



# DISASTER MEDICINE

SECOND  
EDITION

**David E. Hogan**  
**Jonathan L. Burstein**



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# *Disaster Medicine*

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*Second Edition*

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*Dedicated to the victims of September 11 and all other terrorist acts  
And to the billions who have suffered from disasters throughout history.  
You are not forgotten*

*To the victims of natural and intentional disasters throughout the world  
May we remember that we must not stand by watching as our neighbor suffers*

*And to those who have responded to the call and will again:*

*“Take up our quarrel with the foe:  
To you from failing hands we throw  
The torch; be yours to hold it high.”*

*Quotation from “In Flanders Field”  
By John McCrae*

*To my daughter Abigail, who reminds me each day of what we are here for.  
To my wife, Aimee, and my mother, Eleanor, may Abigail emulate their  
character and deeds.*

*To my father and mother, who showed me the right path.*

*To my four brothers, who helped keep me on that path.*

*To my wife Aimee, a woman of valor, who gives me the love and strength to  
face each day.*

*–Jonathan L. Burstein*

*To all who suffered and fought disaster from the beginning of civilization  
because we are all one against the foe.*

*To those who seek to know this foe to defeat it.*

*To those who fight the human disaster of terrorism.*

*If in a million years the remains of our civilization are found by some curious  
minds, they will know that good dwelt amidst the evil and that we did pass  
this way.*

*–David E. Hogan*



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# PREFACE

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It is an honor to have the opportunity to present a second edition of *Disaster Medicine*. The response to our work in the United States and worldwide has been both gratifying and humbling. We have made substantial changes to the content and format of the book in response to recommendations by users of this text. We hope that these changes will make *Disaster Medicine* more usable. Just as the first edition was an initial effort to collect scientific and clinically useful elements of the practice of disaster medicine into a single location, this second edition is a continuation of that effort. As disasters are continually changing, so do the challenges associated with mitigation of the human impact of those disasters. We hope to improve the quality and content of this text in future years to meet some of those challenges.

My portion of this work I dedicate to Ted Kellison, RN, BSN, who left us last year, a casualty of the struggle. He was truly an “old soul” and we all came to benefit from his wisdom. All of us who knew Teddy miss him. He was one of those individuals who truly did make a difference in every life that he touched. So in his words:

“This book belongs to everyone who has longed to make a difference, to everyone who fights the demon of disaster on any front, to everyone who has looked out over a refugee camp of ten thousand souls knowing that despite your best efforts hundreds will die before sunset, and to those whose rough hands have pulled the child from the rubble and stood crying from both exhaustion and joy. You are not alone.”

*David E. Hogan, DO, MPH, FACEP*



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and for giving me the opportunity to learn while teaching her students.

And to the citizens and emergency responders of New York City, thank you for allowing me to help you in your time of need and for being so giving and caring to a single stranger as your world was falling apart.

*—Jonathan L. Burstein*

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*—David E. Hogan*

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# General Concepts

## Chapter 1

### Basic Perspectives on Disaster

*David E. Hogan and Jonathan  
L. Burstein*

*Knowledge comes, but wisdom lingers.  
Alfred Lord Tennyson*

#### INTRODUCTION

Worldwide, more than 3.4 million lives were lost owing to disasters over the past quarter century. Hundreds of millions of people endured diverse suffering caused by these events, and tens of billions of dollars helped repair the damage and reconstruct those lives. Although many societies reached out to others in need in the past, not until the latter part of the last century have highly organized efforts been created to assist with disaster response.

#### People in Disasters

To call an event a disaster, people must be affected. The risk of disasters producing mass casualties worldwide is increasing, in large part because of the increase in world population (1). The world population reached an estimated 6 billion on November 16, 1999. With a steady growth of approximately 1.33% (78 million people each year), current projections are that the population will be 8.9 billion by 2050 (2). Most individuals are living in areas that are prone to hurricanes, earthquakes, tsunamis, floods, and drought. As such, the potential for human impact from these natural hazards is growing accordingly.

#### Natural Hazards

The rate of occurrence of events associated with natural hazards on earth may be increasing; this is probably due to variations in innate cycles, such as solar maxima, earthquakes, and volcanic activity (3). In addition, the earth is warming, which, at a minimum, is projected to increase severe storm activity in some areas and to cause drought in others (4). Other indications are that the range of diseases and disease-carrying vectors is expanding because of warming, bringing a number of infectious diseases to nonimmune populations (5–8). In addition, changes in growing seasons, weather conditions, and ambient temperature and humidity are beginning to impact food supplies, allergen production, and other human health issues (5–9).

