemiology is defined as the use of epidemiology to assess the short-term and long-term adverse health effects of disasters and to predict consequences of future disasters. It brings together various topic areas of epidemiology, including acute and communicable disease, environmental health, occupational health, chronic disease, injury, mental health, and behavioral health. Disaster epidemiology provides situational awareness; that is, it provides information that helps responders understand what the needs are, plan the response, and gather the appropriate resources.
The main objectives of disaster epidemiology are as follows:

- Prevent or reduce the number of deaths, illnesses, and injuries caused by disasters.
- Provide timely and accurate health information for decision makers.
- Improve prevention and mitigation strategies for future disasters by collecting information for future response preparation.

As with other types of epidemiology, disaster epidemiology focuses on identifying disease and injury patterns and risk factors to the population and community affected by the disaster. This information serves as the basis for developing prevention and mitigation strategies that are driven by three contexts of disasters: time, place, and person. For example, hurricane season on the U.S. East Coast, as well as in the Caribbean, is June 1 through November 30. In addition, the geographic area generally at risk is defined. Although people who live on or near the coast are at increased risk of injury or death during a hurricane, evacuation from the hurricane zone minimizes or eliminates this risk. In contrast, the usual season for flu occurrence is over the winter months in the United States, and flu risk is related to exposure, immunization status, and other factors such as age; generally, elderly and very young populations, people with chronic illness or immunocompromise, and pregnant women are at increased risks for complications and mortality, depending on the flu strain that is active in a given year. Prevention strategies would focus on immunization of highest-risk populations, and depending on the severity of an outbreak, isolation of people who have contracted flu or who have been exposed and are likely to expose others to risk.

In a disaster situation, three types of epidemiology generally are used: descriptive, analytic, and evaluative. Each contributes to the understanding of the disaster event, as well as the prevention and mitigation of harm from future events.

### A. Descriptive Epidemiology

Epidemiologists use descriptive epidemiology to identify the distribution of disease or injury among the population groups affected by the disaster. This includes identifying the health-related issues that occur among people who are responding to the event.

After the World Trade Center disaster on 9/11, responders to the scene were exposed to various types of particulate matter, as well as larger pieces of debris, some of which fell from the collapsing towers. Other responders have complained of resulting respiratory problems. The epidemiology of the health aftermath of the disaster continues to emerge; longitudinal surveys are providing information on various health outcomes. A study of 2960 disaster workers found that 70% did not meet criteria for posttraumatic stress disorder (PTSD), but at 6 years after the event, 4.2% of nonrescue disaster workers still exhibited symptoms of PTSD or partial PTSD. Risk factors for ongoing PTSD included major depressive disorder 1 to 2 years after the event, history of trauma, and extent of occupational exposure.

Asthma rates are increased in the disaster responders as well, with a lifetime prevalence by 2007 that was almost twice (19% vs. 10%) that of the general population.

On a larger scale, the World Trade Center Health Registry at the New York City Department of Health and Mental Hygiene will provide a 20-year follow-up through periodic contact with the enrollees (Box 27-1).

### B. Analytic Epidemiology

Analytic epidemiology can provide information about differences between people who were injured or became ill during an event and those who did not. The benefit is that analytic epidemiology gives information about the risk and protective factors related to a disaster event. For example, an ongoing investigation of deaths and injuries after the 2011 tornado outbreak in Alabama can provide data about where people were when they were killed or injured, the types of...
injuries sustained, and whether protective factors had an impact on the occurrence of injuries. These may be environmental or behavioral factors. This type of study allows informed recommendations for interventions to help protect people from injury caused by tornadoes.

C. Evaluative Epidemiology

In using evaluative epidemiology, investigators can determine the effectiveness of specific interventions that have been implemented and identify factors that have resulted in their success or failure. It allows them to modify strategies and develop new interventions. This allows epidemiologists to determine, for example, if specific immunization strategies are effective in preventing spread of flu, or whether environmental changes (building standards) are effective in decreasing building collapses, and therefore deaths and injuries, in earthquakes.

