Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

1 CHAPTER

Introduction to Disaster Medicine

Gregory R. Ciottone

What exactly is disaster medicine? If you have decided to purchase and read this book, it is likely a question you have wrestled with. Disaster itself is not an easily defined entity, thus the new medical specialty evolving around it is continuously undergoing metamorphosis. Because a disaster is a local event, throughout history, the local medical responders have cared for the victims of disaster. The same medical personnel who provide health care on a daily basis also assume the responsibility of providing care to patients with illness or injury resulting from a disaster. Unlike other areas of medicine, however, the care of casualties from a disaster requires the health care provider to integrate into the larger, predominantly nonmedical multidisciplinary response. This demands a knowledge base far greater than medicine alone. To operate safely as part of a coordinated disaster response, either in a hospital or in the field, an understanding of the basic principles of emergency management is necessary. Now we begin to see the evolution of the specialty of disaster medicine. To respond properly and efficiently to disasters, all health care personnel should have a fundamental understanding of the principles of disaster medicine (which incorporates emergency management in its practice) and what their particular role would be in the response to the many different types of disasters.

In the mid-1980s, disaster medicine began to evolve from the union of disaster management (now called emergency management) and emergency medicine. Although disaster medicine is not yet an accredited medical subspecialty, those who practice it have been involved in some of the most catastrophic events in human history. Practitioners of present-day disaster medicine have responded to the aftermaths of the tsunami in Southeast Asia,[1] Hurricane Andrew,[2] the Haiti Earthquake,[3] the Madrid Train Bombings,[4] and the World Trade Center Attacks,[5] to name a few. During the past several decades, we have seen the first applications of basic disaster medicine principles in real-time events, and as demonstrated by the devastation caused by Hurricane Sandy in 2012 and the devastating Ebola Outbreak of 2014-2015, there is sure to be continued need for such applications.

The impetus for this text grew from a realization that as the specialty of emergency medicine grows, emergency physicians must take ownership of this new field of disaster medicine and ensure that it meets the rigorous demands put upon it by the very nature of human disaster. If we are to call ourselves disaster medicine specialists and are to be entrusted by society to respond to the most catastrophic human events, it is imperative that we pursue the highest level of scholarly knowledge and moral conduct in this very dynamic area. Until there is oversight from a certifying board, it is our responsibility to the public to maintain this high level of excellence. As in medical ethics, where patients rely on the virtue of their physicians to compel them to abide by moral standards, so must we exercise virtue in how we conduct the medical response to disaster.

THE DISASTER CYCLE

Because disasters strike without warning, in areas often unprepared for such events, it is essential for all emergency services personnel to have a foundation in the practical aspects of disaster preparedness and response. The first step is to understand that disaster can strike here at home. I can assure you the people of Haiti minutes before the earthquake of 2010 and the people of Japan minutes before the earthquake and tsunami of 2011 all were going about their normal daily routine, not expecting disaster to strike. Then it did.

As is discussed in other chapters throughout this text, emergency responders have an integrated role in disaster management. All disasters follow a cyclical pattern known as the disaster cycle (Figure 1-1), which describes four reactionary stages: preparedness, response, recovery, and mitigation or prevention. Emergency medicine specialists have a role in each part of this cycle. As active members of their community, emergency specialists should take part in mitigation and preparedness on the hospital, local, and regional levels. Once disaster strikes, their role continues in the response and recovery phases. By participating in the varied areas of disaster preparation and response, including hazard vulnerability analyses, resource allocation, and creation of disaster legislation, the emergency medicine specialist integrates into the disaster cycle as an active participant. Possessing a thorough understanding of the disaster medicine needs of the community allows one to contribute to the overall preparedness and response mission.