#### Technological Hazards

The technological development of human society has resulted in the creation of an entirely new set of hazards, such as industrial waste and radiation and chemical disasters. Tons of hazardous materials are transported through densely populated areas each day, with each ton representing a latent disaster (10,11). Humankind's increasing development and dependence on a rather fragile industrial–technologic complex presents new possibilities for disaster. The information systems that operate our economic, transportation, and distribution systems and regulate our lives are relatively sensitive to disruption. Failure of these systems for even a short period may induce fear and injury into a population. Hurricanes Katrina and Rita have clearly demonstrated that even local destruction of such computer-based information systems adds substantially to the impact of such a natural disaster (12).

#### Human Conflict

Humankind continues to be its own worst enemy. Will Rogers said it this way in his autobiography, “You can’t say civilization don’t advance . . . in every war they kill you in a new way” (13). With wars both great and small

occurring at regular frequency on earth, and now a global war against terrorism, ample opportunity is found for “advancement.” These activities create, both directly and indirectly, numerous casualties that require medical care, public health, and psychological management (14–16). The creation of weapons of mass destruction and the real and the potential use of these devices against human populations represent a new and increasingly complex problem for emergency health care providers (17).

## THE NATURE OF DISASTERS

Disasters are generally considered “low probability–high impact” events. In fact, only a few disasters in the United States have resulted in more than 1,000 casualties (18). When disaster does strike, only 10 to 15 disasters a year result in more than 40 casualties. These statistics are often used to defer funding for disaster planning efforts in lieu of other projects. However, in fact, the impact of disaster in the United States and worldwide is much more significant than these narrow statistics imply. For instance, although Hurricane Andrew killed only 44 individuals directly, it affected the lives of almost 3 million people, caused more than 3 billion dollars in damage, and involved significant national resources for rescue and recovery efforts (19). The disruption of the normal lives of the population measures the true impact of a disaster. Medical infrastructure may be totally disrupted during a disaster, thereby requiring time to reestablish normal function. Recovery efforts to repair a disaster-stricken community and the psychoemotional damage may last for years.

### Defining a Disaster

Because of the multidisciplinary nature of disaster planning and response, the definition used for a disaster is often as varied as the discipline using it (20). Examples of disaster definitions are found in various sources. Usually each definition reflects the nature and focus of the organization or individuals defining it. The World Health Organization (WHO) defines a disaster as “a sudden ecological phenomenon of sufficient magnitude to require external assistance” (21). This broad focus definition may exclude some events that result in mass casualties. A more focused definition often used by practitioners of emergency medicine is when “... the number of patients presenting within a given time period are such that the emergency department cannot provide care for them without external assistance.” This definition would exclude events such as aircraft crashes that result in mass death but place little or no stress on the medical system (22). Others may define disasters as “an imbalance in the availability of medical care and a maldistribution of medical resources versus casualties within a community” (23). Most emergency

health care providers have some definition in mind regarding disasters, but more commonly the response is simply that they “know a disaster when they see one.”

Disasters are not defined by a specific number of casualties but rather by the event itself and the venue in which it occurs. A motor vehicle crash with five casualties in a metropolitan area will likely go unnoticed except as a footnote in the evening paper. The same crash casualties presenting to a rural community emergency department (ED) will probably require activation of the hospital disaster plan. In all definitions, disasters are something outside the normal experience of daily life that requires a change from daily management style and thinking.

## Disaster Medicine

*Disaster medicine* is a system of study and medical practice associated primarily with the disciplines of emergency medicine and public health. Disaster medicine is concerned with the health and medical and emotional issues of disaster casualties. To provide care efficiently, however, the health care provider must be familiar with several elements of disaster management, including planning, mitigation, assessment, response, and recovery. Disasters may destroy or disable the medical infrastructure of a given area, making access to routine health care impossible. Infectious diseases endemic to the population may increase in frequency, mandating the deployment of epidemiological surveillance and intervention programs. Nutritional problems that necessitate evaluation and intervention can surface, particularly during long-duration complex disasters. Long-term and short-term emotional and psychiatric conditions may plague the disaster-stricken community, requiring counseling and well-planned support systems.

When using the broad definition of disaster medicine, one must realize that no individual can be facile in all elements of this topic. Finding any true expert in disaster medicine is difficult if one uses such a broad definition. Analogous to the observation of World War II correspondent Ernie Pyle that, to the individual soldier, the war was rarely bigger than 100 yards on either side (24), those in disaster medicine would acknowledge that, although each may become skilled in his or her 100 yards of a disaster, one needs a larger view to improve planning and response significantly.

