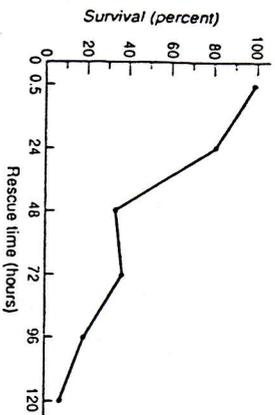


**Figure 4-1.** Epicenters of significant earthquakes in the United States, 1970. (Reproduced from: Centers for Disease Control: *The Public Health Consequences of Disasters*, United States Department of Health and Human Services Public Health Service, Centers for Disease Control, 1989.)



**Figure 4-2.** Survival rates versus rescue time for victims trapped in the Tangshan earthquake, 1976. (Adapted from Smith GS: Research issues in the epidemiology of injuries following earthquakes. In: *International Workshop on Earthquake Injury Epidemiology from Mitigation and Response*. Johns Hopkins University, 1989.)

be considerable, as are secondary effects on crops, sanitation, and vector-borne infections. When casualties occur, they are usually due to drowning.

By contrast, developing countries with poor watershed management and rapid growth of agriculture and urban development on floodplains have seen large number of casualties in isolated events. Casualties from secondary effects, such as famine, have occasionally been large (eg, in Bangladesh). Mitigation (eg, through watershed engineering projects and limiting development on floodplains) and early warning are the most effective means of reducing deaths.

### Tsunamis

Tsunamis are tidal waves due to sudden geologic events occurring at sea, such as earthquakes and volcanic eruptions. A giant wave of water results that may travel from the epicenter at hundreds of miles per hour. The onset is often heralded by a sudden ebb of water that exposes the sea floor and is followed in minutes by a wall of water that may rise to 100 feet. Massive damage occurs

to the shore and structures; casualties are due to drowning. Mitigation by building sea walls and locating structures on high ground and through early warning are the only effective means of reducing casualties.

### Volcanoes

Volcanoes are channels of molten rock (magma) from deep in the earth that vent to the surface in one of several forms. They may cause eruptions of molten rock (lava) or spew ash and debris. Volcanoes tend to be localized to the boundaries of tectonic plates (eg, the Pacific Rim). Injury is most commonly due to falling debris, collapse of structures under the weight of ash, being buried in mudslides or lava flows, or toxic effects of gases (eg, carbon dioxide, hydrogen sulfide). Effects on agriculture and property can be extensive. In many cases, early warning, although imprecise, can allow evacuation and mitigate casualties.

Hogan DE, Atkins DC, Osburn AE: The May 3, 1999 tornado in Oklahoma City. *Ann Emerg Med* 1999;34:225. [PMID: 104244927] (Good account of emergency room events during this disaster, outlining many of the problems encountered.)

Petig K et al: Earthquake disasters—lessons to be learned. *Int Med Assoc J* 2002;4:361. [PMID: 120408261] (A review of earthquake disasters and planning.)

## NONNATURAL DISASTERS

### Fires

Collectively, fires produce approximately 5000 deaths and 300,000 injuries each year in the United States, although the number has been on a steady decline since the 1950s. Under the right conditions, hot gases can produce winds that collect in a rotating cyclone (called a fire storm). Most deaths are due to asphyxiation from carbon monoxide and other toxic gases and to burns.

### Transportation Accidents

Transportation accidents are the most common incidents producing multiple casualties in the United States. Airplane crashes produce a high ratio of fatalities to total injuries; highway accidents have the opposite characteristic. Railway accidents may produce significant injuries if passengers are involved and also have resulted in release of hazardous materials.

Transportation accidents are the prototypical geographically localized multicausal events practiced in most communities' disaster drills. They are realistically apt to occur, and they lend themselves to management within the jurisdiction and structure of local emergency medical services (EMS).

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The patterns of injury are well known to most emergency workers and consist of fractures, contusions, lacerations, and head and thoracoabdominal blunt injury.

### Industrial Accidents

Industrial accidents that cause large-scale disasters most commonly result in the release of a hazardous material. The most notorious occurred in 1984 in Bhopal, India, where a release of methyl isocyanate killed more than 2000 and injured up to 200,000.

Injuries vary depending on the nature of the agent. Asphyxia, respiratory distress, skin and eye irritations, neurologic abnormalities, or teratogenic effects may occur.

### Radiation & Nuclear Accidents

Aside from the atomic explosions in Japan in World War II, few deaths have resulted from nuclear disasters, although several significant incidents have occurred. The most deadly was the 1986 Chernobyl reactor explosion in the former Soviet Union, in which 27 people died and 135,000 were evacuated, many of whom were exposed to high radiation levels.

In nuclear accidents, injuries are due to the immediate blast effects, to exposure to toxic chemicals used at reactor sites (eg, sulfuric acid, chlorine, ammonium), and to radiation exposure.

### Structural Collapse & Explosions

Structural failure of a building or man-made structure can be precipitated by natural forces (eg, earthquake) or may occur unexpectedly (eg, the Hyatt skywalk collapse in Kansas City, 1981; 113 dead, 200 injured). However, most such events in the United States have been limited in scope and have not produced many casualties. Injuries are predictable and consist of head injuries, fractures, lacerations, and blunt thoracoabdominal injuries.

### Acts of Violence

Unfortunately, acts of violence do occur in the United States. Whereas casualties can be massive in armed conflicts (primarily due to explosives), in the civilian arena they are usually limited to a small number. Injuries are usually penetrating-type trauma.

### Acts of Terrorism

(See Chapter 3.) Given the September 11, 2001 attack on the World Trade Center, the prior bombing there in the parking structure, the bombing of the Murrah Federal Building in Oklahoma City in 1995, the same gas