NATURAL AND HUMAN-MADE DISASTERS

Over the course of recorded history, natural disasters have predominated in frequency and magnitude over human-made ones. Some of the earliest disasters have caused enormous numbers of casualties, with resultant disruption of the underlying community infrastructure. *Yersinia pestis* caused the death of countless millions in several epidemics over hundreds of years. The etiologic agent of bubonic plague, *Y. pestis*, devastated Europe by killing large numbers of people and leaving societal ruin in its wake.[6] During the writing of this chapter, an Ebola outbreak raged in West Africa, along with concern that a worldwide pandemic might ensue.[7] The 2014 and 2015 Ebola and Middle East respiratory syndrome (MERS) outbreaks have proven that, despite the passage of time and the great advances in medicine, the world continues to be affected by disease outbreaks. In addition, diseases that have been eradicated have the potential of being reintroduced into society, either accidentally from the few remaining sources in existence around the world, as in the 2015 measles outbreak in the United States, or by intentional release. Such events have the potential of devastating results, as the baseline intrinsic immunity the world population developed during the natural presence of the disease has faded over time,

FIG 1-1 The Disaster Cycle.

putting much larger numbers of people at risk. Finally, with the advent of air travel allowing people to be on the opposite side of the world in a matter of hours, the bloom effect of an outbreak is much harder to predict and control. Disease outbreaks that were previously controlled by natural borders, such as oceans, no longer have those barriers, making the likelihood of worldwide outbreak much greater now than it was hundreds of years ago. We saw evidence of this in 2014, with Ebola-infected patients arriving in Spain and the United States from West Africa. During that outbreak, naysayers to intrusive actions such as quarantine and travel restrictions cited following the "science" learned since the disease emerged in central Africa in the 1970s. The problem with such logic was that Ebola had never before been seen in urban settings such as Nigeria, New York City, and Dallas, Texas. Transmission parameters in such settings were truly uncharted waters for the medical community.

In addition to epidemics, with each passing year, natural disasters in the form of earthquakes, floods, and deadly storms batter populations. One need only to remember the destruction in terms of both human life and community resources caused by the Indian Ocean Earthquake and Tsunami of 2004, the Haiti Earthquake in 2010, or the earthquake, tsunami, and radiation disaster in Japan in 2011 to understand the need for preparedness and response to such natural events. Considering that the earthquakes that caused these tsunamis occurred hours before the devastation, it is difficult to understand how today's advanced society, able to travel far into space among other great achievements, was unable to mitigate against some of the most deadly natural events in recent history. The realization that disaster can strike without warning and inflict casualties on the order of the 2004, 2010, and 2011 earthquakes and tsunamis, despite our many technological advances, serves as a warning that mitigation, preparedness, response, and recovery to natural disaster must continue to be studied and practiced vigorously.

Today, the possibility of terrorist attack threatens populations across the globe. Both industrialized and developing countries have witnessed some of the most callous and senseless taking of life, for reasons not easily fathomed by civilized people. It is unusual to read an Internet news article or watch a television newscast without learning of a terrorist attack in some part of the world. With the advent of more organized groups such as the Islamic State of Iraq and Syria (ISIS), Boko Haram, the Revolutionary Armed Forces of Colombia (FARC), and the Epanastatikos Agonas (EA), these attacks are more frequent and deadly, often using horrifying means of execution. The commonplace nature of a terrorist attack in modern society ensures it is unquestionably something that will continue long into the future, and will very likely escalate in scale and frequency.

The multilayered foundation on which ideological belief evolves into violent attack is beyond the scope of analysis that this book ventures to undertake. These ongoing events do demonstrate, however, that the principles studied in the field of disaster medicine must include those that are designed to prepare for and respond to a terrorist attack. Because there are very intelligent minds at work designing systems to bring disaster on others, equally there must be as robust an effort to prepare for and respond to those disasters. Such response involves the deployment of law enforcement, evidence collection, and military personnel and equipment, which are typically not seen in the response to a natural disaster. The integration of these unique assets into the overall response is essential for the success of the mission. The disaster medicine specialist must have a thorough understanding of the role of each.

DEFINING DISASTER

A thorough discussion of disaster preparedness and response must be predicated on a clear definition of what, in fact, constitutes a disaster. Used commonly to describe many different events, the word *disaster* is not easily defined. The Indian Ocean Tsunami in 2004 and the Haiti Earthquake in 2010, each killing significantly more than 200,000 people, would certainly meet the criteria for disaster. However, the 2015 flood in Peru that killed 20 people and tropical storm in Madagascar that killed 14 have also been called disasters. Likewise, the 2003 explosion of the space shuttle *Columbia* on reentry into Earth's atmosphere that killed the crew of seven astronauts onboard has often been referred to as the *Columbia* Disaster in the lay press. How can an event resulting in the loss of seven people be placed in the same category as one that kills hundreds of thousands? Herein lies the paradox of disaster. What is it? Who defines it, and by what criteria?