## Emergency Medicine Role in Disaster Medicine

Emergency physicians, nurses, and paramedics in the United States have commonly been drawn to disaster medicine. These health care providers represent the first line of medical defense in a community, and they are usually the first to know of a disaster impact. The *American College of Emergency Physicians* (ACEP) states, “emergency



physicians should assume a primary role in the medical aspects of disaster planning, management, and patient care.” Additionally ACEP believes that emergency physicians should . . . pursue training that will enable them to fulfill this responsibility” (25–27). The knowledge base and skill sets afforded to the resident during training in emergency medicine, as well as the broad and adaptive practice environment of the specialty, translates well to the disaster setting.

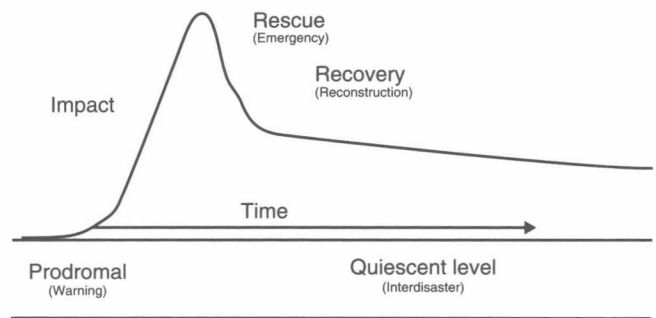
On the converse, emergency medicine in no way has the only knowledge or skill sets needed during a disaster. An appropriate medical response will vary substantially based on the nature and extent of the event. The provision of health care after a disaster is dependent on multiple areas of medical expertise, such as public health, primary care, surgery, infectious diseases, toxicology, and many others.

## DISASTER – BASIC “PHYSICS”

A set of repeating elements have been identified over the years during most disasters that make up the disaster process. These elements have been variously described, tongue-in-cheek, as the *Basic Physics of Disasters* and they may constitute a set of principles on which one’s understanding of disasters can be built. The primary sets of problems consistently seen during disasters are with communications, personnel, and supplies (28). The activities that result within these three major areas represent a set of human behaviors that are quite persistent. Some disaster plans have sought to oppose these behaviors during a disaster and have met with variable success. A more reasonable approach might be to start by understanding these behaviors more fully. Once they are understood, planning may take the form of channeling these behaviors into activities that are more constructive, rather than opposing the strong force of mass human will.

## The Disaster Cycle

Each disaster follows a general pattern in its development. This pattern is often repeated throughout nature and is demonstrated in Fig. 1-1. This identified pattern has been termed the *Disaster Cycle* or *Disaster Life Cycle* and represents much of the basis for planning, response, and research into disasters (29). The phases of disasters have been variously defined and described. All the divisions of the life cycle of a disaster are artificial as one phase of a disaster merges with another. However, dividing disasters into phases is useful from both a response and research point of view (21,30,31). Disaster planning, response, and research may be simplified by using the disaster cycle as a model for these complex events.



**FIGURE 1-1.** General phases of the disaster life cycle.

### Quiescent Phase

Initially, a *quiescent* level or interdisaster period is seen during which the combinations of events that will eventually lead to the disaster are occurring. Although the disaster in the making may not be obvious, the underlying cause of the disaster may be readily apparent. Disaster risk assessment techniques may be of benefit during this period in predicting what types of local hazards may result in a disaster.

### Prodrome Phase

A *prodrome* or warning phase develops next and lasts a variable amount of time depending on the disaster type. The warning period represents a time during which a particular event (e.g., a hurricane, volcanic eruption, or armed conflict) is clearly likely to occur. Steps may be taken during the warning period to mitigate the effects of the event. During this phase, public warnings and protective action, such as sheltering and evacuation, may occur.

### Impact Phase

The impact phase coincides with the occurrence of the event. This phase may be short as in an earthquake or prolonged as in famine. Usually, little can be done to decrease the impact of the disaster on human populations if prior steps have not been taken. Even protective behaviors, such as sheltering during a tornado, require previous education and warning programs. Proper planning and reasonable preemptive actions will have the greatest effect in decreasing the impact of the actual disaster-causing event.

### Rescue Phase

The rescue phase (also known as the *emergency*, the relief, or the isolation phase) represents a time during which immediate assistance can save lives. During this time, people may be salvaged by first responder actions, search and rescue, and basic and advanced life-support methods. This period often depends on bystander rescue as the

local search and rescue agencies (if they exist) may be overwhelmed or incapacitated.