III. PURPOSE OF DISASTER EPIDEMIOLOGY

Disaster epidemiology allows investigators to identify the priority health problems in the community affected by a disaster. Although the primary focus is on health problems related to the disaster itself, epidemiologists can also learn about preexisting health problems that impact a community’s resilience and create needs for specific services during a disaster. In a disaster or public health emergency, it is also important to identify the causes of disease and injury and associated risk factors in the context of the event. This may include examining the results of laboratory testing of biological and other specimens to identify specific disease agents or toxic substances involved in the event.

Various methods of classifying severity of injury or illness can aid in determining priorities for health interventions.

The epidemiologic assessment of health problems allows for a rapid needs assessment that leads to planning for interventions; identification of the need for additional help; and modifications as well as additional support for the infrastructure. As an event evolves, continued surveillance and epidemiology allow tracking of the course of diseases, as well as identification of emerging issues. For example, although many people were killed and injured in the 7.0 earthquake in Haiti on January 12, 2010, it took several days to identify the emergence of cholera, which presented a significant risk to the survivors. Epidemiology was used to identify cases and the spread of the disease. In January 2011 the Pan American Health Organization released a report on the health impact of the earthquake, highlighting lessons that could be applied to the next major disaster event. In this way, the epidemiology and surveillance from one disaster can be used to inform planning and response for future events.

A. Forensic Epidemiology

Forensic epidemiology is not discussed as often as it might be with respect to disaster epidemiology. The field of forensic epidemiology brings together public health and a legal investigative approach to examining a disaster or emergency situation. This is especially important in cases of suspected bioterrorism and other intentionally created events. Forensic epidemiology explores the intent, persons involved, degree of harm, and risk factors, to form a complete picture of an intentional disaster. The 1985 investigation of intentional contamination of salad bars in Oregon led to the prosecution of the religious group responsible.

IV. DISASTER SURVEILLANCE

As with other parts of epidemiologic practice, surveillance plays a critical role in epidemiologic investigations during and after a disaster. One of the major challenges of surveillance in disasters is that many routine surveillance systems may not provide the information necessary to assess needs or identify disease or injury patterns. This occurs in both natural and human-made disasters and creates difficulty for all types of disaster epidemiology. Disasters present special circumstances in which surveillance may be difficult, and during which routine surveillance systems may not be functional or accessible, because of the circumstances of the disaster.

A. Syndromic Surveillance

Syndromic surveillance uses indicators of population and individual health that may appear before widespread disease is confirmed through clinical or laboratory diagnosis. This type of surveillance is often set up as a routine surveillance mechanism that is in place to monitor for specific diseases. For example, a sharp increase in sales of over-the-counter cold remedies might indicate the emergence of a new respiratory virus. Across the United States, emergency departments participate in syndromic surveillance systems designed to detect clusters of events in the early phases of an outbreak, such as gastrointestinal illness caused by food poisoning or disaster. Syndromic surveillance systems may be based on existing data systems, particularly when electronic health
records are available in real time. If the focus is looking for a specific disease, case criteria for surveillance are identified, whereas in a more general syndromic surveillance strategy, data may be monitored for unusual patterns that could indicate emerging disease. The Centers for Disease Control and Prevention (CDC) has developed definitions for diseases associated with critical bioterrorism agents. In addition, syndromic surveillance may be implemented on a short-term basis during specific events when there is a possibility of either disease transmission or an intentional act that results in illness. For example, during the 2002 Kentucky Derby Festival, 12 hospitals successfully participated in the surveillance system that was set up.

B. Challenges in Disaster Surveillance and Epidemiology

To perform disaster surveillance activities, it is important to predefine the variables and data points that would be of interest during a particular type of disaster. Although a core set of variables is important in any disaster event, each type of event has unique circumstances that need to be documented to understand fully the impact of the event. For example, the spread of a newly emerging strain of flu would necessitate identification of the strain causing infections in the population of interest, at least to the extent that one can assume the cases beyond a certain point in time could be attributable to the agent that has already been identified. In the case of a tornado or earthquake, the specific location of victims, with details about the type of building, the force of the tornado or earthquake, and the injuries sustained and their severity, and the outcome for each person injured are all important data to collect. In an infectious disease outbreak, the trajectory of the impact on the population is very different, and there may be more time to collect data in order to plan for the resources and interventions that will be needed. These are data points in addition to demographic data.