It is difficult to dispute that an event causing thousands of casualties should be considered a disaster, but let us analyze why that is the case. What is it about the sheer number of dead and injured that allows the event to be called a disaster? In terms of medical needs, it is simply because there is no health care system on Earth that can handle that number of casualties. Therefore an event of such magnitude is a disaster because it has overwhelmed the infrastructure of the community in which it occurred. Following this logic, we can then also make the statement that any event that overwhelms existing societal systems is a disaster. This definition is close to the definition of *disaster* given by the United Nations International Strategy for Disaster Reduction (UNISDR)[8]:

> *A serious disruption of the functioning of a community or a society involving widespread human, material, economic, or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources.*

A similar definition is used by the World Health Organization (WHO). By applying these definitions, one can understand how an event in a rural area with 10 to 20 casualties may also be considered a disaster because the limited resources in that area may prevent an adequate response without outside assistance.

The widely accepted UNISDR and WHO definitions of *disaster* justify describing both the 2010 Haiti Earthquake and the 2015 flood in Peru as disasters. However, what about the destruction of the space shuttle *Columbia* on reentry? Clearly, this definition does not allow one to justify the use of *disaster* in describing that horrific accident, which brings to light a discrepancy in how disaster specialists and the public term events. The *Columbia* accident, as an example, does not meet any accepted criteria of disaster. It was, however, an exceedingly tragic event, seen by millions on television, as it was unfolding. It was tragic by the word's very definition in the *Cambridge Dictionary*: "A very sad

event, especially one involving death or suffering." Public perception of such events may cause this misnomer, with a tragic incident being termed a disaster. Much like disaster, tragedy can also have a profound and lasting effect on society, especially a tragedy that is widely viewed through modern media outlets. This text, however, will follow the UNISDR and WHO definitions when discussing disaster.

DISASTER MEDICINE

Disaster medicine is a discipline resulting from the marriage of emergency medicine and disaster management. The role of medicine and emergency medical services in disaster response has abundant historical precedence. Responsibility for the care of the injured from a disaster has been borne by the emergency specialist or its equivalent throughout history. Therefore disaster medical response, in its many forms, has been around for thousands of years. Whenever a disaster has struck, there has been some degree of a medical response to care for the casualties. In the United States, much of the disaster medical response has followed a military model, with lessons learned through battlefield scenarios during the last two centuries.[9] The military experience has demonstrated how to orchestrate efficient care to mass casualties in austere environments. However, it does not translate directly into civilian practice. For instance, scenarios encountered on the battlefield with young, fit soldiers injured by trauma are vastly different from those encountered in a rural setting, where an earthquake may inflict casualties on a population with baseline malnutrition or advanced age. With this realization came the need to create disaster medicine as an evolution from the military practice. This recent organization of the medical role in disasters into a more formalized specialty of disaster medicine has enabled practitioners to define further their role in the overall disaster preparedness and response system.

Disaster medicine is truly a systems-oriented specialty, and disaster specialists are required to be familiar and interact with multiple responding agencies. The reality is there is no "disaster clinic." No practitioners leave home in the morning intent on seeing disaster patients. Disaster medical care is often thrust upon the practitioner and is not necessarily something that is sought out. The exception to this is the medical specialist who becomes part of an organized (usually federal) disaster team, such as a disaster medical assistance team (DMAT). In this case, one may be transported to a disaster site with the intention of treating the victims of a catastrophic event. In all other circumstances, however, the disaster falls on an unsuspecting emergency responder who is forced to abandon his or her normal duties and adopt a role in the overall disaster response.

Unlike the organized disaster team member, if an emergency provider treats casualties from a disaster, it will most likely be because of an event that has occurred in his or her immediate area. Because of the random nature of disaster, it is not possible to predict who will be put into that role next. Therefore it is imperative for all who practice in emergency health services to have a working knowledge of the basics of disaster medicine and disaster management. In addition, especially with natural disease outbreaks and the escalation in perceived and real terrorist threats of 2014-2015, there are several possible natural or attack scenarios that may involve dangerous chemical, biological, or nuclear agents and modalities. A response to these events may also require a robust public health system and knowledgeable health care practitioners spanning all specialties. Most clinicians will have a very limited knowledge of many of these agents, so it is therefore important to educate our potential disaster responders on their specifics.