### Recovery Phase

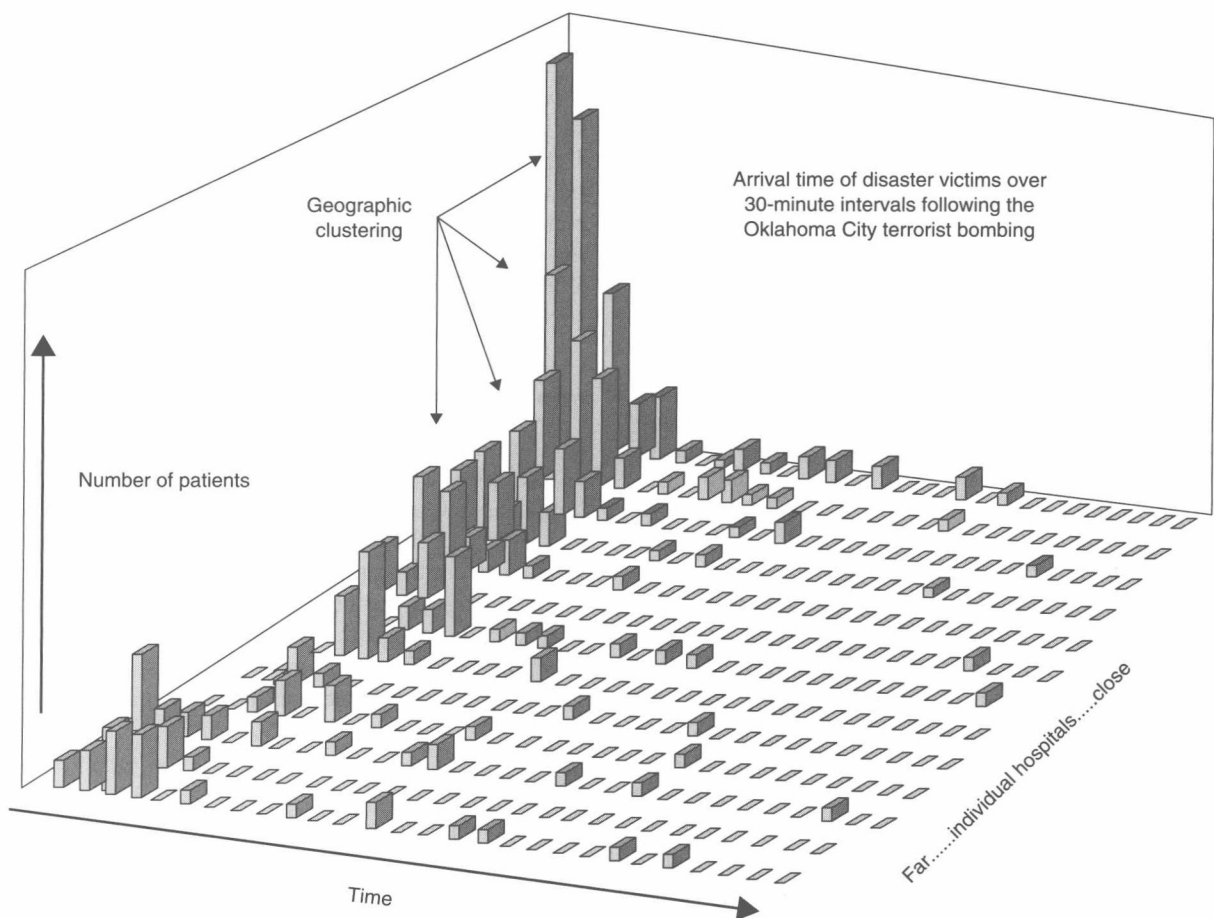
The recovery or reconstruction phase has been variously subdivided, but it can be considered as a single entity. This phase consists of all the required actions and elements (e.g., emergency medical services [EMSs], public health, engineering, social services) needed to return the population to a functional society. This period may last months or years, and it resolves with the community returning to the quiescent or interdisaster phase.

### The Geographical Effect

A well-known truism for disasters in most regions of the world is that the closest health care facilities to the disaster site will be the ones most significantly impacted by casualties. This is of clinical and statistical significance, and is illustrated in Fig. 1-2 from the casualty distribution of the Oklahoma City bombing (32). The geographical

effect results from a number of factors. Casualties capable of self-extrication and transport usually travel to the closest facility for care by whatever means is available. Laypersons assisting nonambulatory casualties will usually transport them to the closest facility. Some casualties go to the closest facility out of loyalty to the hospital or for financial reasons.