Surveillance is also important after the disaster, particularly if there are risks for the development and increased transmission of infectious diseases due to the nature of the event. Events that disrupt water supplies and sanitation place the communities affected at risk for the spread of infectious disease from contaminated water sources. Other postdisaster outcomes of interest include recovery status of injured disaster victims. An understanding of the severity of injuries sustained, as well as long-term rehabilitation and support needs, will aid in community planning.

C. Designing a Disaster Surveillance System

As much as possible, a disaster surveillance system should not require a large amount of additional resources during a disaster event. Because personnel will be consumed with responding to the disaster and implementing interventions, requirements for collecting large amounts of additional data are likely to create difficulties for the personnel involved. The number of skilled staff may be insufficient to collect the data needed, or the staff responding may not have a good understanding of basic epidemiologic principles and measurement. There may be limited access to the population of interest. If a sample of the population is surveyed, it may not be representative of the overall population affected by the disaster. Cultural and language barriers pose additional problems, along with the difficulty in investigating the long-term needs of the affected population.

A core set of data points can be used in surveillance in most disaster events. Demographic data as well as simple outcome data for both victims and responders are useful in tracking the impact of the disaster as well as identifying the need for resources. A data system design that allows for a modular approach, depending on the type of event as well as the phase of the event, may be useful. System design requires consideration of the data collection methods that are routinely available and that may be available after the disaster. In addition, it is important to consider the burden that data collection will present to an already-stressed system. Whenever possible, it is important to use existing data systems rather than creating new systems that have not been tested or accepted by those involved in a disaster response; the simpler the data collection, the better. It is also possible to collect postdisaster data and interview people who were at the scene, but this is not always optimal because of the potential for recall bias and for data to be missing from patient records. Data collection during and after a disaster must take into account existing data sets and information; the size, demographics, and baseline health status of the population affected; and available resources. Geographic mapping can be useful in examining the impact of environmental factors in a disaster.

When there is an urgent need for information or acquisition of resources, a rapid survey may be done. In this scenario, only the minimum information necessary to meet the surveillance goals is collected. Only information that is not already available or cannot be collected in another way is obtained, and the goal becomes to collect as representative a sample as possible to ensure generalizability to the population affected. This type of survey is sometimes repeated and refined over the course of the event and postevent period.

In the postdisaster period, surveys of persons who were present during the event may be helpful, as may surveys of those who were injured or who became ill during the event. Key informant interviews can provide information about risks and mitigating factors experienced in the community and can help identify approaches to planning for future events. As previously described, longitudinal surveys of survivors and responders provide information about long-term health and social impacts.

V. ROLE OF GOVERNMENT AGENCIES AND NONGOVERNMENTAL ORGANIZATIONS

Preparedness and response to disasters and pandemics require a coordinated effort from multiple agencies and organizations. Although an in-depth discussion is beyond the scope of this chapter, a brief summary of the role of federal agencies and nongovernmental organizations (NGOs) is helpful in understanding the multifaceted nature of preparedness and response.

Public health focuses on overall population health and ensuring that population-based measures are in place for disaster preparedness and response. Surveillance activities are in the realm of public health, as is disease reporting and investigation of disease and injury occurrence. Emergency
management agencies, which exist at various governmental levels, focus on the overall management of a disaster response and coordination of recovery services, and may be responsible for allocation of resources. The U.S. Federal Emergency Management Agency (FEMA), now in the Department of Homeland Security, works to plan for disasters and terrorism, makes recommendations to the public on how to prepare for events, provides education for responders, and reviews disaster declaration requests from governors to ensure that resources are appropriately allocated and distributed.12

Various other agencies are involved in preparing for and responding to disasters at the local, state, and federal levels. The private sector and NGOs, such as the American Red Cross,13 have an important role as well, providing services such as shelter, food, and clothing. NGOs also respond to disasters that occur around the world, providing emergency and long-term shelter, health care, food, clothing, and other services.

VI. SUMMARY

Disaster epidemiology and surveillance are critical components of a disaster response and can contribute to understanding the nature of an event as well as the implications for planning for future events. There are unique challenges presented in performing surveillance during disasters, but the efforts made at surveillance and epidemiology provide valuable contributions to our understanding of disasters and planning for future events.

References