The field of disaster medicine involves the study of subject matter from multiple medical disciplines. Disasters may result in varying injury and disease patterns, depending on the type of event that has occurred. Earthquakes can cause entrapment and resultant crush syndrome; tornados may cause penetrating trauma from flying debris; and infectious disease outbreak, either natural or intentional, can result from many different bacteria, viruses, and fungi. Because of the potential variability in casualty scenarios, the disaster medicine specialist must have training in the many injury and illness patterns seen in disaster victims. Even though the expanse of knowledge required is vast, the focus on areas specifically related to disaster medicine allows the science to be manageable. The study of disaster medicine should not be undertaken without prerequisite medical training. A disaster medicine specialist is always a practicing clinician from another field of medicine first and a disaster specialist second. By integrating these many disciplines, one is better prepared for the variety of injury and illness patterns that may be faced.

Finally, disaster medicine presents unique ethical situations not seen in other areas of medicine. Disaster medicine is predicated on the principle of providing care to the most victims possible, as dictated by the resources available and by patient condition and likelihood of survival. This amounts to a balance of needs versus assets, an equation that can change over time as more resources are pulled into the response. Thus the triage of patients in disasters is fluid and should be repeated regularly. Disaster triage involves assigning patients into treatment categories based on their predicted survivability. This triage process may dictate that the most severely injured patient is not given medical care but rather, it is given to a less critically injured patient. To the best of his or her ability, the triage officer must make a determination as to whether, in the environment of the specific disaster and the availability of resources, a given patient has a significant probability of survival or does not. If it is the latter, disaster triage principles mandate that care be given to the patient with a higher likelihood of survival. This basic disaster triage principle can have a profound psychological effect on the care provider. As a physician, one is trained to render care to the sick and not to leave the side of a needy patient. To deny care to a critically ill or injured patient can be one of the most emotionally stressful tasks a disaster medicine specialist performs.

The unique and ever-changing circumstances under which disaster medicine specialists operate mandate the continued evolution and vigorous pursuit of academic excellence in this new specialty. A comprehensive approach that unifies medical principles with a sound understanding of disaster management procedures will yield a well-rounded and better-prepared disaster responder. If emergency medicine providers around the world can develop a basic understanding of the fundamental principles of this specialty, great advances in the systems included in the disaster cycle will surely follow. The more widely dispersed this knowledge becomes, the better prepared we are as a society to respond to the next catastrophic event.

REFERENCES

1. Wattanawaitunechai C, Peacock SJ, Jitpratoom P. Tsunami in Thailand-disaster management in a district hospital. *N Engl J Med*. 2005;352 (10):962–964.
2. Nufer KE, Wilson-Ramirez G. A comparison of patient needs following two hurricanes. *Prehospital Disaster Med*. 2004;19(2):146–149.
3. Kirsch T, Sauer L, Guha Sapir D. Analysis of the international and US response to the Haiti Earthquake: recommendations for change. *Disaster Med Public Health Prep*. 2012;6(3):200–208.
4. Gutierrez de Ceballos JP, Turegano Fuentes F. Casualties treated at the closest hospital in the Madrid, March 11, terrorist bombings. *Crit Care Med*. 2005;33(1 Suppl):S107–S112.

5. Simon R, Teperman S. The World Trade Center attack: lessons for disaster management. *Crit Care*. 2001;5(6):318–320.
6. Lowell JL, Wagner DM, Atshaber B, et al. Identifying sources of human exposure to plague. *J Clin Microbiol*. 2005;43(2):650–656.
7. Timen A, Sprenger M, Edelstein M, Martin-Moreno J, McKee M. The Ebola crisis: perspectives from European Public Health. *Eur J Public Health*. 2015.
8. United Nations International Strategy for Disaster Reduction. Available at: http://www.unisdr.org/we/inform/terminology.org.master.com/texis/master/search/mysite.txt?q=disaster+preparedness&order=r&id=60413a1214953850&cmd=xml.
9. Dara SI, Ashton RW, Farmer JC, Carlton Jr. PK. Worldwide disaster medical response: an historical perspective. *Crit Care Med*. 2005; 33(1 Suppl):S2–S6.