Prehospital personnel contribute to the geographical effect. In the process of triage by first responders, casualties are commonly brought to the EMS triage field location by laypersons. These casualties may already be loaded in the back of pickup trucks or other vehicles. If the casualty is stable and there is a lack of immediate EMS transport, the layperson drivers are often directed to take the casualty to the closest facility (33). In addition, after triage and initial treatment, prehospital personnel often transport casualties to the closest facility because of concerns about patient stability, familiarity with the local ED, and hopes of achieving a short turnaround time and thereby a rapid return to the field to assist in the response.



**FIGURE 1-2.** The geographic phenomenon with more cases arriving at closer hospitals in a shorter period during the Oklahoma City bombing.

The geographical effect may result in a substantial maldistribution of casualties throughout the community. The closer facilities may be overwhelmed with patients, whereas other facilities are almost idle. Most disaster plans for EMS contain mechanisms to decrease the impact of the geographical effect, such as transporting some critical casualties to farther facilities or putting priority 3 casualties on buses and taking them to more distant EDs for treatment. Such actions have met with limited success, probably because they go against human nature. How many, after losing their home and means of transport, are going to be willing to be placed on a bus and taken to an unfamiliar hospital on the other side of town? Further research into the causes of the geographical effect may lead to innovative plans to blunt its impact by accepting these acts of human nature and planning for them. Community planning for rapid upstaffing of impacted facilities by special credentialing of health care providers along with augmentation of supplies may be one partial solution.

### The Dual-Wave Phenomenon

Casualties generally arrive for care at EDs after a disaster in two waves (28,34). The first wave of patients usually begins appearing within 15 to 30 minutes of the impact of the disaster. It is comprised primarily of the walking wounded or priority 3 casualties due to the fact that they were able to self-extricate and walk or drive to the ED. Then, within a variable time (on average, 30–60 minutes), a second wave of casualties begins to arrive. These casualties are typically unable to get to the ED by themselves because of the need for extrication or transport and the severity of their injuries. This second wave consists mostly of priority 1 and priority 2 casualties. This effect seems to be more pronounced in facilities that have been more heavily impacted by the geographical effect (32). The danger is in overloading an ED with priority 3 and priority 2 casualties from the first wave before the arrival of the more critical cases in the second wave. Adherence to good triage principles can decrease the impact of the dual-wave phenomenon on a facility. In addition, recognition of the potential for the dual wave by EMS, coupled with enhanced communication protocols from prehospital to ED components, may improve transport coordination of casualties. Although usually noted, the dual-wave phenomenon is not always seen at each facility depending on the nature of the disaster and the location of the facility in relation to the disaster location (35).

### The Babel Effect

The most common problem associated with any disaster is a failure in communications (28). This breakdown is

due to the sudden increase in the volume and the need to communicate on the part of impacted public, responders, and witnesses of a disaster. Landline telephones are not capable of managing a high percentage of users at one time. The result is a rapid saturation of the available circuits and a jamming of the telephone lines. Cellular telephones suffer a similar fate as the available cells are quickly engaged with high-volume traffic. In addition, landline facilities and cellular towers may be destroyed. Disaster communication plans that rely on cellular or landline telephones alone have high risk for failure.

Radio communication technology is commonly employed by emergency and disaster response agencies. However, with this technology, the increased volume of radio traffic also overwhelms the limited number of frequencies available to emergency responders. In addition, local radio equipment specifically set aside for disasters usually has not been maintained. Therefore, dead batteries and electronic component deterioration are a common problem. Moreover, the personnel who suddenly need to use the radio equipment are often not properly trained. After-action reports of disasters often note a lack of ability to communicate between various agencies due to the absence of shared frequencies (18). Despite these reports, many agencies never correct this problem before the next disaster.

Another common problem is the lack of clear speaking during a disaster. Most agencies rely on various codes during radio transmissions to shorten the duration of the call and to specify complex meanings. Unfortunately, radio codes often vary from region to region and from agency to agency. During the 1995 Oklahoma City bombing, an EMS inquiry as to the status of one hospital brought the reply "We are on Code Black!" The EMS dispatch understood this to mean the hospital could take no more patients and advised all EMS units to divert from this facility. In reality, "Code Black" was the term used at this hospital to indicate that it was ready to receive multiple patients (23). This simple misunderstanding resulted in a temporary overload of a neighboring hospital with EMS-transported casualties. Code talking should be avoided during a disaster in favor of clear speaking, in accordance with the old adage, "Say what you mean and mean what you say."

Communications is one area where new technology may have a profound impact on the ability to respond to a disaster. Once the human behaviors and system needs behind disaster communication problems are understood, new adaptive technologies may be created to minimize obstacles (see Chapter 14).

### The Federation Effect

The helping response of individuals to victims of disasters is impressive. Like the mythical Federation of Star Trek, humans are a species of "Captain Kirks and Kathryn